Methodological and technical perspectives on e-governance

Bo Sundgren
2013-10-15

Contents

INTRODUCTION ......................................................................................................................... 9

AN INTRODUCTION TO ENTERPRISE ARCHITECTURES (EA) ................................. 10
  Historical background ........................................................................................................ 10
  Some definitions ................................................................................................................ 10
  Scope ................................................................................................................................... 10
  Methods and tools ............................................................................................................. 11
  Top four EA methodologies ............................................................................................. 11
  The Zachman Framework ................................................................................................. 12
  TOGAF’s Enterprise Architecture .................................................................................... 13
  Gartner EA Process Model ............................................................................................... 14
  The Federal Enterprise Architecture (FEA) ........................................................................ 15
  Typical concepts and terms in EA practice ....................................................................... 16
  Service Oriented Architecture (SOA) ................................................................................ 17
    SOA as an extension to EA ............................................................................................. 17
    What is a Service Oriented Architecture (SOA)? ......................................................... 19
    SOA and legacy systems: using “sarchophaguses” .................................................... 20
  Enterprise architectures and the systems approach ....................................................... 21
    SOA, process-orientation, object-orientation, and the systems approach .................... 21
    Basic concepts of the Systems Approach .................................................................... 21
    Different types of systems ............................................................................................. 23
  Enterprise architectures (EA) and information systems .................................................. 23
    Enterprises where information management is the business ....................................... 24
  Literature ............................................................................................................................ 24

USING MODELS FOR THE DESIGN OF E-GOVERNANCE AND E-SERVICES ........ 26
  Introduction ......................................................................................................................... 26
  Modelling the universe of discourse for different purposes .......................................... 27
    Object systems ................................................................................................................. 27
    Society as seen through the glasses of official statistics .............................................. 28
  Data modelling .................................................................................................................. 38
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modelling the concepts of a business and their relations</td>
<td>38</td>
</tr>
<tr>
<td>Transforming a conceptual model to a relational data model</td>
<td>43</td>
</tr>
<tr>
<td>Multidimensional models and star models</td>
<td>48</td>
</tr>
<tr>
<td>Process modelling</td>
<td>51</td>
</tr>
<tr>
<td>Introduction</td>
<td>51</td>
</tr>
<tr>
<td>Business processes and task units</td>
<td>51</td>
</tr>
<tr>
<td>The Rent-A-Video case</td>
<td>52</td>
</tr>
<tr>
<td>Business landscape</td>
<td>57</td>
</tr>
<tr>
<td>What is a business process?</td>
<td>58</td>
</tr>
<tr>
<td>Process types</td>
<td>60</td>
</tr>
<tr>
<td>Business objects</td>
<td>63</td>
</tr>
<tr>
<td>Modelling business processes</td>
<td>68</td>
</tr>
<tr>
<td>Products and services</td>
<td>71</td>
</tr>
<tr>
<td>Modelling a company</td>
<td>73</td>
</tr>
<tr>
<td>Internet and business processes</td>
<td>74</td>
</tr>
<tr>
<td>Literature</td>
<td>75</td>
</tr>
<tr>
<td>INFORMATION SYSTEMS FOR CONCERTED ACTIONS</td>
<td>79</td>
</tr>
<tr>
<td>Introduction</td>
<td>79</td>
</tr>
<tr>
<td>Information and Data</td>
<td>79</td>
</tr>
<tr>
<td>Reality as a Mental Model and Social Construction</td>
<td>81</td>
</tr>
<tr>
<td>Information Processing and Data Processing</td>
<td>82</td>
</tr>
<tr>
<td>Human Interaction: Communication, Co-operation, and Conflicts</td>
<td>83</td>
</tr>
<tr>
<td>Direct and Indirect Communication</td>
<td>84</td>
</tr>
<tr>
<td>Communication over Time and Space</td>
<td>85</td>
</tr>
<tr>
<td>Sharing of Data and the Need for Metadata</td>
<td>86</td>
</tr>
<tr>
<td>Concerted Actions Towards Goals</td>
<td>86</td>
</tr>
<tr>
<td>Human Beings and Computers</td>
<td>87</td>
</tr>
<tr>
<td>Implications for Computerised Information Systems</td>
<td>89</td>
</tr>
<tr>
<td>Metadata</td>
<td>90</td>
</tr>
<tr>
<td>Data Systems as Business Infrastructure</td>
<td>92</td>
</tr>
<tr>
<td>Operative and Directive Data Systems</td>
<td>93</td>
</tr>
<tr>
<td>Information and Data System Tools</td>
<td>96</td>
</tr>
<tr>
<td>Conclusion</td>
<td>96</td>
</tr>
<tr>
<td>References</td>
<td>97</td>
</tr>
<tr>
<td>WEB PORTALS</td>
<td>98</td>
</tr>
<tr>
<td>What is a web portal?</td>
<td>98</td>
</tr>
<tr>
<td>Different types of web portals</td>
<td>100</td>
</tr>
</tbody>
</table>
CLOUD COMPUTING

DATA MODELLING

CLOUD COMPUTING
Similar concepts .................................................................................................................. 122
Different types of clouds: private, public, community, hybrid ........................................ 123
  Private cloud .................................................................................................................. 123
  Public cloud .................................................................................................................. 123
  Community cloud .......................................................................................................... 124
  Hybrid cloud .................................................................................................................. 125
Issues .................................................................................................................................. 125
  Threats and opportunities of the cloud ........................................................................ 125
  Privacy ............................................................................................................................. 126
  Compliance ....................................................................................................................... 126
  Legal .................................................................................................................................. 127
  Vendor lock-in .................................................................................................................. 127
  Open source ..................................................................................................................... 128
  Open standards ............................................................................................................... 128
  Security ............................................................................................................................. 128
  Sustainability .................................................................................................................... 129
  Abuse .................................................................................................................................. 129
  IT governance .................................................................................................................. 129
  Consumer end storage ................................................................................................... 130
  Ambiguity of terminology ............................................................................................. 130
  Performance interference and noisy neighbours ......................................................... 130
  Monopolies and privatization of cyberspace ................................................................. 130

BIG DATA ............................................................................................................................. 132
  Big Data: definitions and characteristics ...................................................................... 132
  Examples of Big Data ..................................................................................................... 133
    Big science .................................................................................................................... 133
    Science and research .................................................................................................... 133
    Government .................................................................................................................. 134
    Private sector ............................................................................................................... 134
    International development .......................................................................................... 134

BUSINESS INTELLIGENCE .................................................................................................. 136
  History ............................................................................................................................. 136
  Business intelligence and data warehousing ............................................................... 136
  Business intelligence and business analytics ............................................................... 137
  BI applications in an enterprise ..................................................................................... 137
  Prioritising and increasing the benefits of business intelligence projects ..................... 138
  Success factors of implementation ................................................................................. 138
Management commitment ................................................................. 138
Business needs ................................................................................ 139
Amount and quality of available data ................................................. 139
User aspects ...................................................................................... 140
BI Portals .......................................................................................... 140
Marketplace ....................................................................................... 141
Structured, semi-structured, and unstructured data ......................... 141
The use of metadata .......................................................................... 142

**VISUALISATION** ........................................................................... 143
Definition and purpose of data visualisation and information visualisation ......................................................................................... 143
Information visualisation .................................................................... 143
Definition and analysis of infographics .............................................. 144
Overview ............................................................................................ 144
Analysis ............................................................................................... 144
Scope of data visualisation .................................................................. 145
Different types of visualisations ......................................................... 146
Time-series ......................................................................................... 146
Statistical distributions ...................................................................... 146
Maps ................................................................................................... 147
Hierarchies ......................................................................................... 147
Networks ............................................................................................ 147
Visualisation tools .............................................................................. 148
Related fields ..................................................................................... 149
Data acquisition ................................................................................ 149
Data analysis ...................................................................................... 149
Data governance ................................................................................. 150
Data management .............................................................................. 150
Data mining ....................................................................................... 150
Data presentation architecture ........................................................... 150
Objectives .......................................................................................... 150
Scope .................................................................................................. 151
Visualisation of statistical data: four examples .................................. 151
Example 1. Trendalyzer, Gapminder ................................................. 152
Example 2. Statistics eXplorer, NcomVA .......................................... 153
Example 3. The factlab, Mike Andersson .......................................... 154
Example 4. Google Public Data Explorer, Ola Rosling .................... 155

**INFRASTRUCTURES** ..................................................................... 156
Definitions and characteristics .............................................................. 156
Hard and soft infrastructures .................................................................. 157
  Hard infrastructures ........................................................................... 157
  Soft infrastructures ............................................................................. 158
Organising and managing registers, databases, and information systems .... 159
  Registers and databases ..................................................................... 159
  Metadata and conceptual models ....................................................... 162
  Literature ............................................................................................ 163
More about the concept of “infrastructure” .............................................. 163
  Uses of the term “infrastructure” ........................................................ 163
  Typical attributes of infrastructures .................................................... 164
Bibliography ............................................................................................. 166

E-LEARNING, NET-BASED LEARNING, AND SELF-LEARNING ................. 170
  An overview of concepts and terms ........................................................ 170
  Next Generation Learning (NGL or NxGL) .......................................... 171
  Flexible learning .................................................................................. 172
  Distance education and distance learning .......................................... 173
  E-learning ............................................................................................ 174
  Networked learning ............................................................................. 174
  Collaborative learning ........................................................................ 175
  Virtual education ................................................................................ 175
  Virtual campus ................................................................................... 177
  Virtual university ................................................................................ 178
  Open universities ................................................................................ 179
  Open Educational Resources (OER) ..................................................... 179
  Massive Open Online Courses (MOOC) .............................................. 179
  Self-learning ......................................................................................... 180
  Application .......................................................................................... 180
  Corporate and professional ................................................................. 181
  Teaching teaching & Understanding understanding ............................... 181

E-BUSINESS AND E-COMMERCE ............................................................ 182
  The difference between e-business and e-commerce ............................ 183
  Classifications of e-business and e-commerce ..................................... 184
    Internal/external ................................................................................ 184
    Business applications ....................................................................... 184
    Business models .............................................................................. 185
    Provider/consumer ............................................................................ 185
Governmental regulations ................................................................. 185
Global trends .................................................................................. 186
Impact on markets and retailers ....................................................... 186
See also ....................................................................................... 187
Potential concerns ......................................................................... 187
  Security ........................................................................................ 187
  Privacy and confidentiality ............................................................ 187
  Authenticity .................................................................................. 188
  Data integrity .............................................................................. 188
  Non-repudiation .......................................................................... 188
  Access control ............................................................................ 188
  Availability .................................................................................. 188
Common security measures ............................................................. 188
Physical security ........................................................................... 189
Data storage .................................................................................. 189
Data transmission and application development .......................... 190
System administration .................................................................... 190
Security solutions ........................................................................ 190
Access and data integrity ............................................................... 190
Encryption ..................................................................................... 191
Digital certificates ......................................................................... 191
Digital signatures ......................................................................... 191
Web browser discrimination .......................................................... 191

HEALTH CARE AND E-HEALTH .................................................... 192
  What is e-health? ......................................................................... 193
  E-health data exchange ................................................................ 194
  Early adopters ............................................................................ 194
  Mental health .............................................................................. 194
  Cybermedicine ........................................................................... 195

3D-PRINTING – TOWARDS A 3D-MODELLING AND MANUFACTURING
REVOLUTION IN E-SOCIETY .............................................................. 196
  Background of 3D printing, what it is and what it does.................. 196
  Exciting new applications and changing research climate ........... 196
  Upheaval of patents .................................................................... 197
  What 3D printing means for consumers ..................................... 197
  A new business model is facilitated / Maker movement / Open Source .. 198
  3D printers and the dangers that come with it ............................ 199
Introduction

This document contains separate articles about the following topics:

- Enterprise Architecture (EA), including Service-Oriented Architecture (SOA)
- Using models for the design of e-governance and e-services
- Information systems for concerted actions
- Web portals
- Cloud computing
- Big Data
- Business Intelligence (BI)
- Visualisation
- Infrastructures
- E-learning, net-based learning, and self-learning
- E-business and e-commerce
- Health care and e-health
An introduction to Enterprise Architectures (EA)
Bo Sundgren
2013-09-05

Historical background

According to Sessions (2007), it was shortly before 1990 that a new field was born that soon came to be known as enterprise architecture. The field initially began to address two problems:

1. **System complexity** – Organisations were spending more and more money building and maintaining IT systems

2. **Poor business alignment** – Organisations were finding it more and more difficult to keep those increasingly expensive IT systems aligned with business needs

Expressed in a bit more elaborated way, organisations experienced that:

- the IT systems were unmanageably complex and increasingly costly to maintain
- the IT systems were hindering the organisation's ability to respond to current, and future, market conditions in a timely and cost-effective manner
- mission-critical information was consistently out-of-date and/or just wrong
- a culture of distrust existed between the business and technology sides of the organisation

Some definitions

Here are three selected definitions from the literature:

1. **Weill (2007)**: ... the organising logic for business processes and IT infrastructure reflecting the integration and standardisation requirements of the company's operating model ... the desired state of business process integration and business process standardisation for delivering goods and services to customers

2. **United States Government (2007)**: ... defines the mission of an agency and describes the technology and information needed to perform that mission, along with descriptions of how the architecture of the organisation should be changed in order to respond to changes in the mission (United States Government)

3. **Gartner (2012)**: ... the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key requirements, principles and models that describe the enterprise's future state and enable its evolution

Scope

The term “enterprise” in “enterprise architecture” is a generic and potentially complex term:

- The term enterprise is generally applicable in many circumstances, including
  - Public or private sector organizations
  - An entire business or corporation
  - A part of a larger enterprise (such as a business unit)
  - A conglomeration of several organisations, such as a joint venture or partnership
  - A multiply outsourced business operation

Wikipedia (2012)
• The term *enterprise* includes the whole complex, socio-technical system, including:
  – people
  – information
  – technology
  – business (e.g. operations)

Giachetti (2010)

• Defining the boundary or scope of the enterprise to be described is an important first step in creating the enterprise architecture. “Enterprise” means more than the information systems employed by an organisation.

Giachetti (2010)

• Composing holistic solutions that address the business challenges of the enterprise and support the governance needed to implement them. Gartner (2012).

**Methods and tools**

According to Wikipedia (2012):

• Enterprise architects use various methods and tools to capture the structure and dynamics of an enterprise. In doing so, they produce taxonomies, diagrams, documents and models. These artifacts describe the logical organization of business functions, business capabilities, business processes, people organization, information resources, business systems, software applications, computing capabilities, information exchange and communications infrastructure within the enterprise.

• Normally an EA takes the form of a comprehensive set of cohesive models that describe the structure and functions of an enterprise.

• The individual models in an EA are arranged in a logical manner that provides an ever-increasing level of detail about the enterprise: its objectives and goals; its processes and organization; its systems and data; the technology used and any other relevant spheres of interest.

• An enterprise architecture framework bundles tools, techniques, artifact descriptions, process models, reference models and guidance used by architects in the production of enterprise-specific architectural description.

**Top four EA methodologies**

According to Sessions (2007) four of the most popular EA methodologies are:

• **The Zachman Framework for Enterprise Architectures**; Zachman (1987), Zachman&Sowa (1992) — Although self-described as a *framework*, is actually more accurately defined as a *taxonomy*

• **The Open Group Architectural Framework (TOGAF)**; The Open Group (2012) — Although called a *framework*, is actually more accurately defined as a *process*

• **The Federal Enterprise Architecture**; The White House (2007) — Can be viewed as either an implemented *enterprise architecture* or a *proscriptive methodology* for creating an enterprise architecture

• **The Gartner Methodology**; Gartner (2005) — Can be best described as an *enterprise architectural practice*
For many enterprises, none of these methodologies will be a complete solution. Another approach, a blended methodology, means choosing bits and pieces from each of these methodologies, and modify and merge them according to the specific needs of your organisation.

The challenge hasn’t changed: reducing IT cost and complexity, while increasing business value and effectiveness.

**The Zachman Framework**

DataGovernance.com (2008) summarises the Zachman Framework as follows:

“The Zachman Framework is a de facto world standard for expressing the basic elements of an Enterprise Architecture. It provides a formal and highly structured way of defining an enterprise that allows people to clearly describe what group of stakeholders within an enterprise is under discussion, and what concern is being considered.

The framework was originally conceived by John Zachman at IBM in the 1980s. Originally the full technical name was the Zachman Framework for Information Systems Architecture; it was changed in the early 90’s to The Zachman Framework for Enterprise Architecture.

The Zachman Framework can be represented as a grid. Stakeholder groups are represented in six rows: (Visionary, Owner, Designer, Builder, Implementer and Worker)

Columns depict "What" (Data), "How" (Function), "Where" (Network), "Who" (People), "When" (Time), and "Why" (Motivation). Within each cell of the grid are typical artifacts to be used in modeling the enterprise.”
For more information:


TOGAF's Enterprise Architecture

The Open Group Architecture Framework is best known by its acronym, TOGAF. TOGAF is owned by The Open Group. TOGAF’s view of an enterprise architecture is shown in the figure below.

![Enterprise Architecture](image)
As shown in the figure, TOGAF divides an enterprise architecture into four categories, as follows:

1. **Business architecture**—Describes the processes the business uses to meet its goals
2. **Application architecture**—Describes how specific applications are designed and how they interact with each other
3. **Data architecture**—Describes how the enterprise datastores are organized and accessed
4. **Technical architecture**—Describes the hardware and software infrastructure that supports applications and their interactions

TOGAF describes itself as a "framework," but the most important part of TOGAF is the Architecture Development Method, better known as ADM. ADM is a recipe for creating architecture. A recipe can be categorized as a process. Given that ADM is the most visible part of TOGAF, I categorise TOGAF overall as an architectural process, instead of either an architectural framework (as The Open Group describes TOGAF) or a methodology (as it describes ADM).

Viewed as an architectural process, TOGAF complements Zachman. Zachman tells you how to categorise your artifacts. TOGAF gives you a process for creating them.

TOGAF views the world of enterprise architecture as a continuum of architectures, ranging from highly generic to highly specific. It calls this continuum the Enterprise Continuum. It views the process of creating a specific enterprise architecture as moving from the generic to the specific. TOGAF’s ADM provides a process for driving this movement from the generic to the specific:

- **Level 1.** TOGAF calls most generic architectures *Foundation Architectures*. These are architectural principles that can, theoretically, be used by any IT organisation in the universe.
- **Level 2.** TOGAF calls the next level of specificity *Common Systems Architectures*. These are principles that one would expect to see in many—but, perhaps, not all—types of enterprises.
- **Level 3.** TOGAF calls the next level of specificity *Industry Architectures*. These are principles that are specific across many enterprises that are part of the same domain.
- **Level 4.** TOGAF calls the most specific level the *Organisational Architectures*. These are the architectures that are specific to a given enterprise.

**Gartner EA Process Model**

According to Sessions (2007), the best summation of the Gartner practice is the following one:

- Architecture is a verb, not a noun.

Sessions continues the explanation as follows. It is the ongoing process of creating, maintaining, and, especially, leveraging an enterprise architecture that gives an enterprise architecture its vitality. An architecture that is just a bunch of stiff artifacts that sit in a corner gathering dust is useless, regardless of how sophisticated your taxonomy is for categorising those artifacts or how brilliant your process is that guided their development.

Gartner believes that enterprise architecture is about bringing together three constituents: business owners, information specialists, the technology implementers. If you can bring these three groups
together and unify them behind a common vision that drives business value, you have succeeded; if not, you have failed. Success is measured in pragmatic terms, such as driving profitability, not by checking off items on a process matrix.

Gartner believes that the enterprise architectures must start with where an organisation is going, not with where it is. If we are going to clean house, we don't need to exhaustively document everything we are throwing out. Let's focus our energy on what we want to end up with. As soon as we know our goal, we can see how what we have relates to that goal.

Gartner recommends that an organisation begin by telling the story of where its strategic direction is heading and what the business drivers are to which it is responding. Gartner will want this story in plain language, without worrying about prescribed documentation standards, acronyms, or techno-babble. The only goal is making sure that everybody understands and shares a single vision.

Most organisations are facing major changes in their business processes. The process of creating an enterprise-architecture vision is the organization’s opportunity to sit down, take a collective breath, and ensure that everybody understands the nature, the scope, and the impact of those changes.

As soon as an organisation has this single shared vision of the future, it can consider the implications of this vision on the business, technical, information, and solutions architectures of the enterprise. The shared vision of the future will dictate changes in all of these architectures, assign priorities to those changes, and keep those changes grounded in business value.

Enterprise architecture, in the Gartner view, is about strategy, not about engineering. It is focused on the destination. The two things that are most important to Gartner are where an organisation is going and how it will get there. Any architectural activity that is extraneous to these questions is irrelevant. "Just enough enterprise architecture, just in time," is another saying you will hear from the Gartner analyst. So far Sessions (2007).

The Federal Enterprise Architecture (FEA)

FEA is described in several documents issued by the United States Government, e.g. The United States Government (2007), and The White House (2007). The following description is based on those documents, and on Sessions (2007).

The figure below is from The United States Government (2007), page 8.
FEA is an attempt by the United States Government to unite its agencies and functions under a common enterprise architecture. FEA is a rather complete methodology. It has both a comprehensive taxonomy, like Zachman, and an architectural process, like TOGAF. FEA can be viewed as

- either a methodology for creating an enterprise architecture
- or the result of applying that process to a particular enterprise—namely, the U.S. Government.

FEA consists of:

- A perspective on how enterprise architectures should be viewed (the segment model)
- A set of reference models for describing different perspectives of the enterprise architecture (business, service, components, technical, and data)
- A process for creating an enterprise architecture
- A transitional process for migrating from a pre-EA to a post-EA paradigm
- A taxonomy for cataloging assets that fall within the enterprise architecture
- An approach to measuring the success of using the enterprise architecture to drive business value

There is a hope that FEA could help to transform the Federal government into a citizen-centered, results-oriented, and market-based organization.

The FEA Perspective on EA is that an enterprise is built of segments. A segment is a major line-of-business functionality, such as human resources. There are two types of segments: core mission-area segments and business-services segments.

A core mission-area segment is one that is central to the mission or purpose of a particular political boundary within the enterprise. For example, in the Health and Human Services (HHS) agency of the federal government, health is a core mission-area segment.

A business-services segment is one that is foundational to most, if not all, political organisations. For example, financial management is a business-services segment that is required by all federal agencies.

**Typical concepts and terms in EA practice**

From Wikipedia (2012). Note that most of the concepts and terms belong to the solutions level of an Enterprise architecture:
Service Oriented Architecture (SOA)

As a smooth continuation from the description of FEA above, we will start our discussion of Service Oriented Architectures by describing an initiative by the Chief Information Officers of the United States federal administration.

SOA as an extension to EA

The Chief Information Officers of the United States federal administration have taken an initiative to extend the Federal Enterprise Architecture (FEA) to include the concept of a Service Oriented Architecture. See United States Government (2008). This is how they motivate their initiative:

“The world is changing at an accelerating rate and the federal government needs to keep pace. Broad-based change is always difficult, but the federal government is plagued by a variety of inhibitors to change, including vertical vs. mission organizational orientation; bureaucratic culture; budgetary cycles and processes that do not facilitate agility or reuse; and a large and diverse current technology base. Service Oriented Architecture (SOA) promises to help agencies rapidly reconfigure their business and more easily position IT resources to serve it. Improved business agility – through sharing and reuse of infrastructure, services, information, and solutions - is a growing requirement in the federal government today and will be increasingly critical in the future.

The purpose of this document is to describe a target federal service oriented architecture vision and to provide guidance in the management and governance of enterprise-wide services. Many federal organizations are considering or planning for a broad based adoption of SOA. In order to effectively move to an SOA environment, an organization must conduct careful planning and assessments for a variety of organizational, architectural, and technological challenges.

With recent advances in federal enterprise architecture, federal chief architects and chief information officers have a deeper insight into their current IT architectures at all levels of government. In most organizations, this visibility has exposed many inefficiencies and undesirable redundancies, as well as disconnect between the promise and the reality of technology for improving business outcomes. In turn,
this has led to a variety of consolidation initiatives and reengineering efforts at all levels of the federal government. The most widely publicized and recognizable are those government-wide initiatives compiled into the annually published Federal Transformation Framework (FTF) from the Office of Management and Budget (OMB).

While the FTF is concerned with cross-agency initiatives which leverage reuse efficiencies and improved organizational performance, agencies themselves are faced with similar internal challenges. Recognizing this concern, as well as others, OMB published the Federal Enterprise Architecture (FEA) Practice Guidance that introduces Segment and Solution Architectures and their relationships with Enterprise Architecture (EA) through a notional framework (see Figure 1-3 of the FEA Practice Guidance document). The Solution Architecture is equivalent to an IT system that is reconciled to the Segment Architecture. The FEA Practice Guidance strongly indicates that Segment and Solution Architectures inherit their structure, policies and standards and re-usable and sharable solutions from the Enterprise Architecture. This is directly aligned with the direction of Service Oriented Architecture.

Just as industry has adopted SOA best practices, it stands to reason that federal organizations will turn to SOA best practices to optimize their IT and business architectures. SOA is not just a technology to be leveraged; it is a true paradigm shift and requires substantial organizational, cultural and management changes to be effective.”

The following figure from United States Government (2008) illustrates how SOA best practices could extend an enterprise architecture:
What is a Service Oriented Architecture (SOA)?

When designing information systems, one may use standardised structuring methods and architectures, such as database orientation, process orientation, client/server architecture, and service orientation.

Today’s applications are often database-orientated, that is, different functions of the system interact with each other via a common database, including both data and metadata.

Until recently, database-orientation has often been combined with a structuring of the information system according to the client/server principle. In its original form, the client/server architecture consists of two types of subsystems: user-oriented client systems, which are served by server systems, handling common resources like printers and databases. There are developments of the client/server architecture, using three or more types of subsystems, called tiers. In a three-tier client/server architecture there is a distinction between

- subsystems for user interactions
- subsystems for business logic
- subsystems for data management

With the rapidly growing importance of the Internet and web-based information systems, the client/server architecture is becoming replaced by service-oriented architectures (SOA), based on well-defined, standardised services, which can be used in a standardised way, via standardised messages and communication protocols, by other services.

Service-oriented architectures are based on the following design principles; Erl (2005):

- **Loose coupling** – Services maintain a relationship that minimises dependencies and only requires that they retain an awareness of each other.
- **Service contract** – Services adhere to a communications agreement, as defined collectively by one or more service descriptions and related documents.
- **Autonomy** – Services have control over the logic they encapsulate.
- **Abstraction** – Beyond what is described in the service contract, services hide logic from the outside world.
- **Reusability** – Logic is divided into services with the intention of promoting reuse.
- **Composability** – Collections of services can be coordinated and assembled to form composite services.
- **Statelessness** – Services minimise retaining information specific to an activity.
- **Discoverability** – Services are designed to be outwardly descriptive so that they can be found and assessed via available mechanisms.

More briefly and concretely expressed, a service is a piece of reusable software, smaller or bigger, which performs a well-defined function, described in a standardised way. The service can be requested by other pieces of software, which may themselves be services, through standardised messages. The service requestor should not have to know anything about the internal functioning of the activated service, and the latter should not have to know anything about its external environment, but only perform its function and (possibly) provide a standardised response message in return. During its execution a service may itself request the execution of other services in the same way.

The figure below illustrates the SOA concept.
Service-Oriented Architecture (SOA)

SOA and legacy systems: using “sarcophaguses”

Service-orientation, as defined above, has the great advantage that it can be introduced step by step in an organisation, e.g. a statistical agency. Any large organisation today has an enormous burden of legacy systems that cannot quickly and easily be redesigned and redeveloped. A legacy system that has not been developed in accordance with modern design principles can be encapsulated into a large black box component, which is not internally consistent with service-oriented principles, but which interacts with its environment according to such principles. Of course it requires some work to develop the “sarcophagus” surrounding the black box, making it look and behave like a true service to the other services in the system, with which it interacts, but this is a small effort in comparison with a total make-over or redevelopment of the whole legacy system. The figure below illustrates the sarcophagus approach for coping with complex legacy systems.

Complex monolithic legacy system ...

... encapsulated by a “sarcophagus” (or a cloud) ...

... which makes the complex, monolithic system behave towards its environment like a set of loosely coupled, well-defined services (although they are faked) ...

... and step by step the faked services are replaced by real services in the new, emerging and truly service-oriented system
Enterprise architectures and the systems approach

There is a close kinship between concepts like

- Enterprise Architecture (EA)
- Service-Oriented Architecture (SOA)
- Object Orientation (OO)
- The Systems Approach (SA)

They all represent attempts to come to grips with problems which are too complex in order to be tackled in one go by the human brain, problems that need to be subdivided into parts, which can be solved separately and rather independently of each other – and yet in such a way that the solutions of the partial problems can be combined and synthesised into a solution of the whole problem, which was initially too complex to be tackled.

SOA, process-orientation, object-orientation, and the systems approach

Service-orientation often goes hand in hand with process-orientation. On the business level – for example the business of statistics production – the employees interact with customers, suppliers (respondents and data providers in the case of statistics production), colleagues, and external and internal service systems (typically computerised), in order to provide services, demanded by the customers. This work may be organised into processes, preferably standardised processes, so as to ensure that the work is done according to best methods and best practices and will give the same good quality results to the customer, regardless of which individual persons are executing the processes.

Service-orientation can be seen as a further development of earlier software design methodologies like modular programming and object-orientation. It is obviously well in line with the general systems approach and systems thinking; cf the description of services above with treatments of the systems concept and about how to manage complexity and unperceivable systems; see for example Langefors (1966).

A short summary of the systems approach for managing complex, unperceivable systems:

- The systems approach is a paradigm for managing the design, operation, and evaluation of unperceivable systems, systems which are too big and complex for the human brain to grasp in one go

- Combination of top-down and bottom-up, overview and detail, comprehensiveness and precision, soft and hard

Basic concepts of the Systems Approach

The basic concepts of the systems approach is summarised on the next two pages, heavily based upon Heylighen (1998). Selected readings on systems thinking, by a large number of prominent researchers, can also be found in Emery (1969, revised 1981).

The systems approach was elaborated by Bertalanffy (1968). He noted that all systems studied by physicists are closed systems: they do not interact with the outside world. When a physicist makes a model, she assumes that all masses, particles, forces that affect the system are included in the model. It is as if the rest of the universe did not exist. This makes it possible to calculate future states with perfect accuracy, since all necessary information is known.
However, as a biologist von Bertalanffy knew that most practical phenomena cannot be treated as closed systems. If a living organism is separated from its surroundings, it will die shortly because of lack of oxygen, water, and food. Organisms are open systems: they cannot survive without continuously exchanging matter and energy with their environment. Open systems interact with other systems outside of themselves through inputs and outputs. A system and its environment are in general separated by a boundary, an interface. The output of a system in general a direct or indirect result from the input. But the system is not just a passive tube, but an active processor, a transformer. For example, the food, drink and oxygen we take in, leave our body as urine, excrements, and carbon dioxide. The transformation of input into output by the system is usually called throughput. This has given us the basic components of a system as it is understood in systems theory; see figure 1.

![Figure 1. A system in interaction with its environment. From Heylighen (1998).](image)

When we look more closely at the environment of a system, we see that it, too, consists of systems interacting with their environments. For example, the environment of a person is full of other persons. If we now consider a collection of such systems which interact with each other, that collection could again be seen as a system. For example, a group of interacting people may form a family, a firm, or a city. The mutual interactions of the component systems, or parts, are what makes the system as a whole something more than the sum of its parts. With respect to the whole, the parts are seen as subsystems. With respect to the parts, the whole is seen as a supersystem.

If we look at a system as a whole, we don't need to be aware of all its parts. We can just look at its total input and total output without worrying which part of the input goes to which subsystem. For example, if we consider a city, we can measure the total amount of fuel consumed in that city (input), and the total amount of pollution generated (output), without knowing which person was responsible for which part of the pollution. This point of view considers the system as a black box, something that takes in input, and produces output, without us being able to see what happens in between. In contrast, if we can see the system's internal processes, we might call it a white box, or, maybe better, a transparent box. The black box approach is often necessary for the human brain to be able to grasp a complex system. However, when necessary, one may make a black box transparent, in order to see the details of the inside of a system – this requires that the inside of the system is known, though, which is not always the case. See also figure 2.
These two complementary views of the same system, "black" and "transparent", illustrate a general principle: systems are structured hierarchically. They consist of different levels. At the higher level, you get a more abstract, encompassing view of the whole, without attention to the details of the components or parts. At the lower level, you see a multitude of interacting parts but without understanding how they are organised to form a whole.

Different types of systems

There are different types and views of systems. We have already talked about open vs closed systems, and about black box views vs transparent views. There is also a distinction between soft systems and hard systems. Hard systems, e.g. technical systems, are associated with quantifiable variables, whereas soft systems usually involve people and both quantifiable variables, and variables that are not easy to quantify; see, for example, Checkland (1981) and later works by the same author.

We may also distinguish between man-designed systems and systems that are just “given” – by God, by Nature, or whatever we choose to believe. Among the man-designed systems we may distinguish between man-independent systems (or parts of systems) that will continue to exist, at least for some time, even if all human beings were to disappear from earth, and man-independent systems that are what Berger&Luckmann (1966) call social constructions of reality, in the sense that will cease to exist, if they lose their human components. Buildings are examples of the former category, whereas enterprises are examples of the latter.

Enterprise architectures (EA) and information systems

A general review of Enterprise Architectures (EA), including purposes, definitions, scope, and methods, can be found in Sundgren (2012). In this presentation, I will discuss, inter alia, the following issues:

- The role of information systems and information system architectures in EA frameworks is not quite clear
- Information systems typically appear on the solution level, not so often on the business level or the strategic level
- Information system architectures typically have two orthogonal dimensions:
  - Concepts and data structures (conceptual models and data models)
  - Processes (process models)
• EA frameworks seem to focus more on processes than on concepts and data structures

• But in some enterprises information management is the business – or at least a very essential part of the business

**Enterprises where information management is the business**

There are enterprises, where information management is the business – or at least an important part of the business. Some examples:

• Production of official statistic
• Archive management
• Business intelligence systems
• Public libraries, databases, and register systems
• Knowledge bases and open access journals
• Research-supporting systems
• E-commerce systems

**Important notes:**

• Most of these enterprises are multi-purpose and serve partly unknown customers and needs
• Complex metadata subsystems and data quality issues are typically essential

**Literature**


DataGovernance.com (2008) *Zachman Framework*  
http://www.datagovernance.com/fwo3_zachman_framework.html

Prentice-Hall

http://folk.ntnu.no/alexanno/skole/infoSys/InfoSys/GartnerEA.pdf

http://www.gartner.com/it-glossary/enterprise-architecture-ea/

CRC Press, Boca Raton, FL.


Sundgren, B. (2010a) *The SOA paradigm*

Sundgren, B. (2010b) *The systems approach to Official Statistics*


Using models for the design of e-governance and e-services
Bo Sundgren 2013-09-22

This article is based on, inter alia, Sundgren&Tolis&Steneskog (2005).

Introduction

There is a long tradition of using different kinds of models in the design and construction of information systems, software, and information system applications. These models typically relate to one or more of the following three levels:

- The level of “the real world”, “reality”, “the object system”, or “the Universe of Discourse” (UoD)
- The conceptual level, or the level of information and meaning
- The level of data representations

The conceptual level is in the minds of people and is used when we observe the real world and interpret data representations.

The real world is what people believe exists in an objective sense, outside the minds of individual human beings, for example buildings, cars, and other physical objects, but it also contains many so-called “social constructions” in the sense of Berger & Luckmann (1966), for example companies and other organisations, which seem to exist in a reasonably objective way outside the minds of individual human beings, but which are yet dependent on the existence of people, and which would cease to exist if all human beings were wiped away from the real world.

The data level contains data. Data are physical representations of information about the real world. Data are either obtained by direct observations of the real world through the senses of human beings (seeing, hearing, smelling, feeling) or indirectly through different types of measurement instruments (thermometers, questionnaires, etc).

The following picture, called Ogden’s triangle, illustrate the relationships between Reality, Information, and Data; see also Sundgren & Steneskog (2003):

![Ogden’s triangle](image-url)
Modelling the universe of discourse for different purposes

More precisely expressed, the Universe of Discourse is the part and aspects of reality that are relevant to study in a particular context. For example, in the context of governance, it is society as a whole, or some part of it, which is relevant to study. In the context of a company, it is the company and its environment (suppliers, customers, owners, etc), which constitute the relevant Universe of Discourse.

Thus the precise and operational meaning of the Universe of Discourse is dependent on the purposes that we have at hand, for example when governing a country, a municipality, or a company.

In this chapter we shall focus on society as our relevant Universe of Discourse in the context of e-governance.

The universe of discourse of governance and government administrations is the system of entities or objects that is governed by the “governors”, that is, the politicians and civil servants.

Object systems\(^1\)

The universe of discourse of governance may be modelled as a system of interacting objects. The objects may be classified into

- **active objects**, “actors”, “subjects” such as persons and organisations, and
- **passive objects**, “things” and “utilities”, such as physical objects and material and immaterial resources

The active objects interact with each other and with passive object in different kinds of

- **interactions**, such as activities, events, and relationships, for example business activities, trade transactions, crimes and convictions, traffic accidents, marriages, employments, births and deaths

The interactions may also be regarded as (complex or secondary) objects in the system of discourse of governance, in the sense that they are observed and analysed in information systems about the universe of discourse, and, at least some of them, acted upon by the governors.

Different sectors of society, and different subject matter areas of governance, are concerned with, and focused on, different subsystems of the universe of discourse. Some examples:

- Labour market governance: focused on businesses and organisations employing persons, employment and unemployment, etc
- Housing governance: focused on dwellings, persons and families living in dwellings, construction companies creating dwellings, etc
- Production governance: focused on businesses and organisations producing commodities and services, using different kinds of material and immaterial resources, etc
- Trade governance: focused on persons, businesses, and organisations interacting in different kinds of trade transactions, involving material and immaterial resources, associated with certain volumes and values, etc
- Education governance: focused on students and teachers and their engagements in courses, education programs, education institutions, funding agencies, etc

\(^1\) The term “object system” could be understood as “the object system of the information system”, containing the objects that are informed about in the information system. In this sense even actors and subjects are (passive) objects, observed and informed about by the information system.
The subjects, (passive) objects, and interactions constitute the structure of the universe of discourse. But governance is also about quantities and qualities associated with the objects, for example the volumes and values associated with trade transactions, the sex, education, and yearly income of persons, the size of a dwelling, and the length of a university education program.

**Society as seen through the glasses of official statistics**

Official statistics is one of the main information systems informing governors and other stakeholders (citizens, enterprises, etc) about the universe of discourse that is relevant in the context of governance and e-services. Thus it is relevant for our present purposes to learn about how the object system of official statistics can be modelled.

A statistical system must be able to provide relevant information contents to its customers. But how can customers and designers of statistical systems find out and specify in a precise way, what is relevant contents, given often rather broadly and vaguely defined information needs. There are different approaches to this problem. One may distinguish between theory-driven and data-driven approaches; see for example Hox (1997).

**Theory-driven approaches** derive the desirable information contents from theories and analytical models based on these theories, for example the analytical models and macroeconomic theories behind the System of National Accounts (SNA). Theory-driven approaches are sometimes described as “top-down”.

**Data-driven approaches** may take their starting-point from existing data within fields and sectors of society that are relevant to the customers of the statistical system to be designed. These data are carefully defined and described in descriptive data models. These models usually need to be further harmonised between themselves in order to become useful as subdomains of an integrated data model. Data-driven approaches are sometimes described as “bottom-up”.

In practice it is both necessary and desirable to work both ways: top-down and bottom up. For a producer of official statistics it is anyhow important that the design of the contents of a statistical system results in an operational, descriptive model of the data contents of the system, a so-called **conceptual model**, or (conceptual) **data model**. We shall now take a quick look at a possible methodology and documentation format for such models. See also Sundgren (1973), Rosén&Sundgren (1991), Sundgren (2005), Sundgren (2006), and Sundgren (2007).

**A data-driven methodology for designing the contents of a statistical system**

Official statistics are often categorised into different domains, also called topics or subject matter areas, and statistical agencies are often organised in stovepipes based on these domains. Examples: Population, Education, Health, Law, Labour Market, Business Activities, Housing and Construction, Agriculture, Energy, Transports, Environment, National Accounts, Financial markets, Trade.
On a general level all official statistics are

- estimated values of parameters of populations of objects (statistical units)

where the parameters are

- summarised (aggregated) values of variables of the individual objects in the populations

Regardless of subject matter domain, a statistical agency counts the objects belonging to a certain population and summarises the values of one or more variables of the objects in the population, using some aggregation function like “sum”, “average”, or “correlation”.

Very often the population (e.g. a population of Persons) is broken down into subpopulations, or domains of interest, by crossclassifying the objects in the population by means of a number of classification variables (e.g. Sex, Region, AgeGroup). Data about the population and its subpopulations may be thought of as belonging to cells in a multidimensional cube, a hypercube, where the dimensions of the hypercube are spanned by the classification variables defining the subdomains of the population, and where the cells contain estimated values of the parameters for the respective subdomains obtained by crossclassifying the population, corresponding to the whole cube. See Figure 1. Sundgren (2001) describes and explains this so-called αβγτ-model of multidimensional statistical data.

A user of official statistics may not be able to state exactly which parameters of which populations he or she is interested in, but faced with a short list of object types (or types of populations), and/or topics, and/or parameters/variables, he or she may be able to select a subset of official statistics of potential interest by selecting, step by step, a subset of object types (populations), variables, and parameters.

In order to provide a user with short lists of object types and variables as a starting-point for the user’s “drill-down” operations, we must be able to give an overview of the contents of statistics in terms of a small number of concepts.

The populations occurring in official statistics are based upon a number of basic object types. Some of these object types may be described as (conscious) actors, objects that are capable of purposeful acting, e.g. persons and organisations (enterprises). Other objects are acted upon by the actors but are not
capable of purposeful acting themselves, e.g. natural resources, products, assets; a common label for basic objects of this kind is "things" (in a broad sense) or utilities.

All actors may be counted in a straightforward way. Many utilities are also countable, e.g. buildings and vehicles, so-called cardinal utilities, but there are also utilities like oil and other substances, wealth, health, etc, which may not be counted but possibly measured in other ways, e.g. by volume, weight, or value; the latter kinds of utilities are non-cardinal or collective utilities.

In addition to the basic object types there are different kinds of complex object types that are counted and/or measured in official statistics. Complex objects involve one of more basic objects. For example, an event, like a road accident, may involve one or more persons and one or more vehicles. A trade transaction will involve a seller, a buyer, and a product. An employment relationship (or event) will involve a person and an organisation. Etc.

Complex object types may usually be categorised as events/transactions (instantaneous, without time extension) or relationships/processes/activities, lasting for a certain time period, delimited by a “begin time” and an “end time”, often associated with a “begin event” and an “end event” respectively.

Let us take a system for population statistics as an example; see Figure 2. Such a system may contain censuses as well as population registers and population surveys. Figure 2 visualises the data contents of the system. The model contains four major types of objects, or statistical units: Person, Household, PersonEvent, and Dwelling. These four object types belong to three main categories defined above: actors (to the left in the figure), “things” or utilities (to the right in the figure) and events (in the middle of the figure), relating actors and “things”/utilities to each other.

On the basis of the simple model in Figure 2 many hypercubes of aggregated statistics may be defined, covering all kinds of population statistics, e.g. “average(Income) of Persons in Sweden by Sex and AgeGroup”. Each cube is defined by putting exactly one of the object types in the basic model in focus, e.g. Person, and by selecting variables for dimensions, e.g. Sex and AgeGroup, and parameters, e.g. income, associated with the data in the cells in the hypercube.

All objects are described by means of variables. Some variables are classification variables, e.g. “Sex of Person”, others are summation variables, e.g. “Income of Person”. By using the relations between the objects, one may define derived variables (adjointed variables) such as “DwellingSize of Person” = “Size of Dwelling of Residence of Person”. By using summation operators on summation variables, one may derive estimates of parameters of populations or domains of objects of a certain type, e.g. “average(Income of Persons)”. The two types of derivations may also be combined, even repeatedly and recursively.
Figure 3 is a generalisation of Figure 2. Actually the contents of all branches of official statistics can be expressed as specialisations of this generic model. This thesis has been verified in a large number of practical examples, and no counter-examples have been found.

Figure 4 provides a conceptual model developed in a project at UNESCO. It covers all education statistics produced by UNESCO on the basis of education data from UNESCO member states.

Figure 5 provides more examples of schematic conceptual models for a number of domains that are typical for official statistics on both national and international level. Further examples can be found in Sundgren (2005), Sundgren (2006), and Sundgren (2007b).
Figure 4. A conceptual model of education statistics collected and produced by UNESCO.
Health statistics.

Labour market statistics.

Housing and construction statistics.

Transport statistics.

Energy statistics.

Business statistics.

Trade statistics.

National accounts.

Figure 5. Examples of schematic conceptual models for domains of official statistics. (Zoom in the electronic version of this figure to make it readable.)
**Zooming in the statistical reality from a helicopter perspective**

Imagine that you are hovering in a helicopter over the world seen through the glasses of official statistics. Or imagine that you have a tool corresponding to Google Earth at your disposal to get overviews and zoom in at interesting parts of the statistical reality. Until we have such tools available we could do a lot with simpler surrogates. *Figure 6* provides an overview of the world in terms of the simple basic concepts introduced above.

Given the simple overview, a user may zoom in some part of it. This may be done by checking certain object types in each one of the three columns of *Figure 6*. These crude object types would then expand into more concrete and precisely defined subtypes. Zooming one step further, a list of variables would also be presented for the selected object types, and some of these variables may be checked for selection. Cf techniques like “query by example”, proposed by Zloof (1975) and used in query languages like Microsoft Access.

By right-clicking an object type or a variable, one would get associated metadata, e.g. definitions of object types and variables. Going further one could be referred to databases containing statistical data (microdata and/or macrodata) about the selected part of reality, as well as more detailed metadata and quality declarations associated with the surveys, registers, etc, from which the data emanate. See also Sundgren (2006).
<table>
<thead>
<tr>
<th>□ <strong>Actors</strong></th>
<th>□ <strong>Topics</strong></th>
<th>□ <strong>Utilities</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Variables</td>
<td>□ <strong>Topics</strong></td>
<td>□ Variables</td>
</tr>
<tr>
<td>□ Parameters</td>
<td>□ <strong>Activities, Relations, Events</strong></td>
<td>□ Parameters</td>
</tr>
</tbody>
</table>

- □ **Person**
  - □ Student
  - □ Employee
  - □ Patient
  - □ Client
- □ **Household**
- □ **Organisation**
  - □ Enterprise
    - □ Agricultural Enterprise
  - □ Institution
  - □ Establishment
- □ **Business Actor**
  - □ Producer
  - □ Seller
  - □ Buyer
  - □ Provider
  - □ Customer
  - □ Subject
  - □ Counter Subject
  - □ Owner
  - □ Possessor
  - □ Employer
  - □ Employee
- □ **Topic**: Population
  - □ **Activity, Relation, Event**
- □ **Topic**: Education
  - □ **Activity, Relation, Event**
- □ **Topic**: Health
  - □ **Activity, Relation, Event**
- □ **Topic**: Law
  - □ **Activity, Relation, Event**
- □ **Topic**: Labour Market
  - □ **Activity, Relation, Event**
- □ **Topic**: Business Activities
  - □ **Activity, Relation, Event**
- □ **Topic**: Housing and Construction
  - □ **Activity, Relation, Event**
- □ **Topic**: Agriculture
  - □ **Activity, Relation, Event**
- □ **Topic**: Energy
  - □ **Activity, Relation, Event**
- □ **Topic**: Transports
  - □ **Activity, Relation, Event**
- □ **Topic**: Environment
  - □ **Activity, Relation, Event**
- □ **Topic**: National Accounts
  - □ **Activity, Relation, Event**
- □ **Topic**: Financial markets
  - □ **Activity, Relation, Event**
- □ **Topic**: Trade
  - □ **Activity, Relation, Event**

- □ **Natural Resource**
  - □ Land
  - □ Mineral
  - □ Oil
- □ **Cardinal Resource**
  - □ Locality
    - □ Real Estate
      - □ Building
      - □ Dwelling
    - □ Vehicle
- □ **Product**
  - □ Commodity
  - □ Service
- □ **Accounting Item**
  - □ Cash Flow Item
  - □ Result Item
  - □ Balance Item
- □ **Welfare Item**
  - □ Education
  - □ Health
  - □ Wealth
  - □ Security

---

*Figure 6. Official statistics from a helicopter perspective.*
Contents By Example (CBE)

Contents By Example (CBE), as proposed here, is a technique for

- giving an overview of the contents of available official statistics (microdata and macrodata)
- allowing a user of official statistics to select a subset of available official statistics that he or she would like to investigate further, e.g. by
  - selecting object types of potential interest
  - opening lists of available variables for selected object types
  - opening lists of available value sets (classifications) for selected variables
  - getting definitions and explanations by moving the cursor over terms used on the screen
  - drilling down for more metadata, also about underlying survey processes, by right-clicking terms and selecting from lists of available metadata and metadata links
  - selecting time intervals and populations of interest

Once again, as often as the user wants to know more about a certain concept (e.g. an object type, a population, or a variable), he or she should be able to “right-click” on the representation of the concept and get associated metadata directly, or indirectly through chains of dynamic links.

Figure 7, Figure 8, and Figure 9 provide three examples of how a data set (microdata or macrodata) could be selected in a very intuitive way. In the first example the user indicates (by #) that he or she wants to count Births of Persons. The count should be broken down according to the Person’s Sex and HomeLocation (the latter variable is made more precise by qualifying it by means of a certain RegionalCode, presumably a standard classification). Furthermore, the count should also be broken down by the Age of the Person’s Mother according to a certain AgeGrouping (probably also a standard classification, otherwise it has to be separately defined by the user, who may be prompted to do so).

In the second example it is Migration events that are counted, crossclassified by the Migrant’s Sex, Age, and Occupation, as well as by the respective Localities from and to the Migrant moves.

In the third example, it is the average Income (marked by an m in front of the Income label) of a population of Persons that is requested, and the figure should be broken down by the Person’s Sex and Education.

In all three examples the population could be more precisely defined by adding properties to the population object type selected, and the user could be interactively assisted in doing this. Furthermore it should be noted that microdata could have been requested (instead of macrodata) just by avoiding marking any variable by a summarising function (like # or m).

---

2 Cf Query By Example (QBE) in relational database theory; Zloof (1975).
<table>
<thead>
<tr>
<th>x Person</th>
<th>□ Topic: Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>x Sex</td>
<td># Birth[Person]</td>
</tr>
<tr>
<td>x Age</td>
<td>x AgeOfMother.AgeGrouping</td>
</tr>
<tr>
<td>x HomeLocation</td>
<td>□ Death[Person]</td>
</tr>
<tr>
<td>.RegionalCode</td>
<td>□ GetMarried[Person, Person]</td>
</tr>
<tr>
<td>□ WorkLocation</td>
<td>□ GetDivorced[Person, Person]</td>
</tr>
<tr>
<td>□ MaritalStatus</td>
<td>□ Membership[Person, Household]</td>
</tr>
<tr>
<td>□ Income(byKind)</td>
<td>□ MarriedTo[Person, Person]</td>
</tr>
<tr>
<td>□ Wealth(byKind)</td>
<td>□ ChildOf[Person, Person]</td>
</tr>
<tr>
<td>□ EducationLevel</td>
<td>□ Residence[Person, Locality]</td>
</tr>
<tr>
<td>□ Occupation</td>
<td>□ Commute[Person, Locality.From, Locality.To]</td>
</tr>
<tr>
<td>□ Household</td>
<td>□ Migration[Person, Locality.From, Locality.To]</td>
</tr>
<tr>
<td>□ Size</td>
<td>□ Immigration[Person, Country.From, Locality.To]</td>
</tr>
<tr>
<td>□ HomeLocation</td>
<td>□ BirthCountry</td>
</tr>
<tr>
<td>□ Income(byKind)</td>
<td>□ Emigration[Person, Country.From, Country.To]</td>
</tr>
<tr>
<td>□ Wealth(byKind)</td>
<td>□ BirthCountry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>xx Locality</th>
<th>□ Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ .RegionalCode</td>
<td>□ RealEstate</td>
</tr>
<tr>
<td>□ Building</td>
<td>□ Dwelling</td>
</tr>
</tbody>
</table>

*Figure 7. Example 1 of a selected data set: Number of births by sex and home location of the child and age of the mother. (4-dimensional frequency macrodata – cf underlying microdata.)*

<table>
<thead>
<tr>
<th>x Person</th>
<th>□ Topic: Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>x Sex</td>
<td>□ Birth[Person]</td>
</tr>
<tr>
<td>x Age.AgeGrouping</td>
<td>□ AgeOfMother</td>
</tr>
<tr>
<td>□ HomeLocation</td>
<td>□ Death[Person]</td>
</tr>
<tr>
<td>□ WorkLocation</td>
<td>□ GetMarried[Person, Person]</td>
</tr>
<tr>
<td>□ MaritalStatus</td>
<td>□ GetDivorced[Person, Person]</td>
</tr>
<tr>
<td>□ Income(byKind)</td>
<td>□ Membership[Person, Household]</td>
</tr>
<tr>
<td>□ Wealth(byKind)</td>
<td>□ MarriedTo[Person, Person]</td>
</tr>
<tr>
<td>□ EducationLevel</td>
<td>□ ChildOf[Person, Person]</td>
</tr>
<tr>
<td>x Occupation</td>
<td>□ Residence[Person, Locality]</td>
</tr>
<tr>
<td>.OccupationCode</td>
<td>□ Commute[Person, Locality.From, Locality.To]</td>
</tr>
</tbody>
</table>

*Figure 8. Example 2 of a selected data set: Number of migrations by sex, age, and occupation of migrant and place moved from and to. (5-dimensional frequency macrodata.)*
Data modelling

In this chapter we will define and exemplify different kinds of data models, e.g. conceptual models and relational data models.

Modelling the concepts of a business and their relations

Modelling the conceptual structure of a business or a (part of) a society will help to understand the business or society. It is called conceptual modelling, and the resulting models are called conceptual models, conceptual data models, or just data models. Such models will help to plan the information infrastructure and the information system applications that the business needs.

We will use a simple example here, Rent-A-Video – a video-renting business, in order to introduce and explain the concepts and methods used in object-oriented modelling of business structures. It does not matter that the example is simple; it is still sufficiently complex for illustrating most problems that occur in a modelling situation of this kind. Businesses of larger complexity anyhow have to be broken down into sub-business of less complexity. This follows from the theory of unperceivable systems (Langefors).

Which are the most important concepts of a video-renting business? Different people may answer this question in slightly different ways, but probably most of them would mention at least “video film” and “customer” as important object types in the business. They might also mention that these object types are related to each other in a certain way: a video film may be rented by a customer (see Figure 10).

![Figure 10. Video renting example, version 1.](image-url)
Already after this short discussion we have a rather good idea of the core of the business structure of a video-renting business. As the next step we may analyse the three basic concepts a little further. Let us start with the relation “IsRentedBy”.

The relationship between two object types will belong to one of the following four categories:

- one-to-one, symbolised by “arrow-to-arrow”:
- one-to-many, symbolised by “arrow-to-fork”:
- many-to-one, symbolised by “fork-to-arrow”:
- many-to-many, symbolised by “fork-to-fork”:

To which category does the relation “IsRentedBy” belong? The answer is determined by the following two questions:

- How many customers can rent a video film at the same time? (One or more?)
- How many video films can a customer rent at the same time? (One or more?)

The second question is the easiest one. The video renting business will allow customers to rent several video films at a time. Thus we get a fork where the “Rents” line hits “VideoFilm” (see Figure 11).

This is an example of a phenomenon that typically appears many times during conceptual modelling of a business. We have discovered a vagueness in a key concept, in this case the concept of a video film. There are different solutions to this problem. One solution is to agree on one of the two possible definitions of the concept. In the figure above we have settled on a VideoFilm to be a VideoCopy.

Another solution is to replace what we first thought was one concept, “video film”, by two concepts, “film title” and “film copy”. We will choose the second solution here. Thus we will now have three object types in our model (see Figure 12).

The relation IsRepresentedBy between FilmTitle and FilmCopy is “one-to-many”, since there may be several physical copies of one and the same film title, whereas every film copy will belong to one unique film title. The FilmTitle object type is a so-called abstraction of the FilmCopy object type. It represents everything that all physical film copies have in common.

One can argue that there is also a IsRentedBy/Rents relation between FilmTitle and Customer. However, this relation is redundant (marked by a dotted line in the figure below), since it can be derived from this other relations according to the following formula:
FilmTitle.IsRentedBy.Customer = \( \text{def} \)  
FilmTitle.IsRepresentedBy.FilmCopy.IsRentedBy.Customer

Omission of derivable concepts in a graphical model will make the model easier to grasp.

**Figure 12.** Video renting example, version 3.

**Figure 13.** Video renting example, version 4.
Figure 13 also shows another relation between FilmTitle and Customer, representing the possibility that a customer may reserve a video film that is not available for the time being. Such a reservation would apply to a film title rather than to particular copy of the film, and it would be “many-to-many”. This relation is not derivable. This example also illustrates the importance of having names for relations; if there are several relations between the same two object types, we would not otherwise be able to keep them apart. Even if there is only one relation between two object types, it is advisable to name them, since otherwise there are increased risks for different interpretations by different persons and at different times.

The discussion above about FilmTitle and FilmCopy illustrates one aspect of defining an object type: distinguishing between related object types on different abstraction levels. Other examples of the same thing are: cars, car models, car types; products, product types; a person’s education (taking place during certain years and resulting in certain marks) and an education as such (civil engineer, priest).

There are many other aspects of defining object types, and there are certain “tricks” for finding particularly important aspects. One such “trick” is to ask what causes or constitutes the “birth” and “death” of objects belonging to a certain object type. For example, when does a customer become a customer of our Rent-A-Video business, and when does he or she cease to be a customer? Note that we do not necessarily mean the physical birth and death of the customer. We are rather looking for the answers to questions like:

- When does a person become interesting for our business?
- When does a person cease to be of interest for our business?

Obviously, if a person rents a film, not being a customer already, he or she will become a customer. But may be would like to include potential customers, prospects, into our customer concept, so that we can direct marketing activities towards them? (What is then the criterion for being a potential customer?) On the other hand, when a person has not been an active customer for a very long time (how long?), maybe we would not like to regard that person as a customer any longer.

Thus even if the natural birth and death of a person is relatively well-defined (with reservation for certain medical and ethical discussion during the last decades), the birth and death of person in his/her role vis-à-vis some kind of business (customer, patient, student, criminal) is not always quite obvious. Even more difficult questions occur, when an object is subject to substantial changes now and then without actually ceasing to exist; for example, a household that gains and loses members, a company that sells out part of its business, or merges with another company, or moves to another country, or changes its legal form. Is such an object the same object after the change, or is it a new one? The answers that we give to such questions may drastically effect our perception of the system under consideration. If we define objects in such a way that relatively small changes result the death of one object and the birth of another on, the system will appear to be very dynamic, and if we make our object definitions in the opposite way, the system will seem to be very stable. In reality, the system is actually the same, regardless of our definitions, but the definitions have the role of a pair of glasses, through which we see the reality.

So far we have discussed the structure, the conceptual structure, of the business we are interested in, the so-called object system. We have defined the structure in terms of objects and relations between objects. This is in line with systems theory, which defines a system as consisting of parts and relations between parts. One reason for identifying the conceptual structure of a business is that it gives us a possibility understand and analyse the business in a more efficient way. When a business grows, it may become more complex, and a complex business may be difficult for the human brain to grasp. A complex business is thus an example of an unperceivable system (Langefors), and such systems must be broken down into subsystems in order to make it possible for human beings to manage them. The conceptual structure of the business in terms of objects and relations between objects, as discussed
here, offers one possibility to break down a complex business into subsystems. Other possibilities to structure and analyse the business in a systematic way are discussed elsewhere in this book, e.g. the process structure and the goal structure of the business. All these methods facilitate, in different ways, the understanding, analysis, and management of a complex business. In certain situations one method may be superior to the others, but very often it is a good idea to use several structuring methods in parallel in order to obtain the advantage of looking at the same business from several perspectives, not to get stuck with prejudice.

But the world is not structure only. First of all the term “structure” sounds very static. The object graphs that have been shown above admittedly give a static, “snap-shot” view of the business. However, we have already seen that, in order to get a good understanding of the meaning of certain objects, e.g. a customer, we need to study their birth and death dynamics. Thus, in addition to the static structure, we also have a dynamic structure of the business.

Furthermore, in addition to structure there is contents. A naked tree in the winter is not very interesting. It is pure structure. But when the leaves are coming in the spring, the tree is struck by life, and as the seasons pass, colours change. The structure has become filled with living contents.

The contents of an object graph are the properties of the objects. Figure 14 shows our Video business object graph after we have associated the objects with some properties. Properties are also called “variables” or “attributes”. More precisely expressed, variables (attributes) take values from value sets. For example, the variable “Category” of the object type FilmTitle may take values like “science fiction”, “detective story”, “comedy”, etc.

Normally, a variable takes one unique value for a certain object instance at a certain time. However, there are multi-valued variables as well. In the example, the variable “Actor” will probably have several values for the same FilmTitle. This is marked by an asterisk (*) after the variable name in the object graph.

Some variables are derivable from others. For example, the NumberOfRents and NumberOfCopies variables of the FilmTitle object type are derivable according to the following definitions:

\[
\begin{align*}
\text{FilmTitle.NumberOfRents} &= \text{FilmTitle.IsRepresentedBy.FilmCopy.NumberOfRents.sum} \\
\text{FilmTitle.NumberOfCopies} &= \text{FilmTitle.IsRepresentedBy.FilmCopy.count}
\end{align*}
\]
So now we have an object graph reflecting both the structure and the contents of our Rent-A-Video business. Is the model complete? It depends upon our intentions. We have certainly gained a better understanding of some very basic concepts in the business. This is good for the purposes of analysis and communication. But does the model help us to find better business solutions? That is more doubtful. Then we must consider the question of business objectives. A possible business objective is that we would like to improve the management of the renting operations of Rent-A-Video, that is, to obtain a more efficient control of who have borrowed which film copies, which rentals are overdue, etc. If we consider this objective, we will find that our model needs to be extended, because in the present model we cannot find the rentals that we want to keep track of. We have the customers, and we have the film copies, but the rentals are missing.

We have something that comes close to the rentals in the object graph above, and that is the rental relation between customers and film copies. But we need to “objectify” this relation, so that we can talk about the rental as such, when it took place, for how long time it should last, etc. This has been done in Figure 15.

![Figure 15. Video renting example, version 6.](image)

**Transforming a conceptual model to a relational data model**

The information structure in Figure 15 is a good starting point for the design of an information system supporting the basic operations of the Rent-A-Video business. It would be appropriate to implement the model by means of a relational database with relational tables corresponding to each object type, each many-to-many relation, and each multi-valued variable in the information model. Many-to-one relations are represented by so-called foreign key columns in the relational table corresponding to the object type on the “many” side of the many-to-one relation.

By following these simple rules we get the relational model shown in Figure 16. The relational model contains one relational table corresponding to each one the object types FilmCopy, Customer, FilmTitle, and Rental. The relational table corresponding to the object type Rental also corresponds to the object relation Rents/IsRentedBy.
The multi-valued variable Actor of the object type FilmTitle is represented by its own relational table called ActorsInFilms, which contains one row for every valid Film/Actor combination as well as some information about which role the Actor plays in the Film.

The many-to-one relation Represents/IsRepresentedBy is represented by the foreign key column FilmId in the relational table FilmCopies. The many-to-one relation IsRentedBy/Rents could also have been represented by a foreign key column in FilmCopies, but it is already represented by the Rentals relational table corresponding to the Rental object type.

Note the name convention here that plural nouns are used for relational tables, whereas singular nouns are used for object types. Thus the object type Customer is represented by the relational table Customers, etc. This convention can be traced back to the distinction between the intension and the extension of a concept. The intension of a concept is what it means, and the extension of a concept is its occurrences or representations in reality. The naming convention reflects the idea that an object type is primarily an abstraction of all objects that have certain properties in common, whereas a relational table contains representations of all objects belonging to an object type.

A relational database implemented on the basis of the relational model above would be more or less non-redundant in the sense that each piece of information, each fact, about the business is stored in
only one place. This minimises storage needs, but, more importantly, it facilitates updating. If you have redundancy in a database or in the information system of the company, seen as one integrated system, you will always run the risk that you will not update all occurrences of a certain fact, when the fact changes, and after such a mistake, the database or the information system will be inconsistent, which will often lead to severe consequences for the business.

There are formal methods to ensure that a relational database is non-redundant. These methods are called normalisation techniques and are well described in the literature on the relational data model. By the method that we used above for constructing the relational model for Rent-A-Video, starting from an object-oriented conceptual model, we got a relational model that was (almost) normalised without having to think too much about it. The only potential redundancies in the model are the columns corresponding to the following formally derivable variables:

- `FilmTitle.NumberOfCopies`
- `FilmTitle.NumberOfRents`

However we may easily avoid these threatening redundancies by defining these columns as so-called virtual columns, that is, they are derived automatically by the software, whenever they are needed; they are not stored physically in the database.

Normalised relational databases are well suited for supporting the basic operational business processes, especially business processes that require fast and efficient processing of individual transactions. In the case of Rent-A-Video, a relational database may be used for

- keeping track of films and film copies
- keeping track of customers
- keeping track of rentals: who rents this film? which films are rented by this customer?
- keeping track of rentals that are over-due, sending out reminders to customers

More and more companies are using computerised information systems not only for their basic operations but also for supporting more high-level, strategic processes. Such information systems are called directive information systems in contrast to the basic operational information systems.

Directive information systems are often used for providing decision-makers with the more or less formalised information, “facts”, that they need when they consider decision alternatives and finally make decisions. The role of formalised information may vary quite a lot, depending on the decision situation and, not least, on the personality of the decision-maker. However, in a country like Sweden there is a rather solid tradition among decision-makers and in the business culture that decisions should be rational and based on facts. This is even the case in situations where the decision-maker has already made up his or her mind on the basis of “guts feelings”. In other business cultures there may be an opposite business culture: even if the decision-maker uses facts, he or she would like to present the decision as the result of an enlightened moment of inspiration (from God, an oracle, or some other authority). Nevertheless, in most cultures formalised information has some role to play in decision-making.

To a large extent the formalised information needed in high-level decision situations, and produced by directive information systems, has the character of statistical information, that is, summarised information about groups of objects, information about the development of a certain phenomenon over time, etc, usually presented in the form of graphs and tables. From a quantitative point of view, statistical processes reduce the information contents, but from a qualitative point of view they may drastically increase the usefulness of available information. For example, compare a listing of all the customers of a company, with all their characteristics, with a tabular or graphical presentation, where
you can see the distribution of customers between a small number of important categories, depending upon what and how much they buy, where they live, etc.

It follows from the discussion above that a directive information system must be able to support efficient processing of more or less complex statistical queries. The queries will often appear in an *ad hoc* manner, that is, they have not been planned in advance. There are of course certain types of queries that appear more regularly, e.g. the monthly report of the company, but many information requests are rather unique for the decision situation at hand.

A normalised relational database is not ideal for supporting directive information processes. Instead it has become popular to organise so-called data warehouses as a basis for directive information systems. A data warehouse takes its input data from the operational information systems of the company, data which are available at no extra cost, and organises these data in a way better suited for statistical processes. In technical terms this may mean that we transform a relational data model into a so-called multi-dimensional model, or star model.

As an example, consider again the business of Rent-A-Video. In the object-oriented conceptual model, as well as in the relational data model, there is basically a kind of network between nodes, where the nodes are object types or relational tables, respectively. Like in all networks the nodes are in a sense equal; there is no hierarchy between them.

In a statistical process we focus on one object at a time. We select a population of objects of the same kind, and we count and summarise these objects and present the results of these calculations and analyses for the whole population and for a number of subcategories of the population. A typical structure for statistical information requests is shown in the table below.
<table>
<thead>
<tr>
<th>STATISTICAL CHARACTERISTIC ( S = O.V.F ): by variables ( G )</th>
<th>REFERENCE TIME ( t ) ( \alpha )-dimension</th>
<th>SET OF OBJECTS ( O ) ( \gamma )-dimension</th>
<th>SUMMARIZING FUNCTION ( f ) ( \beta )-dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S1:</strong> “Average income during the year ( t-1 ) for those persons who were registered in Sweden at the end of the year ( t ): by commune, sex, and age.”</td>
<td>Year ( t = 1995, 1996, \ldots )</td>
<td>Persons registered in Sweden at the end of ( t )</td>
<td>Income( (t-1) ): the person’s income during ( t-1 ) according to taxation performed during ( t )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commune( (t) ): the commune where the person was registered at the end of ( t )</td>
<td>average</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sex( (t) ): the person’s sex at the end of ( t )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age( (t) ): the person’s age in whole years at the end of ( t )</td>
<td></td>
</tr>
<tr>
<td><strong>S2:</strong> “Number of rentals of film copies by customer discount category, film category. 1998 and following years.”</td>
<td>Year ( t = 1998, \ldots )</td>
<td>Rentals from Rent-A-Video during ( t )</td>
<td>Count</td>
</tr>
</tbody>
</table>
The structure contains two examples, one from general population and income statistics for Sweden, and another one from our Rent-A-Video business example.

Each statistical query puts one object type in focus. In the first example above it is Persons, in the other one it is Rentals. We arrange all other information that is relevant for the query around this focus object. The second example shows that this arrangement may require derivation of information from other objects that are related to the focus object in a more or less distant way. Thus FilmCategory (of Rental) requires a derivation via the object types FilmCopy and FilmTitle.

**Multidimensional models and star models**

So-called multidimensional models and star models are used for illustrating the above-mentioned structures and arrangements of information that are typical for statistical information managed by data warehouses and related software.

A multidimensional structure is spanned by so-called classification variables, or \( \gamma \)-variables, that is the variables that classify the population of objects into subcategories. In the second example, it is CustomerDiscountCategory and FilmCategory that make up the two dimensions that we have in this case. The cells in a multidimensional structure contains the estimated values of one or more statistical

![Figure 17. Multidimensional structures – cubes.](Zoom in the electronic version of this figure to make it readable.)
measures applied to zero, one, or more variables of the objects in the subcategory of the population corresponding to the particular cell in the multidimensional structure.

Let us now consider the problem of transforming databases that are used for supporting operative business processes of a company into a data warehouse supporting directive business processes. This is also referred to as transforming the corporate data model into a warehouse data model.

There are a number of considerations that have to be made in this transformation:

1. Put one object type at a time in focus and arrange all relevant information around this object type in a multidimensional star model.
2. Delete variables in the corporate data model that are not of interest in the warehouse model, typically variables that are needed in the support of operative business processes, but which are not of interest in strategic decision-making.
3. Add derived variables that are often requested in strategic decision-making, e.g. counts and sums.
4. Increase the granularity of certain variables, so that summarised data can be organised in fewer categories.
5. Consider the management of time: snapshot data and historical data.

We will discuss each one of these considerations in connection with our Rent-A-Video example.

If we ask ourselves, which of the object types in the corporate data model of Rent-A-Video that are candidates for being in focus in strategic decision-making concerning the business, we might come up with three proposals: Customer, Rental, and FilmTitle. Information about all these three types of objects may seem to be of strategic interest, e.g.

- Which films and categories of films seem to be most popular?
- Which customers and categories of customers are most profitable?
- What percentage of rentals are not finalised before the agreed return date?

A closer analysis of typical directive information needs will show that most such requests could be served by a data warehouse based upon one single multidimensional star model, where the object type Rental is put in focus. Even information needs concerning films and customers (as those in the examples above) could be served by such a model, e.g.

- Number of rentals by film category and customer category

In general it is wise to look for object types that have a many-to-one relationship to as many other object types as possible, since such a structure will make it easy to organise a lot of information around this object type. In our example the object type Rental has a many-to-one relationship to all the other object types in the corporate data model.

Are there any variables in the corporate data model that can be deleted when we transform to the warehouse model? Probably we do not need the names of customers, or the stories of films, for example.

Are there derived variables that could be of such interest that they should be added to the model? For example, it may be useful to derive a variable “Delayed?” of Rental with the value “yes” when ActualReturnDate is later than AgreedReturnDate? After this derivation the two latter variables may even be deleted from the model.

3 The frequency function count is a statistical measure with zero variable arguments. It can be said to operate directly on the counted objects, in contrast to sum, for example, which operates upon one quantitative variable of the objects. The statistical measure correlation operates on two variables at a time.
Now to the question of increased granularity. For directive purposes it seems to be possible to replace a customer’s address by a cruder geographical category such as “area” or “region”, according to some natural subdivision of the city where the business is located and has its customers.

Finally, we come to the most complex consideration – time. As long as we are running a database only for the purpose of supporting operative business processes, we are typically only interested in a database that shows up-to-date information about the objects and the respective business processes, that is, in our example we are interested in snapshot information about rentals, customers and films. In a warehouse developed for directive purposes we are also interested in historical developments and trends, either in the form of regularly series of regularly registered snapshots or in the form of a more or less continuous flow of registrations of events. In both cases the result will be an evergrowing database, from which historical situations and developments can be derived.

Given the corporate data model and the warehouse model, the data warehouse is typically updated from the operative databases at regular intervals, e.g. once a month, once a week, or once a day. What happens then if the status of, say, a customer has changed. Then we must make sure that the warehouse will contain information about both the old status, valid for the previous time interval, and the new status, valid for the next time interval. If the warehouse is implemented by means of relational tables, this means that the table corresponding to the particular object type, in this example the Customers table, must have a primary key consisting of “CustomerId” in combination with “TimePeriod”. Other implementation alternatives would be to have separate relational tables, or separate columns in the same table, corresponding to different time periods.

As a summary of the discussion above we present in Figure 18 a possible warehouse model for our Rent-A-Video business.

---

If we compare the two time management strategies, the second one will make it possible to reconstruct all events and all changes that have ever taken place in the business as represented by the warehouse data model, and it will also make it possible to reconstruct the situation in the business at an arbitrary historical point of time. The first time management strategy, based upon snapshots taken at certain intervals, will only be able to give approximately correct descriptions of historical situations and developments. In a practical case, it may be desirable to have a model that combines (parts of) the two strategies, so that both snapshots and complete pictures of changes are supported.
Process modelling

Process modelling is a tool for analysing and designing business processes. It is the primary tool for further analysis of operations. In this chapter, we present our approach to process modelling and when to use it. The purpose may be to get an overview and overall understanding of operations, to have a base for measuring and controlling the performance of a process and/or to describe the process in detail to be a manual for the process workers. During the last 10 years the use and importance of Process Modelling has grown dramatically.

Introduction

Business modelling is a convenient tool for systematic analysis of the ongoing operations of a business. How the work is done and how customer value is created are identified and modelled by using a process view. It is a way to get a more detailed understanding of value chains, business transactions and order fulfilment; not only to understand but also to control and improve. Here we describe how the steps in a process modelling may be taken in practice. This is by no means a standard recipe but one way to do it.

Modelling is usually not done in one straight sequence. First get a rough picture of the process and then improve it in a more iterative way until the “business painting” is relevant for the current purpose.

There is a wide spectrum of business processes in terms of how pre-defined and repetitive their results as well as their activity sequences are. It is necessary as early as possible to try to understand what type the current process belongs to, as they have to be treated differently.

We present here a number of conventions on how to model processes. In practice it is not that important to use exactly these conventions but they constitute a list of the concepts that is useful to be able to express in process models. Modelling is an art. You need to know and master the basic rules but you may have to go beyond them to express what the business is really about.

Business processes and task units

Business processes are the core of value creation. They are the raison d’être for the task units. The business process in itself is both the successive transformation of input to output and the necessary activities to achieve that transformation.

In all business process concepts there is as strong focus on the activity view of the process. We believe the object view to be of equal importance because it is the object that is transformed and carries the value further on. When the process execution is over, the activities have vanished but the output object remains. Accordingly, there are two “schools” of process modelling – one has more focus on transformation and value creation, one on activities and resource usage/cost. They could well be used complementary in order to understand what a task unit is doing (cf. Figure 1).
The process is the “How” to create the object out – the “What”. The actor/participants perform activities that cause transformations of the objects (cf. Figure 2). Very visible processes are found in manufacturing (e.g. with clogs as objects) and it is easy to track the flow of objects/products along the production lines and to understand their how and what.

**The Rent-A-Video case**

Let us take a look at Rent-A-Video, a shop where the customers may rent videocassettes. What are the important processes in the shop? How do they create value for the customer? Who is the customer?

**Producing video cassettes**

One approach is to start to look at the business constellation. In the Rent-A-Video Shop we find easily the customer and the shop clerk (to begin with, cf. Figure 3).
Next step is to find out what is main object that is transformed and carries value. What are the important objects? Especially, what is delivered from the process as object out, from shop to customer to provide value?

That is obviously the videocassettes (cf. Figure 4).

And now for the processes – the set of transforming activities executed to create customer value and to push the flow of objects further on (cf. Figure 5).

One process is obviously where the customer enters the shop, walks around, selects and picks videocassettes, continues to the cashier. The lease is recorded and the customer is paying and leaving. By using our model of the business transaction it is easy to identify these steps.
The basic graph (cf. Figure 6) shows:

- an incoming object – the customer’s need for a video
- search and select/buy processes (done by the customer) that is adding value to the need by transferring it into a video title and then an order for the selected video title
- a production process where a matching cassette is picked from the shelf and provided to the customer – now the immaterial need is transformed into a physical cassette given to the customer as a loan.
- the object out – the “right” cassette available for 3 days is brought home by the buyer and loaded into the video player.

This seems to be the central process showing the flow of cassettes through the shop creating customer value. To express that it is very useful to rigidly follow a convention of showing an object-process-object-process-object chain to identify the value created. Note the incoming object driving the process forward is not the cassette on the shelf but the customer’s need of it. The need is transformed into a cassette.

Two rules of thumb:

- OPOPO object-process-object-process-object.
- Backbone – then one and same object is transformed all the way through.

Creating customer value

But that is not the whole story. There is no value in just having a loaded cassette. The real value for the customer in this case is how the user (maybe the same person as the buyer, maybe not) is experiencing the performance. Let us track the lifecycle of the object further through the business transaction. It is brought home by the customer (delivered), put into the recorder (integrated) and its data content is exposed to the spectator(s). But who is that? The customer/hirer? Or the customer’s children? Grandmother? (Who is after all the real customer? Cf. Figure 7) The participants may be noted below the process symbol.
But how is value created for the customer? The real value for the customer is created when the video is looked at – it is where the main task is performed (cf. Figure 8). The videocassette is a transformation resource hired by the customer to create pleasure (if it is an entertaining video) or maybe profit (“How to repair your own house”) or free time (“Keep the children quiet”).

The cassette is temporary a part of the process platform, of the transforming resources. Enabling the customer process by lending him resources/cassette for his process is another way of value creation/having fun than to buy clogs and have nice walks that includes transfer of ownership. This video service is similar to hotel services – the customer is temporary hiring a resource – a room - from the provider in order to perform his intended value-creating task all by himself.

We have a service situation – the video shop is just providing resources to enable the customer to run his process.

So, Rent-A-Video is far from the traditional manufacture-deliver business where the normal case is that there is an object out with value is sold to the customer and never coming back. *Especially in service situations it is necessary to model and understand the customer’s process because it is there the desired value is created.*

---

*Figure 7. Who is the real customer? How is value created?*

*Figure 8. The customer's value creation process.*
Now we have a process model of the business transaction including order fulfilment. What do we have more? Let us return to the object life cycle to find out if there is more.

When the cassette has been played one or more times it is returned to the shop, the return is recorded, and the cassette is put back on its shelf. OK? (Receive and restore.) Then the cassette is ready to be selected by another customer.

**The payment process**

But where does payment appear in the models? As a matter of fact the order consists of two parts (or sub-objects): the desired delivery (the cassette, now) and the economic conditions (50 SEK). The latter is transformed into a demand for payment and then into money for the provider. *Figure 9* shows the payment process from order to money.

![Business Transaction Process](image1)

*Figure 9. The payment part of the total business transaction process.*

Now, we have identified all the different parts of the business transaction: Buy/sale, produce, create customer value and pay.

For the customer the need is transformed into own value creation and satisfaction and money to the provider. For the provider the object is enabling customer satisfaction and the money (cf. *Figure 10*).

![Business Transformation Process](image2)

*Figure 10. The Objects of Exchange in a Business Transaction.*
**Value chain process**

But is really the complete transaction lifecycle the same as the complete lifecycle for the cassette as such from the video shop’s point of view? Doesn’t the cassette as such have a birth and a death, too as well as the customer’s need? These questions lead us to model the value chain for the cassette as such (cf. Figure 11).

*Figure 11. The life-cycle for a videocassette.*

There is a long production process to create the cassette including writing the script, recording the video, copying and distributing the cassettes. Then comes for the Video Shop the purchasing process, where the cassette is bought and put on the shelf. What they buy is the content packaged on the cassette. The death then occurs when either the body (the cassette) is broken or the soul (the content) is no longer in demand among the customers. Depending on which died first, different actions are taken.

The Lease/Hire sub-process in the Life-cycle Value Chain process is the shown in the business transaction process. Here, the business transaction between the user and the Video Shop and the long value chain process overlap.

In order to make the graphs easy to grasp and understand we add two more recommendations (in addition to OPOPO and backbone):

- Name each process with a verb in the imperative mode (Search, Put, Lease, Scrap)
- Describe each object with its name and state

It is important that there is no confusion or misunderstandings about what the object really is and to write a clear description or provide a conceptual model may be useful.

**Business landscape**

Now we have a good overview of the business landscape and the most important processes. A primary condition for having an ongoing business is that all nodes perceive a win-win situation. Hence we have to take a closer look at the customers. We have identified two different roles: as a buyer coming to the shop (an actor, a node) and as the user – the spectator looking at the video (an object to be changed). The buyer and the spectator may be the same person but the buyer might be a parent hiring the video for his children in order to keep them quiet and get some time for himself (so he is maybe still the end-customer). All participants must be satisfied, the children must like the video and the parent must be satisfied with the quiet time. Both should want to lease another video.

But is this really process analysis? Isn’t it goal analysis? Yes, it is: In order to understand processes we have to understand why they are run, why the participants are motivated to participate. Thus, during process analysis we do some strategic thinking, too, because the processes are going to create value in the customer’s task according to our business strategy. When modelling the processes only rough strategic modelling may be done, but has to be in accordance with more complete strategy models. In the same way process modelling requires some object modelling to avoid confusion. Sometimes a careful description of the business object and its different parts are necessary to do. In the Rent-A-Video case there are two different parts of the object we have to be aware of: the video (data) and
the cassette (physical carrier). In our case they are stuck to each other but in some cases the data may be set free and run amok on the Internet in the same way as music is doing.

A detailed concept model of all relevant objects is usually done first when the data requirements for an IT solution are to be identified.

Process modelling needs to be completed with ideas/models of the business landscape, the objects/concepts and the goals/strategies in order to be put in context.

**What is a business process?**

This question is misleading. “What do we mean by calling something a business process” would be a better formulation. To look upon something with a process view is to organise the description of the reality according to a given framework (cf. *Figure 12*). There is no generally agreed-upon definition of the basics of such a framework but one version is “... a process is simply a structured, measured set of activities designed to produce a specific output for a particular customer or market.” (Davenport, 1993).

![Figure 12. A structured Factory process.](image)

- A Business Process is “a structured, measured set of activities”. The key word is activities. (We add the object view to this definition by “and a measurable value-increasing transformation of objects”.)
- The set of activities, the Business Process, is “designed “i.e. there is some sort of planned structure in the execution of these activities. (In our model the same for the objects but we also cover less designed processes.)
- These activities are to “produce a specific output” i.e. there has to be an output, not necessarily a physical one; it might be data or even mental concepts.
- The output is “for a particular customer or market”. In our approach we build upon that and focus yet more upon the provider’s customer’s process i.e. “for our customer’s pleasure and/or profit.”

Our modifications of the definition depend on that our basic question is “What can we do to create profit and pleasure for our customer?” Our goal is to contribute to the success of customer’s task in all possible ways. Another reason for our extensions is the characteristics of non-factory processes. In the above graphical notation the Business Process is an arrow-shaped box and the object a rectangle.

Davenport’s definition is very relevant for what we call factory processes with physical objects i.e. the traditional manufacturing business with pre-defined output and very repetitive, structured set of activities. That is very relevant for factory-type processes but there are other dimensions we have to consider

- Repetitiveness: how pre-defined and repetitive is the process/sequence of activities and the result/the object out? For many development processes neither the output nor the activities are possible to define in advance.
Object types: physical, digitised data, people. These different types of objects do have different attributes leading up to very different processes.

- Degree of interaction between customer and service provider
- Value created: economic and/or experiential – profit and/or pleasure
- Type of value delivery/customer support: product delivery (selling clogs), enabling services (hire out video cassettes) and/or relieving services (perform a customer process).

We will discuss below how to identify and model these different types of business processes and business transactions in more detail. What was developed during the first generation in order to improve manufacturing processes with physical objects is still valid for those types of processes and tasks. However, those principles have had to be modified in order to be of value for the other types of business processes and objects. It has been ineffective or even disastrous to use the methods for analysis and improvement of industrial mass-producing processes in a fundamentalist way for trying to model and improve the other types of processes – service processes and creative ones.

**Process models and process executions**

Another cornerstone in process thinking is to understand the difference between a process model and the corresponding executions.

In order to explain this difference we can use a three-world model inspired by the philosopher Karl Popper (cf. Figure 13). The model shows:

1. the real world – the “Reality”
2. the mental world – our internal intrasubjective mental models
3. the world of models and descriptions for intersubjective communication.

![Figure 13. The three worlds of data/information.](image)

A process model exists in the 3\textsuperscript{rd} – intersubjective – world and describes the course in its entirety from start to end. A person who is going to participate in the execution of the process has to build his personal mental model of the process (in 2\textsuperscript{nd} world) by combining the process model with his own knowledge and experience. This mental model is then his base for action.

The process execution exists in the 1\textsuperscript{st} real world and is caused by the enactment of the mental models by the participating persons. In the “psychological now” – the only reality that exists – only a
slice of the process model is reflected in the execution. The process model exists all the time in its entirety but process executions only as temporary slices, and often not at all (when no executions are active).

In the clog factory the process models exist all the time. Process executions do not exist during the night. When the morning comes, a number of parallel executions are started and run successively during the day.

The inability to differentiate between the model and the execution has for a long time created confusion in process theory. Attempts to define what a process is has run into trouble because then you try to formulate one definition for two very different (although related) phenomena.

Process executions do almost never happen as described in the process model. The creative, unreliable human being in between has his own unique mental model and his own will. The process model is a framework for desired action but the human being makes his own interpretation of it and adapts it to the current situation. This is a problem in factory type processes and a priceless asset in studio type processes (see further below).

**Process types**

**Factory type processes**
Process modelling is nothing new in the manufacturing area. Already Taylor and Ford did have processes in mind when they designed operational flows in manufacturing although they did not use that term.

How do we describe and model a factory type of business process?
Its main characteristic is the creation and gradual change of an object: object in – change – same object out in a new state. This change is achieved by performing intentional and well-organised activities over and over again in order to transform the input and create the wanted output (cf. Figure 14).

![Figure 14. The basic transformation process.](image)

There is an incoming object e.g. an unpainted clog (state A), a set of activities – painting, and finally an object out – the painted clog (state B). The object has been transformed; customer value has been added, loaded into the object. This process is enacted over and over again. For industrial processes it is an objective to have no unwanted variations in the objects out – all clogs have to be well painted in the same way. Unwanted variations in output are “quality problems”. The design of the object out and of the process is done in advance – when the factory process is executed it is pure production.

A process is then usually broken down in sub-processes with a clear definition of how objects flow between the sub-processes. An order process may be broken down in three sub-processes (cf. Figure 15). Each department (actor, node) performs its sub-process: Order office, Warehouse and Transport. All that counts, is that the customer gets what he wants, the right items at the right place in the right time at lowest possible cost. Each order object is passing through that chain step-by-step and value is added in each step.
The aim of the Business Process modelling is to
1. At least understand the process
2. Maybe also be able to measure and control the process
3. Maybe also be to be able to improve the process e.g. by redesigning it or create a new supporting IT system for it.
4. Finally, to be able to describe it to be used as a worker’s manual.

Level 1 is both achievable and very useful for most companies to really understand how they create value for their customers. Level 2 may be performed for essential processes in order to be able to control them. Level 3 – development/improvement requires a more detailed analysis. If the ambition is to create instructions for the workers/participants one has to consider what professional competence level they are expected to have. Modelling for level 3 and especially level 4 is resource-consuming both to develop and to maintain and often ends up in piles of unused documentation.

For factory type processes (e.g. car manufacturing) it is relatively easy to study the operational flows by tracking the objects and describe how they are transformed step-by-step in order to create value to the customer. But, there are other types of processes that are not so easy to identify and that are not so structured and repetitive.

Since Taylor there has been an ambition to structure and automate all processes to become factory processes. Remaining manual work is treated as just not-yet-automated and still performed by not-so-reliable human beings. However, this ambition is not constructive for all types of processes as will be described below. Attempts to “automate” creative processes tend to be very unsuccessful if not counter-productive.

**Workshop type processes**

The activities in the workshop type processes (e.g. care repair) are not executed in the same rigorous repetitive way as in normal factory type processes. Every execution is here unique, although you will find reoccurring structures of activities and transformations. The execution is more controlled by rules (of thumb) than by rigid process scripts. The skills and the creativity of the human actors as individuals is an important asset for the process.

When working in workshop mode – where the incoming object is e.g. a customer problem or a customer need – the individual execution of the process is adapted to the situation and the result/object out is more or less unique. In a workshop process the sequence of activities as well as the object out is designed and performed/produced concurrently within the limits of the workshop’s resources and rules.

Part of management work could be looked upon as some sort of information workshop. Reoccurring problem are solved in similar but not identical ways.

To represent this workshop mode, we use another symbols for the process. The arrow-formed to represent the fixed factory processes where variances, design and creativity are undesired, the rounded form the workshop type processes where creativity is wanted and unique top-notch objects out are aimed at (cf. *Figure 16*).
In reality every process is a mix of both types and may be put on a scale between inflexible routine and complete chaos with no ones at the extreme ends but it is useful to express what is typical for the processes in focus.

Also we used different symbols (cf. Figure 17) for physical objects that are hard to change, reproduce and transport and data objects that are easier to change, easily re-produced (copied) and transported (if in electronic form).

Initially, we introduced the following classification of processes (cf. Table 2).

<table>
<thead>
<tr>
<th>Objects</th>
<th>Process structure</th>
<th>Physical</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory type</td>
<td>Traditional manufacturing e.g. cars, furniture</td>
<td>Billing, book-keeping</td>
<td></td>
</tr>
<tr>
<td>Workshop type</td>
<td>Sculpturing, Product development (parts of)</td>
<td>Sales Product development Management</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.

**Ad hoc/studio processes**

Many development and managerial processes are not routine at all. It is not possible to define the outcome in advance (this is often done during the process execution), they have or a very sketchy re-occurring structure. There may be some rules of thumb for them but they do need a lot of creativity and experience. Not even the necessary transforming resources may be defined when they start.

To prepare for efficient and effective execution of this type of processes focus is not upon defining objects and describing processes in advance but to collect resources, build a platform of primarily people with knowledge and creative characteristics. The design of the process model and the object is then done real-time during the execution of the process and here the creativity; knowledge and experience of the human beings are assets of immense important.

For these type of processes there is an eternal fight between management that wants to have control (these processes are risky – they may end up in nothing) and the creative people who want as much freedom as possible.

IT development started as ad hoc, creative processes. During the decades they have got more and more structure and control – moved into the workshop type. Sometimes this has led to a lack of creativity and has produced mediocre IT applications but avoiding total disasters. Initiatives to move those processes all the way to the factory type have not proven to be successful. One objective for
the design and development of factory-type processes is to create fixed routines and avoid risky creativity but it is counter-productive to enforce this thinking on creative processes. A reaction has now been the school for so called agile development of IT solutions.

**Business objects**
Another important characteristic for a business process is what type of object it is transforming. To differentiate between physical objects, digitised data and/or people is useful due to the different attributes of these types of objects.

The basic approach in process modelling is to identify the created business object out, identify the object in, track and describe its way through the different sub-processes until the object out is produced. It has proven to be very powerful to describe the state of the object at the transition points between the different sub-processes, departments i.e. at borders where responsibility for the object is transferred from one sub-process to another, from one management node to another. With an increase in outsourcing initiatives and virtual organisations these interfaces and transition points are getting more and more critical.

**Different types of objects**
The business object may be physical, digitised data, people and often in combination. Information appears as all these three types:

- physical (printed on paper)
- digitised (stored in a computer – sometimes called electronic or virtual form)
- mental (information in people’s head)

(Note. Here we use the term information for something in people’s head and the term data for something outside the heads but that has the capability to be transformed into information – i.e. understood by someone.)

Value is created by the change of objects. These different types have very different attributes for transformation (and transportation – which is another type of value creation) it is important to understand those differences.

Digitised data objects have some peculiarities compared to physical ones:

- Easy to copy. In manufacturing the production is in reality a cumbersome re-production of the product developed in a costly development process. For digitised data objects the main process is development – copying and re-production is a minor process. Also the same object (e.g. an electronic article) may appear at the same time to be in all object states (outline, draft, early version etc.) and be processed in all sub-processes at the same time. Physical objects (e.g. clogs) move step by step along the process, exist only in one state and are processed by only one sub-process at a time.
- Easy to transport. Transportation for data objects is very cheap and fast. The same object (e.g. a picture on TV) may appear to be in many places at the same time.
- Easy to modify and change. It is possible to have changes in any state (outline, draft, early version, etc.) without changing any of the other ones (which creates problems). What you want is that a change in an earlier state will update the other downstream states (a change in the outline – new concept is introduces – will later be reflected in draft and final version).

People (or other living creatures) are unique and much more complex. We are objects and participants, we experience the change, we are a mix of physical, psychological and mental active...
beings, and we have our own will. This makes human change a very special process. We cannot treat human beings in the same way as physical or data objects.

So the type of object has a major influence on the characteristics of the transformation process. Physical objects are often transformed in well-structured processes, each object is in one sub-process at a time and is moving forward step-by-step.

Processes dealing with data objects are more often of the workshop type.

As soon as people is subject to transformation their reactions is more or less individual and unpredictable. Although we may have a well-defined change process we really have to be prepared to unexpected reactions and to adjust the process accordingly.

Now let us take a closer look upon these different types of transformation.

**Different types of object transformation**

An object is a “thing”, a logical entity but it must not be the same type of object all the way. In the order process it starts as a data object – the order, is transformed to another data object – the item list, is transformed into a number of physical objects – the package and is transported to the customer. It is the data order that is the object in, the object that contains the vision of the physical output object.

The transformation of an object in a process may be of different types:

- Normally we have transformations without changing object type: physical (a clog is painted), data (an article is revised), person (a lesson is learned).
- A conversion of the object from data to physical (item list to physical package), from data to mental information and so on.
- A transportation of the object (package to customer) without any change of the object in itself.

However, the common quality of these different transformations is that they all increase the customer value of the object.

**Processes for transformation of physical Objects**

The Clog Factory order fulfilment (cf. Figure 18) is a case where we treat all objects as physical ones. The arriving customer order (although it might be arriving via the Internet) is the object in and we are able to physically track how the different physical objects are transformed and put together to create the required object out.
The processes are pre-defined, routine, value-creating transformations. The output is pre-defined the moment we start the process.

**Processes for transformation of data Objects**

Compared to physical things and objects, data objects have some special qualities.

First, data (coded information) does not exist without having a carrier. It might be attached to a physical base e.g. paper or electronically coded in computers. The characteristics of the carrier decide what type of process we have i.e. data carried by a physical object is marred by physical characteristics (e.g. a rune stone).

Newspapers are data carried by physical paper. Once printed, they are difficult to modify, every copy has to be physically produced and then transported as any other physical object.

So, could the creation of a newspaper edition be looked upon as a physical factory operation? But isn’t it a lot of creative work in the production of articles and of the content of the edition?

Let us take a look at it (cf. Figure 19).

**Figure 18. An example of a process transforming physical objects.**

**Figure 19. Creating next newspaper edition.**

The creation of the first edition of the day starts with a preliminary design: how many pages, what balance between advertisements and editorial parts etc. Then these editorial parts of the newspaper have to be filled in: what do we have left from yesterday, what is going on out there in the world, what are our journalists and correspondents producing just now?

If we model the underlying flow of data objects becoming the content of the next edition and we use the traditional process view we will get a graph like this (very simplified) one:
An event occurs, the journalist gets there, captures the data (get informed) and creates text and pictures. This is edited into an article; the articles are rejected or accepted. A number of articles are put into the edition according to the edition plan and at a certain point in time the completed edition is ready for printing.

The usual comment after having modelled this type of processes is: “Well, in a way it is right but in reality it is not done this way because everything is done concurrently. There is an almost continuous inflow of data (electronic form) because new events occur, already captured events develop further etc. There is also feedback (cf. Figure 20) from the process of editing the edition in order to create a physically and logically well-balanced edition: articles have to be re-edited or extended etc.”

![Figure 20. Data flow creating next edition.](image)

As in a manufacturing factory there are new “orders” coming in as new interesting events occur and there is a flow of new articles moving up to the edit process. However due to the copy characteristics of digitised data these changes are not just moved up the chain – they are copied up the chain and finally the data is in a number of places. If the original event develops further or the journalist gets more data the corresponding change is entered and is the (hopefully) propagated up along the process.

The inflow is also controlled by feedback from the edit process because the on-going design of the edition creates demand for more or specific input.

Manufacturing processes are of a step-by-step type, the physical object moves in heavy steps up the line. Digitised data processes are more flows of parts of data objects. These flows are both production i.e. they create data in the articles that are of for the reader, but also design as the journalists design the different articles and the editorial board designs the edition and manage and control the whole edition development process

Then suddenly, at a certain point in time, the newspaper process is taken to the next step.

![Figure 21. "Freezing" the current edition.](image)

The constantly changing edition object is now decided to be what is going to be delivered. The edition is “frozen” by a decision from the editor. It is now converted from being a “free” electronic data object to be stuck to its new carrier – printing plates and then multiplied on physical paper (cf. Figure 21). The edition data object is delivered for printing – getting stuck to physical paper – and then distributed as physical objects according to the rules of the traditional physical world. Compared to that, the web version of the newspaper maybe continuously changed and enhanced all the time. The electronic uploading process maybe not negligible but much simpler that the physical
printing. It is possible to upload new editions very often (almost continuously) and make them available on the Internet. Delivery (down-loading) is then taken care of by the reader. When trying to understand data flows it is important to be aware of their fluent nature. To see them as step-by-step processes as in manufacturing is sometimes a good start and is good enough for many routine data flows. However, the more important and essential data development processes are usually of this more fluent nature consisting of many concurrent executions of the basic creation process.

These processes are usually not carried out in the same predefined repetitive way as the more “hard-wired” factory type of processes (cf. Figure 22). Every execution is partly unique, but you will find certain reoccurring structures of activities for e.g. editing an article. The flow of activities is controlled more by rules, experience and creativity than by rigid job and process description. The skills and the creativity of the human actor as an individual is an important asset for the process. In factory type processes there is an ambition to have “identical”, exchangeable actors and to reduce the risky creativity factors. This is what distinguishes factory operations from workshop operations.

![Figure 22. Symbols for factory and workshop processes.](image)

**Processes for transformation of people and organisations**

Changing people cover a wide spectrum of change from physical hair-cutting to psychological analytical therapy. In some rare cases they may be treated as physical processes (hair-cutting), in many cases as data processes (teaching/learning) but in many cases these approaches are insufficient. We are not going to study all those different types of processes, only to give some hints for those concerning organisational development i.e. how to change the ongoing tasks in a business.

As people are so different compared to other transformed objects it is important not to forget their uniqueness and individuality. In order not to forget that, it is helpful to use a special symbol for that (cf. Figure 23).

![Figure 23. Human beings are complex objects.](image)

A major difference is that for persons the relation between activity and change of the object is not of the same clear cause-effect type as for the other types of objects (painting a clog). As each person is an individual with individual frames of reference each person will have a unique response to an activity and often there is a varying time lag between stimulus and response. In an organisational change we then have to consider the interactions between the members of the organisation – interactions that may influence the direction and speed of change tremendously. “Organisational change is a process – it takes its time.”

An organisational change process is then not possible to predict in advance. First, an organisation is very complex so we are not able to understand it fully. Even if we had the necessary knowledge to model it completely (and we don’t have that knowledge) we would never had the time. Second, as mentioned above – the reactions from individuals and formal and informal groups are unique and not possible to really foresee. Hence, an organisational change has to be managed by trying to
control a process proceeding partly according to its own will. To manage such a process it is necessary to have a vision of to what to achieve and a strategy for how to achieve it. It is then possible to plan the next step and see what happens in some sort of controlled trial-and-error. Running a change process is learning new things all the time. “If you want to understand a system, try to change it. “

This creates a major management problem. Do you dare to start such a process which will cost you a lot of money when you don’t know what the outcome will be and when it will be in place? So, you have to try to make some sort of plan and cost estimate in order to dare to start and not be surprised if the trip will be different from the planned route.

There are similarities between managed organisational change and warfare but there is a main difference – management should not treat their employees as enemies but friends with unpredictable reactions. (Competitors reactions will also count, are also more or less unpredictable – they may be looked upon and enemies.)

**Modelling business processes**

**Core elements**
The core elements of a process are the object in/out and the transforming activities in between (cf. Figure 24). Often we have also to consider and model further entities and are getting close to model the task unit framework from a process view.

The core elements are the business object in/out and the symbol for transformation caused by activities. For each execution of the activity set one business object is transformed, one object out is produced. Also other material e.g. products to pick and pack are consumed by the process at the same rate.

![Figure 24. The standard process model.](image)

Then we have the platform, the task resources (the task base). They are necessary for the execution of the process and are used in a number of executions. The three categories are:

- equipment: factories, machines ...
- participants: people/actors including their skill, knowledge and mental models
- data: to be used by the participants when necessary

We have used special symbols for the arrows in the figure to express the different types of synchronisation (arrow for just in time with the process execution, dot = used for multiple executions.)
Figure 24 also shows how lanes or “swimlanes” are used to express who is responsible for the process executions.

Process relations
The order fulfilment process (cf. Figure 25) is an example of a process that is a part of a more complex process web.

<table>
<thead>
<tr>
<th>Process relations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order office</td>
</tr>
<tr>
<td>Plan</td>
</tr>
<tr>
<td>Pack &amp; Ship</td>
</tr>
<tr>
<td>Deliver</td>
</tr>
<tr>
<td>Order</td>
</tr>
<tr>
<td>Pick &amp; Pack</td>
</tr>
<tr>
<td>Manufacturing</td>
</tr>
<tr>
<td>Accounts department</td>
</tr>
<tr>
<td>Calculate &amp; prepare</td>
</tr>
<tr>
<td>Process</td>
</tr>
<tr>
<td>Send</td>
</tr>
<tr>
<td>Items at customer</td>
</tr>
</tbody>
</table>

Figure 25. Examples of process relationships.

- Object in - The order object in contains two data objects – one of what is going to be delivered, where and when – and another of what is going to be paid for it, how and when. The first is triggering the real order fulfilment process. The latter is triggering an invoicing process that is synchronised by the order process. It is symbolised by unbroken lines with arrows to the left side of the processes.
- Control message - When a package is ready for delivery a message (dotted line) is sent to the invoice process (on top) to enable invoicing.
- Material - Manufacturing processes are building stocks of products. These products are material in to the order process (unbroken line with arrow from below).

Relationships between different processes are of different types and should be denoted in the graphs differently (cf. Figure 25):

- Object out from one process is object to the receiving one for further value adding (consumption) e.g. products from manufacturing to pick & pack. Arrow to the middle of the left side of the receiving process. The relation is synchronised i.e. one object in for each execution of the process.
- Object out from one process is material to be consumed. Arrow to the left side or bottom part of the receiving process.
- Object out from one process is transforming resource for another. Then we have to add a rectangle below the transforming process to denote the process base and the arrow in points to the left side. (There might be an arrow out on the right side if the object is returned to the provider after it is used – a service type situation.)
- Control data emerging in one process is sent to another as control data and is represented by a dotted line to the top of the controlled process. Be very restrictive with this type of arrows because there is usually lot of data flowing between the processes and only those really improving the understanding of the interaction should be used. (If the purpose is to build an IT application for the processes then all links have to be identified and analysed. This is described further under “Modelling IT requirements” below.)
The multiple roles of objects

Objects are passed from process to process. The object out from one process is passed to another. However, it is important to understand what role the delivered object is playing for the receiving process.

Physical objects can take one of the following input roles for the next process:

- Business object - to be value-added by the receiving task (order converted to 300 pair of clogs)
- Material - to be consumed by the receiving task (wood, leather, paint, ...)
- Resource - for repeated use in the process platform (capital investment e.g. nailing machine)

Data is here a complicated object. In the graphs above and below we have selected to use two different symbols for objects: a square for physical objects and a rhomb for data objects. Sometimes it is important to make that difference clear.

Data might appear in many different roles for different purposes:

- Main business object - to be transformed in/out (e.g. a film story)
- Directive data – controlling the current execution of the main object (“This clog is to be green”)
- Directive data for all executions of the process.
- General data – in the platform (process model and description)
- Information - in the participants, heads (know-how)

When e.g. analysing the data requirements for a given business processes it is sometimes necessary to consider and express all these aspects.

Business platforms & swimlanes

To describe who is running a process, which task unit is the responsible one, different ways may be used. The simplest is just to write its name under the process. Another, very expressive, is to have different shelves or swimlanes for different actors/nodes as in the graph below (cf. Figure 26) describing provisioning and order fulfilment for the Clog Factory.
Figure 26. Use of swim lanes to point out the responsible task unit.
(The name swim lanes emerged out of the fish-like symbol used to model factory type processes.)
As shown in a number of examples above, sometimes the content of a platform is changed by another process. Then also the platform may be shown in the graph (cf. Figure 26)

Products and services
A common phrase when a company presents its process map is “here are our processes for delivering goods and services”. Then there is one problem with process modelling in the service business. “What is the business object out from a service process?” In order to identify how value is created and delivered to the customer we have to find and define the object out and that has proven to be not so easy for service businesses.

Factory type of processes produce goods, data processes data chunks, but what does service processes produce?

If a customer has a transport task to perform there are three ways for a provider to support him:

- **Providing enabling products.** The provider is selling nails to the Clog Factory that uses them as material and they are consumed during clog manufacturing. The product could be a resource i.e. the provider offers cars for sale; the customer identifies the offering as a convenient one, buys a car and uses the car as a transforming resource to perform the transportation task (cf. Figure 27).
Figure 27. Enabling by Product Delivery and Transfer of Ownership.

- Providing enabling services. The provider offers cars for leasing and the customer rents a car. The customer uses the car and the car is adding value to his task by enabling him to move his goods from A to B. When the task is finished the car is returned to the provider (cf. Figure 28).

Figure 28. Enabling by leasing resources.

- Providing relieving services. Here the customer out-sources or out-tasks the whole (or parts of the) transportation task to the provider. The customer is still responsible to his customer for a punctual delivery but the provider relieves him from performing the task by executing the process (cf. Figure 29).
Figure 29. Relieving by subcontracting.

Of what type is the Rent-A-Video? The shop just provides a transforming resource – the cassette – to be used by the customer when she is running the process herself. The provider delivers an object that enables the customer to run her process, perform her task so we have an enabling service by leasing a transformation resource – the customer is transformed but the video cassette and content is not (only used).

Another case is ATM-services where the bank is providing a complete system (platform) for self-service. The customer the only actor and is able to withdraw money and to execute the transfer of value from his account and convert it into bills in a self-service mode. The customer is responsible for the task of withdrawal but the bank relieves him by providing a system that performs the process.

Modelling a company
Process models are in many cases available company-wise although the scope more and is widened to cover also customer value creation processes as described above. In spite of the selected scope the following levels of models are the usual ones.

On the top level we have the overall map. This map tries to cover and describe the business as a whole. The main processes are classified according to their overall role. Core processes create and deliver objects of value directly to outside customers. Other processes are named development, support and control processes according to their relations to the core processes.

On the next level these main processes are then described in separate graphs and broken down in subprocesses. Sometimes these subprocesses are further broken down in sub-sub-processes. By following the above rules for modelling value creation processes these graphs shows What is done (transformations) and Why (value objects).

The third level (if used) is usually a shift in view from transformation to activities. The activities of each subprocess are then described using work-flow diagrams or simple checklists depending on the needs. By shifting focus from objects to activities the descriptions become much simpler. To understand the “what & why”; people have to turn to the previous level of process models. The activity descriptions may then be used to further specify IT requirements, IT use cases etc.

The shelving technique may be used not only to express who is responsible for running what process but also to express what resources such as databases or IT-systems has to play role. In this way we find the different use cases or interactions with the IT-systems.
Internet and business processes

Internet processes transform and transport data. The scope and flexibility of the Internet network has had and will have substantial impact upon businesses and their constellations and processes. Modelling is a necessary tool to invent, design and implement new ways of doing business. The important processes (value chain, business transaction and order fulfilment) take place between the nodes/task units in the business constellation and will be radically changed as the possibilities to create new constellation networks is provide by the capabilities of Internet.

To understand e.g. the Internet Bookshop and how it was built it is necessary to relate the order fulfilment process to the different actors in the constellation. Internet enables the construction of new business constellations and gives room for new types of businesses and new patterns of processes.

Some Internet organisations are virtual, i.e. to the customer they look like one organisation but behind the scene there is a number of business nodes in a complex process pattern. The processes are on-going operational processes and there are also processes/tasks for the further development of the products/services and processes. The processes in such an Internet business network may be modelled as other processes. The difference is not in the process view but in the opportunities of the underlying constellation network.

Summary

To understand more in detail how a business creates value for its customers, business process analysis is a powerful method and an almost unavoidable tool for the development of business in the Internet age. Modelling is used to identify, invent, design and implement the main operational flows, what constitutes customer value and where and how it is created.

These value creating processes and flows have different characteristics that should be distinguished. At least the following have to be taken into account:

- **Process structure**: how pre-defined is the process/sequence of activities and the result/the object out?
  - Factory type: a rigid activity structure in order to secure the quality of output, to reduce dependence of individual persons
  - Workshop type: an open structure where process and result are designed and performed/produced concurrently. Craftsmanship and creativity are needed to meet customer needs.

- **Object characteristics**
  - Physical objects: hard to change, arduous to transport, will only be on one place at a time.
  - Digitised data objects: easy to change, easy to transfer electronically, easy to copy = may seem be on multiple places at the same time
  - People: very complex as objects and at the same time being active subjects that may participate in the process (performing activities) or at least have an experience of the process.

- **Degree of direct interaction** between provider and customer during the customer’s value creating process and the rest of the business transaction process.

- **Type of value created** for the customer: economic and experiential (profit and/or pleasure).

- **Type of provider’s support** to customer’s value-creating task: product delivery, enabling services and/or re-living services.

The manufacturing processes i.e. factory processes creating physical objects have been the source of process thinking. From this sound base it has been possible to extend this thinking and modelling to fit also the other types of work situations. But to model non-factory processes for non-physical products the manufacturing way of thinking has to be extended but not abandoned.

*How to start?*
One approach to find out what a business really in doing in terms of value creation, processes and flow is to take the following steps:

Identify the task unit/node in focus – the “Star” – whose world is going to be understood.

Identify the most obvious participating business task units/nodes around (suppliers and customers) Study the business transaction process between our provider node and its customers and identify the type of provider support that is the dominating one (product delivery, enabling services, relieving services).

Turn inwards
- Sales, order flows, production/manufacturing processes, (development processes), management and control of these processes.
- What are they doing in order to create customer value? What is unique and/or difficult to copy?
- Where do problems appear in the processes and where in the processes are these problems created?

Turn outwards
- Who is the end-customer? What is their value-creating process?
- What are the nodes between?
- Do we have any important value chains upstream and downstream?

Map the Business Landscape including Constellation etc.

Iterate the work with the processes: Order Fulfilment, Business Transaction and Value Chain.

As data plays an increasingly important role in business today both as value added object in processes as well as control data for processes, IT and Internet has had and will be of major importance. It is used to rationalise and support existing processes but also creates opportunities for new types of processes and new business ideas and strategies.

Internet and its possibilities to easily connect a great number of business actors independent of time and place has already been used to improve existing processes and to develop new ones. Still, one should not forget that all nodes in the new business constellation must be motivated to participate. If one group won’t participate, the business will not get into the air. I many cases the presumed customers have not lived up to expectations. For a business constellation to work all nodes must participate.

For a company – to model and understand its Business Landscape and the different processes crossing it, is getting more and more necessary as new technologies cause radical changes of both constellations in the landscape and of the value-creating processes.

**Literature**


Introduction
It is often said that we are entering the Information Society. But hasn’t man has always been forced to obtain information about what is going on around him just to stay alive? Didn’t the members of the hunting pack communicate with each other during concerted actions to kill their quarry? Being able to use languages was a giant step forward in communication. Vast amounts of information were coded into some sentences, transmitted, and decoded by the receiver. The next invention was writing. It allowed the sharing of information over time and space. The invention of printing machines enabled mass-production of information in a way that really changed the world into the “Gutenberg Galaxy” (McLuhan, 1962).

Electronic communication facilities with the telegraph, telephone, radio, TV, IT, and now the Internet have radically shortened the time required to communicate over the whole world. We have got an Internet Galaxy.

Still – the purpose of all these exciting developments has been to further improve man’s inherited abilities to get informed and to communicate with others in order to “get things done, to achieve goals beyond the reach of the individual” (Scott, 1998). Our approach here is to see our world as an Information Galaxy, or a Cyberspace, where human beings process information, communicate and use different tools in order to coordinate their thinking and actions. That is why we believe that the study of information management is so important.

Information and Data
A major problem in the present thinking about information is that the words “data” and “information” are often used indiscriminately and interchangeably, without reflection. Or they are defined in terms of each other. There is also a certain terminological inflation here: what was originally called “data” is now called “information” or even “knowledge”.

As mentioned, human beings have always created and processed information and knowledge in their minds. They have also, long before computers were invented, produced and processed data. Actually human beings use two kinds of data. On the one hand, a human being is able to perceive the outside world through her senses: sight, hearing, feeling, taste, and smell. The senses, applied to reality, produce data, perception data, which the human brain is able to interpret. Through these data the human mind will step by step be able to create a mental picture, or model, of the external world.

On the other hand, human beings sometimes try to represent part of their mental models of the real world by means of data – symbolic data. These data symbolise some selected part of the human being’s perception and understanding of the real world. Some symbolic data (iconographic pictures, onomatopoetic sounds) are very easy to interpret. Other symbolic data, for example a word in a language, written in a certain alphabet, are based on some kind of coding convention, and anyone who wants to interpret such data must know the coding convention.

---

5 The human being is also able to perceive signals from her own body like hunger, thirst, pain, etc.
Perception data may be called *direct data*, since they directly reflect the real world. Symbolic data are *indirect data* in the sense that they are (a) the result of a human, creative act, which is then (b) (re)interpreted by (possibly) another human being.

Perception data reach a person via her senses, and the person then interprets the data into an understanding of the current situation, using concepts and frameworks that already exist in her mind – the person’s frame of reference. Concepts and frameworks are the results of a life-long learning process. A major part of that learning is influenced by the social environment where we live, so our frameworks, and hence also our interpretations, are socially based.

Philosophers have always discussed how we obtain information and knowledge about the real world. There are certainly different views, or paradigms, about how the knowledge formation process actually works, but most thinkers seem to agree that we form some kind of mental pictures, or conceptual models, of an outside world inside our own minds, and that these conceptualisations constitute a basis for our understanding of reality and our actions vis-à-vis this reality.

As suggested by Ogden’s triangle (Ogden & Richards, 1956), shown in *Figure 31*, (symbolic) data can be seen to represent, or stand for, a real-world phenomenon, but this relationship is only indirect, since it depends on the real-world phenomenon first being mentally conceptualised by a human being.

Since symbolic data are themselves a part of reality, they may again be perceived by human beings, and re-interpreted into concepts and information. The interpreter may be the person who originally stored the symbolic data, but it may also be somebody else. In the former case, the data may remind the person about something that he or she has already forgotten, and in the latter case the symbolic data may be part of a communication process between the two persons involved.
When a person stores symbolic data in some physical form, or medium, outside the human mind, e.g. on a stone, a piece of paper, or in a computer, the person uses the medium as an extension and amplifier of the memory capacity of her own mind. Similarly, a person may use symbolic data and data processing tools as extensions and amplifiers to her own information processing capabilities. Consider for instance an engineer analysing and solving construction problems by creating and manipulating mathematical symbols and models, supported by instruments like pencil and paper or software-supported computers.

When symbolic data are used for storing and communicating information over time and space, the storage and communication processes may be far from perfect. In fact, one can never know if one person interprets the same data in the same way as another person. One cannot even be sure that the same person will interpret the same data in the same way at different points of time. Different persons, and the same person at different times, will have different frames of reference, and this is one important reason why the interpretations are likely to be different.

Langefors (1995) describes the mental process of interpreting data into information by means of the infological equation

\[ I = i(D, S, t) \]

where

- \( I \) is the information contents obtained by a human being
- \( i \) is the process of interpretation and creation of meaning
- \( D \) is the received data
- \( S \) is the frame of reference, or accumulated knowledge, used by the interpreter
- \( t \) is the time used for interpretation

So far we have analysed how an individual human being may form concepts and information, and how a person may use data and man-made tools in order to amplify her own mental capabilities and communicate with other individuals. But the human being is, to a higher or lesser degree, a social creature. We do things together, both because we like to do things together, and because we need to do them together. In a modern society we are in fact extremely dependent on each other, and it is hard to imagine that anyone of us would survive particularly long, if we were left alone in the world. We will return to this.

**Reality as a Mental Model and Social Construction**

Does reality exist as something objective, independently of human beings perceiving and conceptualising it? This question has been debated by philosophers through ages. An extreme position is that reality exists only in my mind; thus the objective reality is only an illusion; if I cease to exist, so does reality.\(^6\) Most people today are probably convinced that there is an external reality that existed before me and that will continue to exist after I have passed away. But how “objective” is this reality, and how independent is it of the mental models in our minds? There are certainly physical things like mountains, trees, buildings, etc, that seem to have an objective and independent existence; these are things that we can perceive through our senses. But what about an abstract entity like a business or an organisation? We can perceive a lot of entities that are associated with a business, e.g. buildings, equipment, staff, etc, but we cannot perceive the business as such. Yet the

---

\(^6\) Note the distinction between the position that “my reality” is the only reality that exists, and the position that “my reality” is likely to be different from “your reality”, even if we live in “the same reality”.

81
business seems to be much more important than for example the building where the business is located. Let us assume that there is a bad business located in a bad building and a good business located in a good building. Even if these two businesses switch buildings, the bad business will probably continue to be a bad business, whereas the good business will by and large remain a good business. If all people would disappear from earth, all businesses would certainly disappear with them. A business seems to be a part of reality that exists in our minds – and only in our minds. Thus a business seems to be an example of what Berger and Luckmann (1966) call a social construction.

The existence of social constructions does not necessarily imply that the whole of reality, or all its parts, is a social construction. But there is often an element of social construction even in concepts that we normally regard as very “objective”. For example, consider the concept of a table or a chair (Based on a discussion in Flensburg, 1986). Most of us would probably claim that we have no problem distinguishing between tables and chairs; furthermore we might even claim that we are able to provide definitions of the two concepts that would make the distinction between them clear. But if we try to formulate these definitions, we will all the time find that there are chairs that fulfil proposed definitions of tables and vice versa. We cannot rely on semantic aspects only. We must at least introduce pragmatic aspects as well. For what purposes do we use tables, and for what purposes do we use chairs? As human beings being part of a certain type of society, we typically use chairs for sitting at a table, where we have placed things that we are using for whatever we are doing, alone or together with other people.

Information Processing and Data Processing
The human brain is perfectly capable of processing information without any assistance of external tools. We have already discussed how the human mind interprets perceptions from the external world in order to form concepts and information. The interpretation process is partially controlled by earlier interpretations, residing in the human being’s mind. Even if a person is born with a blank mind, or an almost blank mind, her frame of reference will be updated all the time through new perceptions and interpretations. A human being will also reflect upon the information that is already in her mind, and this process will again result in new or modified concepts, new or modified knowledge, and a new understanding of herself and the world around her. We do not know exactly how a human being “digests” information, but there are certainly elements of both induction and deduction. “Intuition” is used as a term for describing a certain type of mental processes that we cannot really analyse.

It is important to realise that information (a) cannot be stored, at least not in a literal sense, outside the human mind where it has been created; (b) cannot be communicated to other people, at least not without more or less serious, and more or less unknown, distortions. Still all humans have always wanted to do exactly these things: we want to store information outside our minds, using external storage media as an extension to and strengthening of our own capabilities of memorising and remembering, and we want to exchange information with other people, for both personal and social reasons. In order to do these things we have certain proxy processes at our disposal, given by God, developed by chance and genetic mechanisms (cf. Darwin), or invented by man. For example, we use spoken and written messages in different languages, and we use computers for processing symbolic data.

Figure 32 gives an overview of some basic interactions between:

- information and information processes in the human mind
- data representing information outside the human mind
- the real world, reality
The figure gives a dynamic view of the world. There is a basic “reality circle” where

1. A person perceives reality using her senses and possibly some man-made instruments
2. The mind interprets perception data, using her existing frame of reference
3. The mind digests existing concepts and information
4. A person decides to do something, e.g. change reality or create data, and acts accordingly
5. Reality is being changed or changes itself.

By combining these basic operations into sequences and iterations we may describe more complex phenomena. Note also that man-made instruments and tools may be used in many processes. For example, a pair of glasses or a microscope may be used when making observations of reality, and pencil and paper may be used when creating data representations.

Reality may also seem to produce data by itself, but the process is actually enabled by man-made instruments, e.g. a thermometer that registers temperature. In that sense all data are dependent on the existence of a human mind. Also when data “automatically” changes reality, e.g. in the case of a thermostat, there is a human mind behind the design and construction of the tool (cf. Langefors, 1995).

Human Interaction: Communication, Co-operation, and Conflicts

We have already noted that the human being is a social creature. We need to communicate in order to co-operate and to achieve certain goals, and, what is maybe even more important for our behaviour, we want communication and co-operation for its own sake. Even hermits need a certain amount of social contact. All human interactions are not idyllic. Sometimes we run into disagreements, conflicts, and wars, but even in such situations it seems to be a natural human
struggle to find ways out, through negotiations and compromises, i.e. through information processing and communication.

Human beings seem to have lived in collectives and societies in all times, that is, they have organised their lives together to some extent. Families, households, villages, tribes, and nations are examples of different kinds of more or less “natural” organisations. The members of a group or a society co-operate in many different ways. Sometimes a task is simply too big for a single person to manage. In other cases specialisation and division of labour turns out to be rational for achieving individual as well as collective goals.

Many societies, e.g. the Vikings, found it worthwhile to establish contacts with others, driven maybe by curiosity as much as by a desire to reach material advantages through trade and conquering. In later times the human drive to co-operate in order to achieve goals beyond the reach of individuals has translated into the formation of organisations for specific purposes, e.g. business companies, but also churches, trade unions, government agencies, hospitals, etc. Today organisations become more and more sophisticated and are themselves organised into higher-level organisations and networks. Whereas an organisation of traditional type usually has a hierarchical structure, networks have more complex mechanisms for control and co-operation. Markets represent yet another form of organised human interaction.

People are the driving force of an organisation. A concerted action requires communication between the participants. Each participant must have a clear understanding – information – about the current situation and what is expected from him or her. This in turn requires every participant to gain sufficient knowledge about professional and business-related frameworks, as well as an understanding of languages and other ways of communicating.

Earlier in this article we used the infological equation and a graphical model to clarify the distinction between information and data and to explain the importance of this distinction for understanding a human being’s usage of information and data. In order also to cover concerted human actions in order to achieve goals beyond the reach of individuals, we need to elaborate these models.

**Direct and Indirect Communication**

*Figure 34* shows models where communication and co-operation between people have been included. Using these models, we can analyse in some detail what happens when a person A communicates with a person B. We may distinguish between direct and indirect communication.

Direct communication may mean that Person A decides to represent some piece of information in her mind with some data (e.g. a spoken statement) that can be perceived and interpreted by Person B. Next step is the inverse process: i.e. Person B replies.

Other situations that can be described by the same pattern are telephone calls, fax transmissions, exchange of surface mail and e-mail, etc. The communication may not always be instantaneous, but it will still be regarded as direct as long as it is sent directly to some identified person(s).

Another important type of direct communication is a non-verbal one. We are part of each other’s reality. Movements, postures and other signals provide rich and varied forms of direct communication. In spite of broadband, TV-conferences, teleworking and telecommuting, face-to-face communication will remain to be of great importance. It is easy to forget that in these days, “Man is man’s joy” (Havamal).
Indirect communication is characterised by the fact that data produced by A is stored and possibly processed by a man-made data processing system from where it can be retrieved by B and other people, not necessarily known to A, possibly long after A stored the original data. This is shown to the right in Figure 34.

Languages using symbolic data have tremendously increased man’s abilities to communicate both directly – the message is delivered unchanged – and indirectly – the message is processed and combined with stored data before being perceived by the receiver.

**Communication over Time and Space**

Due to the shortcomings of human memory, man has been using different techniques for a long time to improve the preservation of information. Nowadays paper and pencils (and electronic equivalents) are important tools for storing and retrieving data of a not-so-well-structured type.

Storing and retrieving data could be looked upon as communication between people over time. Our abilities to remember have grown. In the old days a human being’s mental capabilities to remember was almost the only way for carrying the heritage from generation to generation. Sophisticated methods were developed to ensure this – our ancestors were much more skilled than we are.

Our abilities to eliminate the time gap by storing and later retrieving data have increased substantially by the use of written languages. It has been, and still is, a major tool for accumulating human experiences over the generations. Dramatic improvements in this respect have taken place in the “Gutenberg Galaxy” and now in the Cyberspace.

Communication over longer distances was once solved by the use of couriers (Marathon). This was later improved by the use of written messages carried by a messenger. In order to decrease the delivery times, flagstaffs and smoke-puffs were tools used to communicate over a distance. Recent inventions are the telegraph, telephone, and radio. Now we live in cyberspace, where huge amounts of data are available immediately and everywhere.

Other technological developments have also substantially improved our abilities to expand the richness of our data by the use of photos, pictures and other iconographic data.

Data processing systems can be seen as offering proxy processes for human exchange of information over time and space. If A is an archivist, and B is a researcher using data archived by A, A and B may
not know each other, and they may not even live during the same century. Yet, thanks to the stored data, there may be some kind of communication between A and B. Obviously, this communication will not be perfect – there are many sources of error in the communication process – but there are ways to improve the quality of this kind of communication. However, such improvements require a good understanding of the distinction between information and data.

Sharing of Data and the Need for Metadata
We have just described a situation where people share data (over time and space). Sharing of data is actually a proxy process for sharing of information; as we already know, sharing of information is fundamentally impossible. We can only do our best to improve the chances that different persons sharing the same data will interpret them in the same, or at least similar, ways. How can we do that? A person’s interpretation of data depends on the person’s frame of reference, which consists of concepts and information in the person’s mind. If two persons have the same, or at least compatible⁷, frames of reference, it seems likely that they will interpret the same data in similar ways.

But how do we know that two frames of reference are compatible? They cannot be inspected or compared with each other, at least not directly, without intermediary data processes that will anyhow introduce uncertainties and errors into the comparisons. A frame of reference is the product of life-long learning, driven by the person’s perceptions and reflections. Thus one thing that would increase chances that two persons have compatible frames of reference is that they share similar experiences. If this is not the case, we may try to make the frames of reference more compatible in some other way, e.g. by documenting essential parts of the respective frames of reference and making these documentations available to the persons who need to be able to communicate and share data. This again means representing information by data. Since these data represent background information needed for proper interpretation of other data, we call them metadata; data about data. The communication of metadata is subject to the same fundamental difficulties as the communication of the basic data that they describe, but even so, adequate metadata will reduce the range of possible interpretations of the data that they describe, and thus improve the chances of different persons making similar interpretations of the same data. In other words we increase the intersubjectivity of the data.

Concerted Actions Towards Goals
Adequate information management is especially important when we try to co-ordinate the actions of individuals and groups in complex and unpredictable situations, e.g. in a military campaign, or when managing a multi-national enterprise.

An organisation’s total information system is made up from the mental concepts and frameworks of the participants in the organisation, the data passed to and between the participants (processed along the road), and the resulting individual perceptions and understandings of the situations leading to individual actions. These actions are expected to lead to the fulfilment of shared goals.

Concerted actions towards goals are facilitated by

- common understanding of goals (some of which may be conflicting)
- good communication
- common culture, languages, coding conventions
- compatible frames of reference

---

⁷ Two frames of references are compatible (for a certain purpose) as long as they do not (severely) contradict each other in relevant parts.
• common data and metadata

Individual actions and, even more so, concerted actions by people in co-operation often benefit from a certain amount of planning. In a collective planning process, the participants develop shared descriptions of

• the present situation
• a desirable future situation
• possible ways of getting from the present situation to the desirable situation

The descriptions can be seen as models, and this is an example of how data in the shape of models can be used as instruments for people (alone or in co-operation) to control an external reality.

**Human Beings and Computers**

Computers have become very important tools in this world of information and data but the relationships between humans and computers have varied over the years. When computers first came around they were literally computers; they helped human specialists, physicists and engineers, to make computations in a fast and accurate way. The computers were more advanced and more efficient than the calculators that had existed before, but they were calculators. They were extensions to the human specialists that used them, and they amplified the computational capabilities of their users. The humans were still in full control of their new tool.

At this time the governments in many countries, including Sweden and the United States, appointed committees, where highly qualified experts were asked to estimate the number of computers needed in the future. The prognoses typically indicated that a country would need one, two, or possibly three computers. It should be noted the even the biggest and most powerful computers in those days had much less capacity than the simplest PC has today.

How could the experts be so wrong in estimating the need for computers? There were several reasons. The computers were still very expensive, and it was hard to justify the purchase of a computer. The experts did not foresee the rapid technical progress that would make computers dramatically more powerful and less expensive in a near future. Neither did they take into account that, once computers existed, they would not only solve existing mathematical problems more efficiently, but they would also make it possible to solve new categories of more complex mathematical problems that had not even been possible to consider before.

However, most importantly, the experts were not imaginative enough to realise that computers had the potential to be useful for many other categories of data processing tasks than solving complex mathematical problems. But, as is often the case, when a technical novelty gets used by more and more people, quite unexpected things start happening. Many innovations are driven by curiosity and even by mistakes.

Thus it was soon discovered that computers could do much more than computing. Computers turned out to be well suited to assist human beings with tedious and error-prone tasks like accounting, invoicing, production of statistics, and even quite trivial data shuffling. New categories of people were introduced to computers, and these users had a need for more complex man/machine interfaces than the mathematicians, who just fed the computer with some equations and a few numbers and often expected only a few numbers in return.
Computers were still big, monolithic\(^8\), and very expensive creatures, so all users had to share the same computer. Obviously all of them could not be in the computer room, at least not at the same time. New professions were created: operators, systems programmers, data entry staff, and application programmers, who all acted as middle-persons between the real users and the computer. The real users were now called “end-users”, since they were at the end of a long chain of computer servants. In order to clearly demonstrate their newly acquired status, and not to be unduly disturbed by the end-users, the computer operators and systems programmers, headed by a manager of computer operations, took on white coats, like doctors, and locked the door to the computer room, which now became a so-called closed shop. The application programmers and the data entry staff, to say nothing of the real users, who were now almost forgotten, had to abide outside the closed door, waiting patiently for their turn, which, with some luck, could come approximately once per day.

When this moment occurred, the end-user should have submitted a consistent and complete requirement specification, handed it over to an application programmer, who then converted the specification into a computer program in some user-friendly, high-level programming language, like COBOL\(^9\), after which a data entry operator converted the COBOL program into a bunch of punched cards, and put it in a queue outside the door to the closed shop. The compilation (translation) of the COBOL program on the card deck into machine-readable code would be done by the computer during the following night, and in the morning the application programmer would have to search through a heap of listings outside the closed shop, in most cases just to find that he or she had made some syntactic errors that had prevented the compiled code from being executed. When the programmer had managed to eliminate all syntactic errors, the computer would be able to run the program, but the results would probably be wrong anyhow, because of some logical errors in the program. After some further debugging, testing, and running, the end-user would finally get the results, possibly only a few weeks after the day he or she had submitted the specification to the programmer.

The real users were separated from the computers by staff and technology.

Then there was a revolution. On-line terminals appeared which made it possible for users outside the closed shop to be in direct contact with the computer. Note that in this context the user was initially not the real user, the end-user, but the application programmer, who was now also regarded as a user, since he or she was sitting outside the closed shop. After some further efforts, the application programmers learnt how to develop interactive applications for the end-users, who were then also able to communicate directly with the computer behind the locked door from their terminals. Note how well the words “end-user” and “terminal” describe the real position of the users/customers who were supposed to be served by the computer and the computer servants. It is an indication of a computer-centred world view or “Weltanschauung”.\(^10\)

After yet another decade there was another revolution – and this time it was a real revolution, since it implied a shift of power from the computer servants in their white coats to the real users, the end-users. We refer to the introduction and striking success of personal computers, or microcomputers as they were called by the technicians. Now it was clearly demonstrated what it could mean for development and progress, if a new technology becomes available for everyone. Many people start using the new gadget like a toy. But even if only some small fraction of the usage of a gadget leads to something useful, if only by chance, mass usage often results in important and unexpected innovations. What the technical designers of a new tool have intended is one thing, what the users do and request may be something quite different. But the users may not have been able to specify

---

\(^8\) Monolithic, from Greek “one stone”

\(^9\) COmmon Business Oriented Language

\(^10\) The overall perspective from which one sees and interprets the world.
their needs and requests, before there existed something that could possibly satisfy them, if only partially and imperfectly to begin with.

The personal computers enabled human beings to regain control over computers and computerised data processing systems. They could once again have immediate access to computers and computer-controlled resources without any “white coat” intermediaries. When the personal computers became connected with each other and with common databases, new and more powerful forms of organised work became possible – with individual persons and collectives of persons in control.

The important effects of the PC revolution were of organisational nature. Power structures changed. This has not yet been fully understood and accepted by some surviving “white coats”, who now and then try to get their revenge. “It should not matter where the resources are, as long as they are available as if they were at your finger-tips” is a common type of argument in favour of a more centralised technical organisation. The argument is seductive, and it might even be correct – if nothing would ever go wrong. But things go wrong, and in some rare cases you may even have good reasons to break the rules and do things in another way than according to centrally imposed procedures.

We will now analyse computer-supported human activities from the perspective of human beings, that is, we put the human in focus rather than accepting the view of humans as an end-user to whom information system specialists pay lip services but still too often keep away from real power.

Implications for Computerised Information Systems
We have made it clear in this article that information and information systems (proper) can only exist in human minds. However, many people, who use the term “information system” are actually referring to, what we would call here data processing systems, or possibly computer-supported or computerised information systems: information systems and data processing systems in interaction.

Figure 35 illustrates a number of human beings (with information in their minds) interacting with a shared data processing system. The data processing system supports the information processing capabilities of humans in the sense that it stores and processes data that represent and can be (re)interpreted into information in human minds. The storage and processing functions of a data processing system are proxies of memory and information processing functions of human minds.
Computers have certain advantages over the human brain, mainly by being faster and more accurate in certain types of operations. Because of this, data processing systems may be used for amplifying certain human capabilities. On the other hand, human beings have also certain advantages over computers. For example, humans have creativity, imagination, and intuition, and are capable of contextual thinking and unexpected associations.

Human beings, equipped with suitable, computerised data processing systems, can obviously achieve much more than human beings alone or in co-operation with each other. But these “bastard systems” are not without problems. We have already discussed how important it is that the human users of data processing systems are in full control, preferably without any intermediaries. Only then can people feel that they have a really efficient tool that fits into their hands, or rather their minds; the computerised system becomes a natural extension to the human mind.

Another class of problems have to do with the distinction between information and data that we have also discussed. Data in data processing systems are never perfect representations of anyone’s information. Nor are they objective in the sense that they will automatically be interpreted in the same way by different people. One remedy to this problem that we have mentioned is metadata, “data about data”.

**Metadata**

Let us take a simple example to show the importance and roles of metadata. Consider a statistical table. We look into the table, and somewhere in it we see a cell containing the figure 12345. This figure is data. Seen in isolation it tells us nothing. However, if we know something about statistical tables, we know that there are labels in so-called stubs and headings that briefly describe the intended contents of the cell. For example, we may find out that 12345 is supposed to be “the average income during the year 2002 of people living in city C”. This gives us an idea of the meaning of the data in this table cell. But there are still many uncertainties. What is meant by “income”? Is it income from regular work only, or does it include extra incomes, income from capital, pensions,
allowances, ...? And who were the people living in C during 2002? Everyone living there some time of the year, and if so, how has their income been made comparable with the incomes of those who have lived in C for the whole year? And how precise is the figure 12345? Is it based on data about all persons in C, or is it based on a so-called sample survey, which implies a certain sampling error? Have the data been obtained by means of a questionnaire, and if so, have all respondents understood the questions properly, and have they returned complete data? Have they answered the questions truthfully, or have they had reasons to overestimate or underestimate their incomes, implying a so-called bias?

In order to be able to answer questions like these, we need metadata together with the data. Metadata have a similar relation to data, as the frame of reference (in the human mind) has to perception data entering the human mind. Furthermore both data processing systems and humans require metadata in order to be able to process data.

Metadata may have several roles. They may describe the (intended) meaning of data, the precision of data, the origin of data, the format of data, etc. Very often it is not enough to describe the data as such, information about the processes behind the data is also needed. Let us return to our income example above. It makes a difference in many respects, if income data come from a survey, where the respondents are anonymous, or whether they come from an administrative system managed by a taxation authority. And we need to know what efforts the data producer has made in order to check the quality of the data and investigate suspicious data (possible errors).

Naturally metadata can never be perfect. They can never completely bridge the gap between data and information, and they cannot ensure that different users of the data will interpret them in exactly the same way, even less ensure that the data are interpreted in a “correct” way. But metadata can reduce the discrepancies between different users’ interpretations and improve the conditions for constructive communication between people, without too many misunderstandings – provided of course that the persons communicating want to understand each other.

It should also be noted that some tasks performed by humans and organisations are more demanding in terms of “information harmony” between people than others. If we are conducting research, or if we are going to make an extremely important decision with implications for many people for a long time, we need to be much more rigorous in our communication and information management than if we are engaged in a casual discussion at a dinner party.

The scope of communication and co-operation must also be taken into account. A prime minister speaking to voters with widely varying backgrounds and mental frames of reference has another problem than people working and living together in a small organisation, e.g. a local company, or even a household.

A collective of people who are working together need to share conceptual frameworks and a communication language in order to co-operate efficiently and effectively. These frameworks and the terms of the language and their meaning may be more or less unique for the organisation. The more they are adapted to the task of the organisation, the more unique they are and the less understandable they are for outsiders. Jargon within the guild may be very effective for the insiders but excludes the outsiders. This also strengthens the development of group feelings and of feeling of belonging, but it may also induce destructive thinking: “It is us against them; we are good, and they are stupid”.

91
Data Systems as Business Infrastructure

Information, information and data processing, and data systems are integral parts of a business. A lot of information processing in the daily life of an organisation may not even be recognised as information processes, e.g. informal communication during coffee-breaks and gossiping in the corridors. The more structured and formalised the information and the information processing is, the more likely it is that it is explicitly recognised and handled by some kind of consciously designed and computer-supported data system. Formalised information systems may or may not be more efficient than informal exchange of information. For example, it is often efficient for the organisation to make sure that important knowledge about key processes are not dependent on the presence of individual persons, but is well documented and easily available from a common knowledge base – as we discussed in connection with “tacit knowledge”. On the other hand “management by coffee-drinking” is often a more efficient way of influencing the employees of an organisation than written orders or formalised information meetings.

We may look upon all the information and data systems of a business together as a system, or network, where people are the main components, processing information by their minds, possibly assisted by computerised tools.

Computer-supported data systems nowadays cover most areas of a business. They are more advanced, better integrated, and easier to use than they used to be in the past, and they are becoming an indispensable part of the business infrastructure. Figure 36 visualises the data systems infrastructure of a business. It indicates that the infrastructure consists of a network of loosely coupled business-internal and business-external data systems.

![Figure 36. The data systems infrastructure of a business](image)

The _operative systems_ are the traditional data system applications of a company: order management, production control, inventory, customer management, accounting, personnel. Today many of these applications may be covered by a so-called enterprise system. The applications focus on the management of individual objects and transactions like specific orders, customers, suppliers, employees etc. Since the data directly affect individual cases of individual people and enterprises, it is important that the data in these systems is correct and up-to-date. This kind of data and information is called operative data and information, object-specific data needed by basic operations in the business.

The _analytical systems_ manage data needed in the evaluation of business processes on different levels and in high-level planning and decision-making. This kind of data, analytical data, often consists of statistics and is also called directive data. Analytical or directive data systems often rely on data input from operative data systems. However, analytical data usually need not be as precise and up-
to-date as operative data; it is enough if it has good statistical quality. The purpose of directive data is to improve the quality of decisions.

Office systems, including personal systems, are systems that the employees of an organisation use for managing their own daily work, including communication with others, inside and outside the organisation. Office systems also facilitate for the employees to provide the administrative systems of the organisation with necessary input. Examples of office systems are word processors, spreadsheets, calendars, time accounting systems, knowledge and contents management systems, etc. The office systems may also provide entries to other internal and external systems that are part of the data and communication systems infrastructure. The organisation’s intranet is typically used for this purpose.

It is becoming more and more common for organisations to make external systems more or less integrated parts of their own data systems infrastructure. For example, links to websites of other businesses and government organisations may be of interest for business operations as well as administration (e.g. travel management) and knowledge retrieval. Web links are examples of loose integration. The co-operation with suppliers, customers, and other partners may benefit from stronger forms of integration, e.g. so-called extranets.

Household systems, or home systems, may also become part of the data systems infrastructure of a business. Employees may sometimes work from home and may need access to at least some parts of the data systems infrastructure of the business. Furthermore, households and individuals may also be customers, and as such they may prefer to maintain their relations with the business via the Internet (e.g. electronic banks and other e-businesses).

Many tasks in business processes will require smooth interactions between the different categories of data systems visualised in Figure 36. There is no sharp borderline between what belongs to different systems.

One desirable feature of the data systems infrastructure of a business is that the different systems that are part of the infrastructure should be easy to integrate with each other. Furthermore, it should be easy to add other internal and external data systems in the future. Thus the infrastructure should be an open network of co-operating systems.

Operative and Directive Data Systems
Operative information is necessary for the basic operations of an organisation, “the daily business”. For example, a retailer must know the prices of the products to be sold, a library must know who has borrowed their books, an airline company must have a reservation system in order to be able to book passengers, etc. Without all necessary operative information, a business will stop working more or less immediately. Directive information, on the other hand, is used as a basis for non-routine, managerial decisions.\footnote{Here “directive information” should be interpreted as “information that gives direction or guidance”. It should not be mixed up with directives in the sense of (e.g. military) orders or commands.} Examples of such decisions are

- whether the company should invest in a new production plant, and if so, where to locate it
- which products to focus on in a forth-coming marketing campaign
- whether information services offered on the company’s web-site should be free of charge
- whether the company should put a bid on another company, and if so, what price should be offered
Directive information is also used in the evaluation of business processes on different levels as well as in research and development processes. Directive data often appear in the form of statistics, presented in tables or graphs. However, it should also be noted that a lot of information that is used for managerial decision-making is of a more or less informal nature, based upon the decision-maker’s personal intuition.

Directive data are not necessary, strictly speaking, for the daily business of an organisation. However, they are expected to improve the quality of planning and decision-making. Directive data may be of critical importance for the survival of the business, especially if it operates in a competitive environment.

It is relatively easy to find out which operative data are needed by a certain business. In principle you identify the information that is needed by the basic business processes of the organisation. Once you have identified all this information, there is no need to argue about whether data representing this information are needed or not. They are needed. If you think they are expensive to produce, you still cannot avoid it, but maybe you can find a more efficient way to produce them.

The situation is quite different for directive data. In a technical sense, many managerial decisions can be taken without any computer-produced data at all. As an example, suppose your business is going to invest in a new factory somewhere. You have a choice between two sites, A and B. As a serious, rational manager, you will probably ask for a lot of data, before you make the decision. But why not toss a coin instead? It will save you a lot of time and a lot of work as well.

There are at least two reasons why a typical western business manager would collect and evaluate data to become informed before an important decision is taken. The first reason is of course an ambition to be rational. Many of us are convinced that a decision will be more rational, in the sense that it will lead to results of higher quality, if we behave like “the economic man”:

- identify decision alternatives
- collect data about the alternatives
- evaluate the alternatives
- choose the best alternative

The second reason is an ambition, typical for our culture, to be rational, or at least pretend to be rational, even in situations where we have de facto already decided what to do. Even in such situations we often want to present the decision as if it had been prepared according to the “economic man” model mentioned above. In other cultures there may be opposite preferences about how to present decisions. There may be a dictator who may want the decision to look like an act of God. Nevertheless, a clever dictator in such a culture may secretly collect and evaluate data and information in order to “help” God (or an oracle) to come to “the right” decision.

Another example, which has been an object of debate, is whether experts do better than monkeys on the stock market, that is, whether a data-based placement strategy will beat a strategy based upon a random number generator (or a monkey’s random choices).

It is sometimes debated among business managers, which kinds of directive data and information, and how much of it, would be optimal. Obviously it takes time and resources to collect and process directive data, so there is a balance to be struck between the costs and the benefits of such information. One extreme view on this was expressed by the managing director of a major Swedish bank, who stopped all production of management reports in his organisation. The production of such
reports would be resumed, only if there were strong and well motivated requests for them. The same managing director also claimed that budgets and prognoses are useless.

Typical tasks for operative and directive data systems are listed in Table 2.

<table>
<thead>
<tr>
<th>OPERATIVE DATA SYSTEMS</th>
<th>DIRECTIVE DATA SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automating or supporting manual and, to a large extent, repetitive processes</td>
<td>Supporting planning and control processes, which are, to a great extent, of a non-repetitive character</td>
</tr>
<tr>
<td>Supporting repetitive processes within a function, e.g. personnel administration</td>
<td>Supporting decision-making ad hoc</td>
</tr>
<tr>
<td>Taking note of regular events (transactions, operative decisions)</td>
<td>Supporting non-routine strategic decisions</td>
</tr>
<tr>
<td>Supporting a business process initiated by a customer until it is completed</td>
<td>Supporting research and development activities</td>
</tr>
</tbody>
</table>

*Table 2. Typical tasks for operative and directive data systems*

Real world data systems often support a combination of operative and directive tasks. For example, a personnel management system, or a customer management system, may support both routine and non-routine decisions and actions. Another example is a banker, who is handling a loan request from a customer; the banker may use a directive data system in order to determine whether the request should be granted, and if the request is granted, the banker may use an operative data system in order to settle the details of the loan business between the bank and the customer.

In business processes where operative and directive tasks appear closely together, it may be clarifying to analyse the operative and directive subsystems separately. *Table 3* contrasts some typical properties of operative and directive data systems.

<table>
<thead>
<tr>
<th>OPERATIVE DATA SYSTEMS</th>
<th>DIRECTIVE DATA SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users and usages known at systems development time</td>
<td>Users and usages partially unknown at systems development time</td>
</tr>
<tr>
<td>Provide data that is necessary for operative processes; the information must be provided despite costs</td>
<td>Provide data that improves the quality of directive processes; there is a trade-off between value and cost</td>
</tr>
<tr>
<td>Repetitive usage</td>
<td>Ad hoc usage</td>
</tr>
<tr>
<td>Data collection is well planned and forms an integral part of the system</td>
<td>Combine available data from different sources</td>
</tr>
<tr>
<td>Strong connections between collection and use of data</td>
<td>Data are used for different purposes than those originally intended</td>
</tr>
<tr>
<td>Users know the meaning and quality of data relatively well</td>
<td>Metainformation has an important role: information about definitions and quality</td>
</tr>
</tbody>
</table>

*Table 3. Typical properties of operative and directive data systems*
A directive data system should serve situations, which can only partially be foreseen at systems development time. When a concrete, directive data need becomes manifest, for example when a decision-maker is going to make a concrete decision, there is seldom time to change the data system, or even to collect new data. Thus the user must use existing systems and existing data. On the other hand, in an operative data system the usage situations are repetitive and can often be described with good precision at system development time.

In an operative data system there are often close connections between collection and usage of data. An order receptionist, for example, adds new data to the order management system in the same process as he or she uses data from the same system. One good effect of such close connections between data collection and usage is that the user will gain a good understanding of the meaning and quality of the data in the system, i.e. is able to create good information.

In a directive data system the connections between collection and usage of data are much weaker. Data often come from several other data systems, and formalised, computerised data must often be combined with informal data from other sources, including information from the user’s own memory and judgement. In order for the user to be able to interpret the meaning and relevance of data that has been collected elsewhere and for other purposes, the data must be accompanied by some kind of “quality declaration”, or metadata.

Requirements on directive data systems are not as precise and stable as requirements on operative data systems. A directive data system must not only be able to adapt to changes in transaction volumes and other technique-related changes; it is constantly confronted with new data and processing requirements. For such a system one can never “freeze” a requirement specification; on the contrary, the system must be planned for ever on-going changes in user needs and business environment conditions.

**Information and Data System Tools**

ICT –information and communication technology – is constantly providing us with new tools for supporting our management of information and data. It started with the telegraph then was followed by the telephone, the radio, the TV and very complex network technologies such as fibre and satellites. For processing, storing and retrieving data we got mainframe computers and personal computers. Presently, there is a flow of new products such as mobile phones, hand-held computers and combinations thereof.

Our use of all these new possibilities allows our information potential to grow rapidly. People are communicating directly and indirectly, face-to-face or not, in ways never seen before. Projects are run with participants in different countries in more or less constant contact with each other and sharing documents in real time. Ad hoc meetings and demonstrations are quickly organised by established Internet communities. Football teams and military forces are using more or less complex networks for communication and data management to co-ordinate the actions of the individual persons.

**Conclusion**

The present evolution of information and communication technology and its applications creates new possibilities for people to work together and to co-ordinate their activities in order to achieve personal and common goals.

To understand and possibly control these developments, it is important to take an information and data view on the different types of enterprises we work with: societies, markets, companies, groups of people, and so on. People and computers are the nodes in such networks, where data are flowing
between the nodes, and information processing in people’s minds is leading to concerted action towards common goals. As man is the main component in these networks too much focus on data processing systems is sub-optimal. To refer to man – the main component – as the “end-user” at the “terminal” (the end of the real world – the data processing system) is a dangerous misconception of the world of information and data.

A human-centred approach requires knowledge from a number of disciplines, primarily systems theory, data systems development, information science, cognitive psychology, and philosophy. It is not enough to have a deep but narrow competence in one area – a wider perspective is necessary for the efficient management of information and data.

References


**Web portals**

References:


Web portals are useful instruments for creating entry-points to e-services, and, if designed properly, they may focus on the needs of the users, for example citizens of businesses in e-society.

The scope of a web portal may vary a lot. It may be the entry-point to a particular e-service, provided by a particular agency or company, it may be the entry-point to a wide collection of e-services, provided by an organisation, or it may be an entry-point a lot of e-services that are relevant for a particular kind of user with a particular kind of problem or need. In the latter situation, there may be services and “sub-services” from a wide range of agencies and businesses co-operating behind the scene.

A web-portal may be used to provide solutions to the problems mentioned earlier:

- The need for one-stop solutions (an organisational problem)
- The need to adapt to user equipment and user software

In order to solve the first problem, overcoming the structural clash between the user’s problem and the stove-pipe organisation of the service provider(s), the web portal service, which is visible to the user, may send messages to other services, provided by the same organisation or other organisations, asking them to do certain things, and send a message back to the requesting service, when it has done what it was asked to do. (This is an application of a service-oriented architecture, SOA.) The sub-services, may again send service requests to other sub-services, etc. When the web portal service has finally got responses from all sub-services that it has used, it may give a response to the service request from the user, hopefully providing a complete solution to the user’s problem or need.

The process just described may be quite complex, involving several organisations (agencies and/or businesses), and several departments within each organisation. An important technical problem in this context is to manage what happens, if the processing of a particular user request should be broken at some stage, either voluntarily by the user, or because some sub-service was denied, for example a credit card payment, or because of some kind of technical error. The whole user request must then be rolled back, so that the statuses of all systems and subsystems are reset to what they were before the user request was initiated.

In order to solve the second problem, adapting the service to any kind of user equipment and/or software, the web portal and the services that can be initiated from the web portal are made available to all kinds of technical environments in user devices.

**What is a web portal?**

The term **web portal** usually refers to a Web site that acts as a gateway to other Web sites. In other words, portals are Internet-based sites that present information from multiple sources in a coherent fashion and that allow Internet users to access other Web sites.

Usually, web portals serve as an anchor site for Internet users when they are initially connecting to the Web. They typically offer a range of information resources and often give users some basic services. For example, most Internet portals provide users with access to search engines, community chat forums, personalized home pages, and email access. In addition, a portal can allow users to check news headlines, review stock prices, obtain driving directions, or get up to speed on entertainment gossip.

Ideally, web portals provide users with basic functionality, such as search and navigation capabilities and information management. As technology becomes more advanced, some of these gateways are also offering users the ability to customize their portal pages to fit their own individual interests. For instance, some portals allow a user to customise weather reports so that the weather forecast is automatically provided for a specific city.

National, state, provincial, and local governments may use portals in order to communicate with their citizens. These sites can include everything from news about the country, province, state, or city to information about government services and departments. A government portal may also include statutes, speeches, consumer guides, and tax information. Some of these sites also provide job, education, and public safety notices.

Corporate portals are also growing in popularity. A corporate portal can provide both employees and customers with a range of self-service activities. For example, employees may be able to use their corporate gateway to review their benefits information, paycheck data, or corporate documents and notices. Similarly, customers may use these sites to perform basic tasks around the clock, such as reviewing invoice and payment history, accessing purchase quotes, tracking product shipments, and collaborating on projects. Generally, these corporate sites are accessed using secure authentication sign-on methodologies.

**Related wiseGEEK Articles**

- What Is a Voice Portal?
- What Is a Self-Help Portal?
- What Is a Community Portal?
- What Is an Internet Portal?
- What Is a Portal Application?
- What Is a Business Portal?


A **web portal** is most often one specially-designed Web page at a website which brings information together from diverse sources in a uniform way. Usually, each information source gets its dedicated area on the page for displaying information (a portlet); often, the user can configure which ones to display. Variants of portals include Mashup (web application hybrid) and intranet ”dashboards” for executives and managers. The extent to which content is displayed in a "uniform way" may be more or less depending on the intended user and the intended purpose as well as the diversity of the content. Very often design emphasis is on a certain "metaphor" for configuring and customising the presentation of the content and the chosen implementation framework and/or code libraries. In
addition, the role of the user in an organization may determine which content can be added to the portal or deleted from the portal configuration.

A portal may use a search engine API to permit users to search intranet content as opposed to extranet content by restricting which domains may be searched. Portals provide a way for enterprises and organizations to provide a consistent look and feel with access control and procedures for multiple applications and databases, which otherwise would have been different web entities at various URLs. The features available may be restricted by whether access is by an authorised and authenticated user (employee, member) or an anonymous site visitor.

In the late 1990s the web portal was a web IT buzzword. After the proliferation of web browsers in the late-1990s many companies tried to build or acquire a portal to attempt to obtain a share of an Internet market. The web portal gained special attention because it was, for many users, the starting point of their web browsing if it was set as their home page.

The interest in portals saw some old media companies racing to outbid each other for Internet properties but died down with the dot-com bust in 2000 and 2001.

**Different types of web portals**


**Horizontal and vertical web portals**

A horizontal portal is used as a platform to several companies in the same economic sector or to the same type of manufacturers or distributors.

A vertical portal is a specialised entry point to a specific market or industry niche, subject area, or interest. Some vertical portals are known as "vertical information portals" (VIPs). VIPs provide news, editorial content, digital publications, and e-commerce capabilities. In contrast to traditional vertical portals, VIPs also provide dynamic multimedia applications including social networking, video posting, and blogging.

**Personal portals**

A personal portal is a web page at a web site on the World Wide Web or a local HTML home page including JavaScript and perhaps running in a modified web browser. A personal portal typically provides personalised capabilities to its visitors or its local user, providing a pathway to other content. It may be designed to use distributed applications, different numbers and types of middleware and hardware to provide services from a number of different sources and may run on a non-standard local web server. In addition, business portals can be designed for sharing and collaboration in workplaces. A further business-driven requirement of portals is that the content be presented on multiple platforms such as personal computers, personal digital assistants (PDAs), and cell phones/mobile phones. Information, news, and updates are examples of content that would be delivered through such a portal. Personal portals can be related to any specific topic such as providing friend information on a social network or providing links to outside content that may help others beyond your reach of services. Portals are not limited to simply providing links. Outside of business intranet user, very often simpler portals become replaced with richer mashup designs. Within enterprises, early portals were often replaced by much more powerful "dashboard" designs. Some also have relied on newer protocols such as some version of RSS aggregation and may or may not involve some degree of web harvesting.
News portals

The traditional media houses try to adapt to the new technologies by creating news portals.

Government web portals

Many governments have created portal sites for their citizens. These include primary portals to the governments and their agencies as well as portals developed for specific audiences. Examples of government web portals include:

- [australia.gov.au](https://australia.gov.au) for Australia
- [USA.gov](https://www.usa.gov) for the United States (in English) & [GobiernoUSA.gov](https://gobiernousa.gov) (in Spanish)
- [Disability.gov](https://www.disability.gov) for citizens with disabilities in the United States
- [Europa (web portal)](https://europa.eu) links to all EU agencies and institutions in addition to press releases and audiovisual content from press conferences
- [gov.uk](https://www.gov.uk) for citizens & [businesslink.gov.uk](https://www.businesslink.gov.uk) for businesses in the United Kingdom
- [Health-EU portal](https://health-eastern-slovenia.eu) gathers all relevant health topics from across Europe
- [india.gov.in](https://www.india.gov.in) for India
- [National Resource Directory](https://nationalresourcedirectory.gov/) links to resources for United States Service Members, Veterans and their families
- [Saudi.gov.sa](https://www.saudi.gov.sa) for Saudi Arabia

Cultural portals

Cultural portal aggregate digitised cultural collections of galleries, libraries, archives and museums. This type of portals provides a point of access to invisible web cultural content that may not be indexed by standard search engines. Digitised collections can include books, artworks, photography, journals, newspapers, music, sound recordings, film, maps, diaries and letters, and archived websites as well as the descriptive metadata associated with each type of cultural work. These portals are usually based around a specific national or regional groupings of institutions. Examples of cultural portals include:

- [DigitalNZ – A cultural portal led by the National Library of New Zealand focused on New Zealand digital content.](https://digitalcollections.govt.nz)
- [Europeana – A cultural portal for the European Union based in the National Library of the Netherlands and overseen by the Europeana Foundation.](https://www.europeana.eu)
- [Trove – A cultural portal led by the National Library of Australia focused on Australian content.](https://trove.nla.gov.au)
- [Digital Public Library of America](https://dp.la)

Corporate web portals

Main article: [Intranet portal](https://en.wikipedia.org/wiki/Intranet)

Corporate intranets became common during the 1990s. As intranets grew in size and complexity, webmasters were faced with increasing content and user management challenges. A consolidated view of company information was judged insufficient; users wanted personalisation and customisation.

Many companies began to offer tools to help webmasters manage their data, applications and information more easily, and through personalized views. Portal solutions can also include workflow management, collaboration between work groups, and policy-managed content publication. Most
can allow internal and external access to specific corporate information using secure authentication or single sign-on.

Corporate Portals also offer customers & employees self-service opportunities.

**Stock portals**

Also known as stock-share portals, stock market portals or stock exchange portals are Web-based applications that facilitates the process of informing the share-holders with substantial online data such as the latest price, ask/bids, the latest News, reports and announcements. Some stock portals use online gateways through a central depository system (CDS) for the visitors (ram) to buy or sell their shares or manage their portfolio.

**Search portals**

Search portals aggregate results from several search engines into one page.

**Tender's portals**

Tender's portals stands for a gateway to search/modify/submit/archive data on tenders and professional processing of continuous online tenders.

With a tender portal the complete tendering process—submitting of proposals, assessment, administration—are done on the web.

Electronic or online tendering is just carrying out the same traditional tendering process in an electronic form, using the Internet.

Using online tendering, bidders can do any of the following:
- receive notification of the tenders
- receive tender documents online
- fill out the forms online
- submit proposals and documents
- submit bids online

**Hosted web portals**

Hosted web portals gained popularity a number of companies began offering them as a hosted service. The hosted portal market fundamentally changed the composition of portals. In many ways they served simply as a tool for publishing information instead of the loftier goals of integrating legacy applications or presenting correlated data from distributed databases. The early hosted portal companies such as Hyperoffice.com or the now defunct InternetPortal.com focused on collaboration and scheduling in addition to the distribution of corporate data. As hosted web portals have risen in popularity their feature set has grown to include hosted databases, document management, email, discussion forums and more. Hosted portals automatically personalise the content generated from their modules to provide a personalized experience to their users. In this regard they have remained true to the original goals of the earlier corporate web portals. Emerging new classes of internet portals called Cloud Portals are showcasing the power of API (Application Programming Interface) rich software systems leveraging SOA (service oriented architecture, web services, and custom data exchange) to accommodate machine to machine interaction creating a more fluid user experience for connecting users spanning multiple domains during a given "session".

102
Domain-specific portals

A number of portals have come about that are specific to the particular domain, offering access to related companies and services, a prime example of this trend would be the growth in property portals that give access to services such as estate agents, removal firm, and solicitors that offer conveyancing. Along the same lines, industry-specific news and information portals have appeared, such as the clinical trials specific portal: IFPMA Clinical Trials Portal

Engineering aspects


Overview
The main concept is to present the user with a single web page that brings together or aggregates content from a number of other systems or servers.

The application server or architecture performs most of the crucial functions of the application. This application server is in turn connected to database servers, and may be part of a clustered server environment. High-capacity portal configurations may include load balancing strategies.

For portals that present application functionality to the user, the portal server is in reality the front piece of a server configuration that includes some connectivity to the application server. For early web browsers permitting HTML frameset and iFrame elements, diverse information could be presented without violating the browser same-source security policy (relied upon to prevent a variety of cross-site security breaches.) More recent client-side technologies rely on JavaScript frameworks and libraries that rely on more recent web functionality such as async callbacks using HttpXMLRequests.

The server hosting the portal may only be a "pass through" for the user. By use of portlets, application functionality can be presented in any number of portal pages. For the most part, this architecture is transparent to the user.

In such a design, security and concurrent user capacity can be important issues, and security designers need to ensure that only authenticated and authorized users can generate requests to the application server. If the security design and administration does not ensure adequate authentication and authorization, then the portal may inadvertently present vulnerabilities to various types of attacks.

Tools
One currently popular client-side library is jQuery. Service-Oriented Architecture (SOA) is one server-side example of how a portal can be used to deliver application server content and functionality. SOAP was one of the early XML-based protocols used for servers to communicate within such an architecture. Many such approaches still relied on a Java applet on the client side or, more often, the extensive use of JavaScript on the client side. Some servers used advanced programming paradigms to generate the JavaScript within the HTML to be rendered by the client browser or by site-specific or task-specific browsers (the latter are more common in government agencies with military and security responsibilities).

While Java is now less often used with a browser plug-in, Java remains a major implementation language for complex server-side implementations of secure portal designs with heavy concurrent loads. Apache Tomcat with JBoss using JMS, JMX and related Java services are very common
implementation elements. There is some indication of recent reimplementations and new designs moving from XML to JSON and from SQL to NoSQL implementations given the successes achieved by Google and by Amazon.

Sociological problems
Very often the client implementation programmers are unaware of the engineering history relating, say, Ruby and Objective-C to Smalltalk or JavaScript to LiveScript and Self with the attendant risk of "re-inventing" if not the wheel, then, say, the inflated rubber tire on the wheel rim. Client-side developers often have no experience as server-side developers in languages such as C or in high-level alternative languages that are not often encountered in HTTP client implementations.

The failure to recognise the advantages of some seldom learned programming languages either for server-side aggregation tasks or for generating JavaScript suited to the aggregated information remains a challenge in portal design and implementation and is often aggravated by out-sourcing to countries whose technical institutes tend to graduate either C/C++ or Java or JavaScript "programmers" rather than computer science graduate software engineers. This phenomenon is more striking in recent server-side "programmers" who "code" only in Python or only in Ruby, just as it has been a long-standing issue in non-portal dynamic web pages produced by "PHP-only" programmers. The problem is further aggravated by technical schools which move from introducing computer science as "programming in Java" to CS as "programming in Python" while ignoring multi-paradigm languages such as Oz or even web-oriented client languages such as MIT Curl or Rebol or more mature server VM-based languages such as Smalltalk.

CS graduates often enter graduate school with no acquaintance with smart server software implemented in anything other than a general-use language. Many server-side programmers only know regular expression parsing of aggregated content and are unaware of the emergence of PEG parsing or of PEG-equivalent Rebol as an alternative to, say, Perl, grep or awk and sed. The bias for SQL in DBMS selection and for XML in data format selection is a topic in sociology of business computing and IT management. The opportunity cost of such non-scientific biases is another concern in an area of applied science seemingly influenced by "buzzwords" and journalists more than evidence-based research and social science. The irrationality may be amplified by HR policies and education policies without regard to economic risk. The high failure rate of portal projects is a matter of concern as is the short lifespan of some implementations and the failure to successfully replace some older designs.

Web robots, Internet bots, Web crawlers, and Web scraping

Sources:

An Internet bot, also known as web robot, WWW robot or simply bot, is a software application that runs automated tasks over the Internet. Typically, bots perform tasks that are both simple and structurally repetitive, at a much higher rate than would be possible for a human alone. The largest use of bots is in web spidering, in which an automated script fetches, analyses and files information from web servers at many times the speed of a human. Each server can have a file called robots.txt, containing rules for the spidering of that server that the bot is supposed to obey or be removed.
Bots are also being used as organization and content access applications for media delivery. **Webot.com** is one example of utilising bots to deliver personal media across the web from multiple sources. In this case the bots track content updates on host computers and deliver live streaming access to a browser based logged in user.

A **Web crawler** is an **Internet bot** that systematically browses the **World Wide Web**, typically for the purpose of **Web indexing**.

A Web crawler may also be called a **Web spider** or an **automatic indexer**.

**Web search engines** use Web crawling or spidering software to update their **web content** or indexes of others sites' web content. Web crawlers can copy all the pages they visit for later processing by a search engine that **indexes** the downloaded pages so that users can search them much more quickly. Crawlers can validate **hyperlinks** and **HTML** code. They can also be used for **web scraping** (see also **data-driven programming**).

**Web scraping (web harvesting or web data extraction)** is a computer software technique of extracting information from **websites**. Usually, such software programs simulate human exploration of the **World Wide Web** by either implementing low-level **Hypertext Transfer Protocol** (HTTP), or embedding a fully-fledged web browser, such as **Internet Explorer** or **Mozilla Firefox**.

Web scraping is closely related to **web indexing**, which indexes information on the web using a **bot** or **web crawler** and is a universal technique adopted by most search engines. In contrast, web scraping focuses more on the transformation of unstructured data on the web, typically in **HTML** format, into structured data that can be stored and analyzed in a central local database or spreadsheet. Web scraping is also related to web automation, which simulates human browsing using computer software. Uses of web scraping include online price comparison, weather data monitoring, website change detection, research, **web mashup** and web data integration.
Data modelling

See also:


Society as seen through the glasses of the general purpose official statistics produced by Statistics Sweden.

Introduction

“Relevance” is one of six major dimensions in Eurostat’s quality concept; Eurostat (2003). The other five are accuracy, timeliness and punctuality, accessibility and clarity, comparability, and coherence. Relevance must always be related to a specific use. Only a user with a specific information need may judge which statistics are relevant in that situation. What can be done in order to help a user find potentially relevant statistics and judge the relevance of retrieved statistics?

A statistical agency can do three things to help users find statistics relevant for them: (i) provide an overview over available statistics; (ii) provide search tools; (iii) provide informative metadata. I will discuss how to present overviews of available statistics, enabling users to match their mental conceptualisations of desired information against the agency’s formalised view of available statistics.

There are many pitfalls. Different persons have different mental pictures of the real world. Persons living in the same community and working on similar problems may have similar mental frames of reference. There will be bigger differences between conceptual frameworks of people from different communities or working on different problems. General-purpose statistics should meet the needs of different people, with different backgrounds, and different tasks.

Statistical agencies usually provide two access roads to official statistics: (a) through a hierarchical listing of available statistics; (b) by means of a search function. The first method is rigid. It implies one hierarchical conceptualisation of society, one classification of real world phenomena. It is not likely that this view is shared by many users. It is more likely to fit nobody’s mental picture of society. Search functions are not perfect either, even if the best ones are chosen, like the Google, since different users use different concepts and terms, and these may again be different from the concepts and terms used by statisticians designing and producing official statistics. Good thesauri may amplify the power of search functions, by making use of synonyms and other related terms, but search functions usually do not take advantage of the inherent structure of statistical information. Ideally structured search methods, free-text searches, and thesauri should be combined in a creative and intelligent way.

Human conceptualisations of reality and the problems associated with information sharing are studied by several disciplines. Philosophers speculate about the relations between the real world and the world of ideas. Psychologists study how individuals form and develop mental models of reality. Sociologists focus how people in groups and organisations affect each other’s conceptualisations; this may lead to intersubjective models of society, social constructions; Berger&Luckmann (1966). Definitions and classifications developed and used by statisticians could be seen as formalised social constructions – reality as a statistical construction. Problems come from the fact that this statistical construction may not coincide with the social constructions of users of statistics.
A simple and flexible structuring of the real world is proposed in this paper, sharable between users and producers of official statistics. It is based on a simple generic model and can be used for giving both overviews and detailed information about official statistics. It is able to accommodate a wide range of views of society. A user may, step by step, cut out a subset of potentially relevant official statistics, without having to follow any specific order or use any predefined set of terms.

A generic model of the contents of official statistics

Official statistics are often categorised into different domains, also called topics or subject matter areas, and statistical agencies are often organised in so-called stovepipes or silos based on these domains. Examples: Population, Education, Health, Law, Labour Market, Business Activities, Housing and Construction, Agriculture, Energy, Transports, Environment, National Accounts, Financial markets, Trade.

On a very general level all statistics are estimated values of parameters of populations of objects, where the parameters are summarised values of variables of the individual objects in the populations. Regardless of subject matter domain, a statistical agency counts the objects belonging to a certain population and summarises the values of one or more variables of the objects in the population. Very often the population (e.g. a population of Persons) is broken down into subpopulations, or domains of interest, by crossclassifying the objects in the population by means of a number of classification variables (e.g. Sex, Region, AgeGroup).

A user of official statistics may not be able to state exactly which parameters of which populations he or she is interested in, but faced with a short list of object types (or types of populations), and/or topics, and/or parameters/variables, he or she may be able to select a subset of official statistics of potential interest by selecting, step by step, a subset of object types (populations), variables, and parameters.

In order to be able to provide a user with short lists of object types and variables as a starting-point for the user’s “drill-down” operations, we must be able to give an overview of the contents of statistics in terms of a small number of concepts.

The populations occurring in official statistics are based upon a number of basic object types. Some of these object types may be described as (conscious) actors, objects that are capable of purposeful acting, e.g. persons and organisations (enterprises). Other objects are acted upon by the actors but are not capable of purposeful acting themselves, e.g. natural resources, products, assets; a common label for basic objects of this kind is utilities.

All actors may be counted in a straightforward way. Many utilities are also countable, e.g. buildings and vehicles, so-called cardinal utilities, but there are also utilities like oil and other substances, wealth, health, etc, which may not be counted but possibly measured in other ways, e.g. by volume, weight, or value; the latter kinds of utilities are non-cardinal or collective.

In addition to the basic object types there are different kinds of complex object types that are counted and/or measured in official statistics. Complex objects involve one of more basic objects. For example, an event, like a road accident may involve one or more persons and one or more vehicles. A trade transaction will involve a seller, a buyer, and a product. An employment relationship will involve a person and an organisation. Etc.
Complex object types may usually be categorised as **events/transactions** (instantaneous, without time extension) or **relationships/processes/activities** (lasting for a certain time period).

**The statistical reality from a helicopter perspective**

Imagine that you are hovering in a helicopter over the world seen through statistical glasses. Or imagine that you have a tool corresponding to GoogleEarth at your diposal to get overviews and zoom in at interesting parts of the statistical reality. Until we have such tools available we could do a lot with simpler surrogates. Figure 1 provides an overview of the world in terms of the simple basic concepts introduced so far.

**Focused views**

Given the simple overview, a user may zoom in on some part of it. Let us assume that the user wants to focus on population statistics. *Figure 2a* shows a basic conceptual model allegedly covering “all” statistical concepts occurring in population statistics. Three basic object types are **Person**, **Household**, and **Dwelling**. In addition there are compound object types of “event type”, here collectively referred to as **PersonEvent**, that is, events such as **Birth**, **Death**, **Marriage**, **Divorce**, **Migration**, etc. Some PersonEvents concern exactly one Person, e.g. Birth and Death, others may be defined to concern either one or two Persons (Marriage and Divorce), and Migration is an event that concerns one Person and two Dwellings (or Locations), one *from* which the person moves and the other one *to* which the Person moves.

For each object type in the model there will be a number of variables defined. For our present purposes it is not necessary to list all these variables concretely, but they will belong to two main categories: classification variables (or qualitative variables) and summation variables (or quantitative variables). Directly or indirectly observed values of summation variables are summarised when estimated values of parameters are calculated in statistical aggregation processes associated with the production of statistical cubes. The classification variables are used for spanning dimensions of the cube.

If the user wants to know more about a certain concept (e.g. an object type, a population, or a variable), he or she should be able to “right-click” on the representation of the concept and get associated metadata directly, or indirectly through chains of dynamic links.
<table>
<thead>
<tr>
<th>Actors</th>
<th>Topics</th>
<th>Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Person</td>
<td>□ Topic: Population</td>
<td>□ NaturalResource</td>
</tr>
<tr>
<td>□ Student</td>
<td>□ ActivityRelationEvent</td>
<td>□ Land</td>
</tr>
<tr>
<td>□ Employee</td>
<td>□ Topic: Education</td>
<td>□ Mineral</td>
</tr>
<tr>
<td>□ Patient</td>
<td>□ ActivityRelationEvent</td>
<td>□ Oil</td>
</tr>
<tr>
<td>□ Client</td>
<td>□ Topic: Health</td>
<td>□ CardinalResource</td>
</tr>
<tr>
<td>□ Household</td>
<td>□ ActivityRelationEvent</td>
<td>□ Locality</td>
</tr>
<tr>
<td>□ Organisation</td>
<td>□ Topic: Law</td>
<td>□ RealEstate</td>
</tr>
<tr>
<td>□ Enterprise</td>
<td>□ ActivityRelationEvent</td>
<td>□ Building</td>
</tr>
<tr>
<td>□ AgriculturalEnterprise</td>
<td>□ Topic: Labour Market</td>
<td>□ Dwelling</td>
</tr>
<tr>
<td>□ Institution</td>
<td>□ ActivityRelationEvent</td>
<td>□ Vehicle</td>
</tr>
<tr>
<td>□ Establishment</td>
<td>□ Topic: Business Activities</td>
<td>□ Product</td>
</tr>
<tr>
<td>□ BusinessActor</td>
<td>□ ActivityRelationEvent</td>
<td>□ Commodity</td>
</tr>
<tr>
<td>□ Producer</td>
<td>□ Topic: Housing and Construction</td>
<td>□ Service</td>
</tr>
<tr>
<td>□ Seller</td>
<td>□ ActivityRelationEvent</td>
<td>□ AccountingItem</td>
</tr>
<tr>
<td>□ Buyer</td>
<td>□ Topic: Agriculture</td>
<td>□ CashFlowItem</td>
</tr>
<tr>
<td>□ Provider</td>
<td>□ ActivityRelationEvent</td>
<td>□ ResultItem</td>
</tr>
<tr>
<td>□ Customer</td>
<td>□ Topic: Energy</td>
<td>□ BalanceItem</td>
</tr>
<tr>
<td>□ Subject</td>
<td>□ ActivityRelationEvent</td>
<td>□ WelfareItem</td>
</tr>
<tr>
<td>□ CounterSubject</td>
<td>□ Topic: Transports</td>
<td>□ Education</td>
</tr>
<tr>
<td>□ Owner</td>
<td>□ ActivityRelationEvent</td>
<td>□ Health</td>
</tr>
<tr>
<td>□ Possessor</td>
<td>□ Topic: Environment</td>
<td>□ Wealth</td>
</tr>
<tr>
<td>□ Employer</td>
<td>□ ActivityRelationEvent</td>
<td>□ Security</td>
</tr>
<tr>
<td>□ Employee</td>
<td>□ Topic: Environment</td>
<td>□ Security</td>
</tr>
<tr>
<td></td>
<td>□ Topic: National Accounts</td>
<td>□ Security</td>
</tr>
<tr>
<td></td>
<td>□ ActivityRelationEvent</td>
<td>□ Security</td>
</tr>
<tr>
<td></td>
<td>□ Topic: Financial markets</td>
<td>□ Security</td>
</tr>
<tr>
<td></td>
<td>□ ActivityRelationEvent</td>
<td>□ Security</td>
</tr>
<tr>
<td></td>
<td>□ Topic: Trade</td>
<td>□ Security</td>
</tr>
<tr>
<td></td>
<td>□ ActivityRelationEvent</td>
<td>□ Security</td>
</tr>
</tbody>
</table>

**Figure 1.** Official statistics from a helicopter perspective.
Figure 2a. Population statistics: Basic model.

On the basis of the simple model in Figure 2a many normalised cubes may be defined, covering all kinds of population statistics. Each normalised cube is defined by putting exactly one of the object types in Figure 2a in focus, and by selecting variables for dimensions and parameters associated with the cube. In the following figures we indicate the object type in focus by giving it yellow colour. Thus in figure 2b the object type Person is in focus. All cubes formed with Person in focus are associated with Person populations. Persons are the objects, or “statistical units” that are counted and measured, and person populations are the populations for which values of parameters are estimated. The dimensions of these cubes are spanned by classification variables of Persons (in addition to the Time and Space dimensions), e.g. Sex, HomeRegion, and the cells contain estimated values of parameters of a Person population; the parameters summarise values of summation variables of Persons, e.g. Age, Income.

Figure 2b. Person statistics.

The Person object type is associated with certain basic classification variables (like Sex) and certain basic summation variables (like Age, Income). Further classification variables may be defined by grouping summation variables, e.g. AgeGroup, IncomeGroup. We may also define so-called adjoined variables of the object type in focus (here Person) by adjoining variables of object types that are related to the object type in focus in a well-defined way. In this case, where Persons are in focus, the following categories of variables may be adjoined to Persons: (i) variables of the Household to which

110
a Person belong; (ii) variables of the Dwelling in which the Person resides; and (iii) variables of the PersonEvents in which the Person is involved.

*Figure 2c* illustrates the situation when some kind of PersonEvent is made the object type in focus. Normalised cubes based on this model will be associated with PersonEvent populations, that is, it is PersonEvents like Births, Deaths, Marriages, Migrations, etc., that are counted and measured, and it is populations of PersonEvents for which parameters are estimated, e.g. the estimated number of migrations between different regions, where Region is primarily a classification variable of the dwellings or location from and to which the migrations take place. This variable (and others) will have to be (logically) adjoined to the Migration objects, before the cube can be properly defined and the requested parameter can be estimated.

In the case of normalised cubes based on PersonEvents, the originally specified basic variables of PersonEvents may be extended by adjoined variables from related object types, in this case Persons, Households, and Dwellings; for example:

- the Sex of the Person involved in the PersonEvent
- the Size of the Household to which the Person involved in the PersonEvent belongs
- the Region(s) in which the Dwelling(s) associated with the PersonEvent is/are associated

**Figure 2c. PersonEvent statistics.**

The dimensions and parameters associated with the normalised cube may of course be both basic and adjoined variables. For example, the parameter of a population of Deaths may be the average Age of the Persons who have died, and the parameter of a population of Migrations may be average Income of the Persons who have migrated, or the average change in Size of the Dwelling to which the Person moves in comparison with the Size of the Dwelling from which he or she comes.

*Figure 2d* and *Figure 2e* illustrate variations of the basic population statistics model where the object types Household and Dwelling, repectively, have been put in focus as the basis for normalised cubes.

*Figure 2f* summarises all the preceding models into one “split vision” model, indicating by yellow colour all the object types that may, one at a time, be focused as the basis for normalised cubes. In the particular case used here for illustration purposes, it actually happens that all object types may be used (and are used in actual population statistics produced by statistical agencies) as the basis for
normalised cubes. However, in other cases, as we shall see examples of further on in this paper, there may also be object types that are not actually used as the basis for normalised statistical cubes, even if, theoretically they probably could be in most cases.

Figure 2d. Household statistics.

Figure 2e. Dwelling statistics.
Figure 2f. Population statistics: Split vision model.

Figure 3 is a simple generic model that actually covers all these domain-oriented models, that is, all subsequent models can be seen as more specific interpretations of this model.

Figure 3. Generic model, covering all statistical domains.

The general model presented above is described in more detail and the examples elaborated in Androvitsaneas&Sundgren&Thygesen (2006).

Contents By Example (CBE)

Contents By Example (CBE)\textsuperscript{12}, as proposed here, is a technique for

- giving an overview of the contents of available official statistics (microdata and macrodata)
- allowing a user of official statistics to select a subset of available official statistics that he or she would like to investigate further, e.g. by
  - selecting object types of potential interest
  - opening lists of available variables for selected object types
  - opening lists of available value sets (classifications) for selected variables
  - getting definitions and explanations by moving the cursor over terms used on the screen
  - drilling down for more metadata, also about underlying survey processes, by right-clicking terms and selecting from lists of available metadata and metadata links
  - selecting time intervals and populations of interest

\textsuperscript{12} Cf Query By Example (QBE) in relational database theory; Zloof (1975).
Once again, as often as the user wants to know more about a certain concept (e.g. an object type, a population, or a variable), he or she should be able to “right-click” on the representation of the concept and get associated metadata directly, or indirectly through chains of dynamic links.

*Figure 4* (a, b, and c) provides three examples of how a data set (microdata or macrodata) could be selected in a very intuitive way. In the first example the user indicates (by #) that he or she wants to count Births of Persons. The count should be broken down according to the Person’s Sex and HomeLocation (the latter variable is made more precise by qualifying it by means of a certain RegionalCode, presumably a standard classification). Furthermore, the count should also be broken down by the Age of the Person’s Mother according to a certain AgeGrouping (probably also a standard classification, otherwise it has to be separately defined by the user, who may be promoted to do so).

In the second example it is Migration events that are counted, crossclassified by the Migrant’s Sex, Age, and Occupation, as well as by the respective Localities from and to the Migrant moves.

In the third example, it is the average Income (marked by an m in front of the Income label) of a population of Persons that is requested, and the figure should be broken down by the Person’s Sex and Education.

In all three examples the population could be more precisely defined by adding properties to the population object type selected, and the user could be interactively assisted in doing this. Furthermore it should be noted that microdata could have been requested (instead of macrodata) just by avoiding marking any variable by a summarising function (like # or m).

---

**Figure 4a. Example 1 of a selected data set:** Number of births by sex and home location of the child and age of the mother. (4-dimensional frequency macrodata – cf underlying microdata.)
Figure 4b. Example 2 of a selected data set: Number of migrations by sex, age, and occupation of migrant and place moved from and to. (5-dimensional frequency macrodata.)

Figure 4c. Example 3 of a selected data set: Average income of persons by sex and education level. (2-dimensional summarised macrodata.)
References


Cloud computing

Note. The text about cloud computing is based upon the following Wikipedia articles:

http://simple.wikipedia.org/wiki/Cloud_computing
http://en.wikipedia.org/wiki/Cloud_computing_architecture
http://en.wikipedia.org/wiki/Cloud_computing

Please refer to these articles for more detailed information and a large number of useful references.

Another recent trend is to replace in-house software developments, and even in-house licensing and installation of commercial software packages, with software components that are provided as services, for free or for a fee, via the Internet. This is called “cloud computing” or “Software as a Service”, SaaS, and is also consistent with service-oriented architectures and process orientation.

What is cloud computing?

Cloud computing is a colloquial expression used to describe a variety of different computing concepts that involve a large number of computers that are connected through a real-time communication network, typically the Internet. Cloud computing is a jargon term without a commonly accepted non-ambiguous scientific or technical definition. In science, cloud computing is a synonym for distributed computing over a network and means the ability to run a program on many connected computers at the same time. The popularity of the term can be attributed to its use in marketing to sell hosted services in the sense of application service provisioning that run client server software on a remote location.

Cloud computing may be described as a kind of outsourcing of computer services, similar to the way in which the supply of electricity is outsourced. Users can simply use it. They do not need to worry where the electricity is from, how it is made, or transported. Every month, they pay for what they consumed. The idea behind cloud computing is similar: The user can simply use computers and computer-supported resources, without having to worry how these work internally.

Cloud computing is a systems architecture model for Internet-based computing. “The cloud” is a metaphor for the Internet based on how the internet is described in computer network diagrams. It is an abstraction hiding the complex infrastructure of the internet. It is a style of computing in which IT-related capabilities are provided “as a service”, allowing users to access technology-enabled services from the Internet without knowledge of, or control over the technologies behind these services.

Cloud computing means that data are permanently stored in servers on the Internet and cached temporarily on clients.

Cloud computing utilises software as a service (SaaS). For example, Google Apps provides common business applications online that are accessed from a web browser, while the software and data are stored on the Internet servers.

Advantages
Cloud computing relies on sharing of resources to achieve coherence and economies of scale similar to a utility (like the electricity grid) over a network. At the foundation of cloud computing is the broader concept of converged infrastructure and shared services.

The cloud also focuses on maximizing the effectiveness of the shared resources. Cloud resources are usually not only shared by multiple users but as well as dynamically re-allocated as per demand. This can work for allocating resources to users in different time zones. For example, a cloud computer facility which serves European users during European business hours with a specific application (e.g. email) while the same resources are getting reallocated and serve North American users during North America's business hours with another application (e.g. web server). This approach should maximize the use of computing powers thus reducing environmental damage as well, since less power, air conditioning, rackspace, and so on, is required for the same functions.

Proponents claim that cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of infrastructure. Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables IT to more rapidly adjust resources to meet fluctuating and unpredictable business demands.

**Characteristics**

As customers generally do not own the infrastructure or know all details about it, mainly they are accessing or renting, so they can consume resources as a service, and may be paying for what they do not need, instead of what they actually do need to use. Many cloud computing providers have adopted the utility computing model which is analogous to how traditional public utilities like electricity are consumed, while others are billed on a subscription basis.

By sharing consumable and "intangible" computing power between multiple "tenants", utilisation rates can be improved (as servers are not left idle) which can reduce costs significantly while increasing the speed of application development. A side effect of this approach is that "computer capacity rises dramatically" as customers do not have to engineer for peak loads. Adoption has been enabled by "increased high-speed bandwidth" which makes it possible to receive the same response times from centralized infrastructure at other sites.

**Some key characteristics**

- **Cost** is claimed to be reduced, and in a public cloud delivery model capital expenditure is converted to operational expenditure. This is purported to lower barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained with usage-based options and fewer IT skills are required for implementation (in-house).
- **Device and location independence** enable users to access systems using a web browser regardless of their location or what device they are using (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.
- **Multitenancy** enables sharing of resources and costs across a large pool of users thus allowing for:
  - Centralization of infrastructure in locations with lower costs (such as real estate, electricity, etc.)
  - Peak-load capacity increases (users need not engineer for highest possible load-levels)
  - Utilisation and efficiency improvements for systems that are often only 10–20% utilised.
- **Performance** is monitored, and consistent and loosely coupled architectures are constructed using web services as the system interface.
- **Reliability** by way of multiple redundant sites, which makes it suitable for business continuity and disaster recovery, however IT and business managers are able to do little when an outage hits them. Historical data on cloud outages is tracked in the Cloud Computing Incidents Database.
- **Scalability** which meets changing user demands quickly, without having to engineer for peak loads. Massive scalability and large user bases are common but not an absolute requirement.
- **Virtualisation** technology allows servers and storage devices to be shared and utilisation be increased. Applications can be easily migrated from one physical server to another.
- **Security** which typically improves due to centralisation of data, increased security-focused resources, etc. but which raises concerns about loss of control over certain sensitive data. Accesses are typically logged but accessing the audit logs themselves can be difficult or impossible.
- **Maintenance** of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.
- **Sustainability** through improved resource utilisation, more efficient systems and carbon neutrality.
- **Agility** improves with users' ability to re-provision technological infrastructure resources.

**Five essential characteristics**

The National Institute of Standards and Technology's definition of cloud computing identifies "five essential characteristics":

- **On-demand self-service.** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
- **Broad network access.** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).
- **Resource pooling.** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. ...
- **Rapid elasticity.** Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear unlimited and can be appropriated in any quantity at any time.
- **Measured service.** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

**Architecture**

Cloud computing architecture refers to the components and subcomponents required for cloud computing. These components typically consist of a front end platform (fat client, thin client, mobile...
device), back end platforms (servers, storage), a cloud based delivery, and a network (Internet, Intranet, Intercloud). Combined, these components make up cloud computing architecture.

The majority of cloud computing infrastructures currently consist of reliable services delivered through data centers that are built on computer and storage virtualisation technologies. The services are accessible anywhere in the world, with The Cloud appearing as a single point of access for all the computing needs of consumers. Commercial offerings need to meet the quality of service requirements of customers and typically offer service level agreements. Open standards and open source software are also critical to the growth of cloud computing.

Cloud architecture is the systems architecture of the software systems involved in the delivery of cloud computing resources (e.g. hardware, software, data). It typically involves multiple cloud computing components communicating with each other over application programming interfaces (APIs), usually web services.

Like SOA, the cloud architecture helps to control the complexity of systems and applications. Cooperation and communication between small, well-defined service modules, make these loosely coupled, modularised systems more manageable than their monolithic counterparts, which were so common in traditional computing.

The cloud architecture extends to clients, where web browsers and/or software applications are used to access cloud applications.

In a cloud architecture, metadata operations are to a great extent centralised, enabling the data nodes to scale into the hundreds, each independently delivering data to applications or users.

A cloud architecture often eliminates the need to install and run the application on the customer's own computer, thus reducing software maintenance, ongoing operations, and support. For example:

- **Peer-to-peer/volunteer computing** (Bittorrent, SETI@home, Skype)
- **Web application** (Facebook)
- **Software as a service** (Google Apps, Salesforce)
- **Software plus services** (Microsoft Online Services)

A cloud client is computer hardware and/or computer software which relies on the cloud for application delivery, or which is specifically designed for delivery of cloud services, and which is in either case essentially useless without a Cloud. For example:

- **Mobile** (Android, iPhone, Windows Mobile)
- **Thin client** (CherryPal, Zonbu gOS based systems)
- **Thick client/Web browser** (Google Chrome, Mozilla Firefox)

The historical development

Cloud computing is being driven by providers e-service providers like Google and Amazon.com, as well as by traditional vendors like IBM, Intel, Microsoft and SAP.

Amazon.com played a key role in the development of cloud computing when upgrading their data centers after the dot-com bubble and providing access to their systems by way of Amazon Web Services in 2002 on a utility computing basis. They found the new cloud architecture resulted in significant internal efficiency improvements.

Increased activity occurred in 2007, including Google, IBM and a number of universities starting large scale cloud computing research project. The term started gaining popularity in the mainstream press.
In August 2008 Gartner observed that "organizations are switching from company-owned hardware and software assets to per-use service-based models" and that the "projected shift to cloud computing will result in dramatic growth in IT products in some areas and in significant reductions in other areas".

**Major types of services provided**

Nowadays there is a wide range of services provided by cloud computing. The basic service types are:

- Software as a Service (SaaS)
- Data as a Service (DaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service

**Software as a Service (SaaS)**

The software-as-a-service (SaaS) service-model involves the cloud provider installing and maintaining software in the cloud and users running the software from their cloud clients over the Internet (or Intranet). The users’ client machines require no installation of any application-specific software - cloud applications run on the server (in the cloud). SaaS is scalable, and system administration may load the applications on several servers. In the past, each customer would purchase and load their own copy of the application to each of their own servers, but with the SaaS the customer can access the application without installing the software locally. SaaS typically involves a monthly or annual fee.

Software as a service provides the equivalent of installed applications in the traditional (non-cloud computing) delivery of applications.

**Data as a Service (DaaS)**

Data as a Service, or DaaS, is a cousin of software as a service. Like all members of the "as a Service" (aaS) family, DaaS is based on the concept that the product, data in this case, can be provided on demand to the user regardless of geographic or organisational separation of provider and consumer. Additionally, the emergence of service-oriented architecture (SOA) has rendered the actual platform on which the data resides also irrelevant. This development has enabled the recent emergence of the relatively new concept of DaaS.

Data provided as a service was at first primarily used in Web mashups, but now is being increasingly employed both commercially and, within public organisations such as national and international statistical offices and others.

**Platform as a Service (PaaS)**

Platform as a service is cloud computing service which provides the users with application platforms and databases as a service. This is equivalent to middleware in the traditional (non-cloud computing) delivery of application platforms and databases.

**Infrastructure as a Service (IaaS)**

Infrastructure as a service is taking the physical hardware and going completely virtual (e.g. all servers, networks, storage, and system management all existing in the cloud). This is the equivalent to infrastructure and hardware in the traditional (non-cloud computing) method running in the cloud. In other words, businesses pay a fee (monthly or annually) to run virtual servers, networks, storage from the cloud. This will mitigate the need for a data center, heating, cooling, and maintaining hardware at the local level.
Standards

A cloud standard is one of a number of existing (typically lightweight) open standards that have facilitated the growth of cloud computing, including:

- **Application**
  - Communications (HTTP, XMPP)
  - Security (OAuth, OpenID, SSL/TLS)
  - Syndication (Atom)
- **Client**
  - Browsers (AJAX)
  - Offline (HTML 5)
- **Infrastructure**
  - Virtualization (OVF)
- **Platform**
  - Solution stacks (LAMP, Space-based architecture)
- **Service**
  - Data (XML, JSON)
  - Web Services (REST)
- **Storage**

Similar concepts

Cloud Computing is the result of evolution and adoption of existing technologies and paradigms. The goal of cloud computing is to allow users to take benefit from all of these technologies, without the need for deep knowledge about or expertise with each one of them. The cloud aims to cut costs, and help the users focus on their core business instead of being impeded by IT obstacles.

The main enabling technology for cloud computing is virtualisation. Virtualisation abstracts the physical infrastructure, which is the most rigid component, and makes it available as a soft component that is easy to use and manage. By doing so, virtualization provides the agility required to speed up IT operations, and reduces cost by increasing infrastructure utilisation. On the other hand, autonomic computing automates the process through which the user can provision resources on-demand. By minimizing user involvement, automation speeds up the process and reduces the possibility of human errors.

Users face difficult business problems every day. Cloud computing adopts concepts from Service-oriented Architecture (SOA) that can help the user break these problems into services that can be integrated to provide a solution. Cloud computing provides all of its resources as services, and makes use of the well-established standards and best practices gained in the domain of SOA to allow global and easy access to cloud services in a standardised way.

Cloud computing also leverages concepts from utility computing in order to provide metrics for the services used. Such metrics are at the core of the public cloud pay-per-use models. In addition, measured services are an essential part of the feedback loop in autonomic computing, allowing services to scale on-demand and to perform automatic failure recovery.
Cloud computing is a kind of grid computing; it has evolved from grid computing by addressing the QoS (quality of service) and reliability problems. Cloud computing provides the tools and technologies to build data/compute intensive parallel applications with much more affordable prices compared to traditional parallel computing techniques.

Cloud computing shares characteristics with:

- **Client–server model** — Client–server computing refers broadly to any distributed application that distinguishes between service providers (servers) and service requesters (clients).

- **Grid computing** — "A form of distributed and parallel computing, whereby a 'super and virtual computer' is composed of a cluster of networked, loosely coupled computers acting in concert to perform very large tasks."

- **Mainframe computer** — Powerful computers used mainly by large organizations for critical applications, typically bulk data processing such as census, industry and consumer statistics, police and secret intelligence services, enterprise resource planning, and financial transaction processing.

- **Utility computing** — The "packaging of computing resources, such as computation and storage, as a metered service similar to a traditional public utility, such as electricity."

- **Peer-to-peer** means distributed architecture without the need for central coordination. Participants are both suppliers and consumers of resources (in contrast to the traditional client–server model).

- **Cloud gaming**—also known as on-demand gaming—is a way of delivering games to computers. Gaming data is stored in the provider’s server, so that gaming is independent of client computers used to play the game.

**Different types of clouds: private, public, community, hybrid**

**Private cloud**

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party and hosted internally or externally. Undertaking a private cloud project requires a significant level and degree of engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. When done right, it can improve business, but every step in the project raises security issues that must be addressed to prevent serious vulnerabilities.

They have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from less hands-on management, essentially "[lacking] the economic model that makes cloud computing such an intriguing concept".

**Public cloud**

A cloud is called a 'Public cloud' when the services are rendered over a network that is open for public use. Technically there is no difference between public and private cloud architecture, however, security consideration may be substantially different for services (applications, storage, and other resources) that are made available by a service provider for a public audience and when
communication is effected over a non-trusted network. Generally, public cloud service providers like Amazon AWS, Microsoft and Google own and operate the infrastructure and offer access only via Internet (direct connectivity is not offered).

<table>
<thead>
<tr>
<th>Comparison between Public and Private Clouds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Initial cost</strong></td>
</tr>
<tr>
<td><strong>Running cost</strong></td>
</tr>
<tr>
<td><strong>Customization</strong></td>
</tr>
<tr>
<td><strong>Privacy</strong></td>
</tr>
<tr>
<td><strong>Single sign-on</strong></td>
</tr>
<tr>
<td><strong>Scaling up</strong></td>
</tr>
</tbody>
</table>

**Community cloud**

A **community cloud** shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realised.
Hybrid cloud

Hybrid cloud is a composition of two or more clouds (private, community or public) that remain unique entities but are bound together, offering the benefits of multiple deployment models. Such composition expands deployment options for cloud services, allowing IT organisations to use public cloud computing resources to meet temporary needs. This capability enables hybrid clouds to employ cloud bursting for scaling across clouds.

Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and "bursts" to a public cloud when the demand for computing capacity increases. A primary advantage of cloud bursting and a hybrid cloud model is that an organisation only pays for extra compute resources when they are needed.

Cloud bursting enables data centers to create an in-house IT infrastructure that supports average workloads, and use cloud resources from public or private clouds, during spikes in processing demands.

By utilising "hybrid cloud" architecture, companies and individuals are able to obtain degrees of fault tolerance combined with locally immediate usability without dependency on internet connectivity. Hybrid cloud architecture requires both on-premises resources and off-site (remote) server-based cloud infrastructure.

Hybrid clouds lack the flexibility, security and certainty of in-house applications. Hybrid cloud provides the flexibility of in-house applications with the fault tolerance and scalability of cloud based services.

Issues

Threats and opportunities of the cloud

Critical voices have warned that the whole concept is rife with privacy and ownership concerns and constitute merely a fad.

However, cloud computing continues to gain steam with 56% of the major European technology decision-makers estimate that the cloud is a priority in 2013 and 2014, and the cloud budget may reach 30% of the overall IT budget.
According to the *TechInsights Report 2013: Cloud Succeeds* based on a survey, the cloud implementations generally meets or exceedes expectations across major service models, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). 

Several deterrents to the widespread adoption of cloud computing remain. Among them are: reliability, availability of services and data, security, complexity, costs, regulations and legal issues, performance, migration, reversion, the lack of standards, limited customisation and issues of privacy. The *cloud* offers many strong points: infrastructure flexibility, faster deployment of applications and data, cost control, adaptation of cloud resources to real needs, improved productivity, etc. The early 2010s cloud market is dominated by software and services in SaaS mode and IaaS (infrastructure), especially the private cloud. PaaS and the public cloud are further back.

**Privacy**

Privacy advocates have criticized the cloud model for giving hosting companies' greater ease to control—and thus, to monitor at will—communication between host company and end user, and access user data (with or without permission). Instances such as the secret NSA program, working with AT&T, and Verizon, which recorded over 10 million telephone calls between American citizens, causes uncertainty among privacy advocates, and the greater powers it gives to telecommunication companies to monitor user activity. A cloud service provider (CSP) can complicate data privacy because of the extent of virtualisation (virtual machines) and cloud storage used to implement cloud service. CSP operations, customer or tenant data may not remain on the same system, or in the same data center or even within the same provider’s cloud; this can lead to legal concerns over jurisdiction. While there have been efforts (such as US-EU Safe Harbor) to "harmonise" the legal environment, providers such as Amazon still cater to major markets (typically the United States and the European Union) by deploying local infrastructure and allowing customers to select "availability zones." Cloud computing poses privacy concerns because the service provider can access the data that is on the cloud at any time. It could accidentally or deliberately alter or even delete information.

**Compliance**

To comply with regulations including FISMA, HIPAA, and SOX in the United States, the Data Protection Directive in the EU and the credit card industry’s PCI DSS, users may have to adopt community or hybrid deployment modes that are typically more expensive and may offer restricted benefits. This is how Google is able to “manage and meet additional government policy requirements beyond FISMA” and Rackspace Cloud or QubeSpace are able to claim PCI compliance.

Many providers also obtain a SAS 70 Type II audit, but this has been criticised on the grounds that the hand-picked set of goals and standards determined by the auditor and the auditee are often not disclosed and can vary widely. Providers typically make this information available on request, under non-disclosure agreement.

Customers in the EU contracting with cloud providers outside the EU/EEA have to adhere to the EU regulations on export of personal data.

U.S. Federal Agencies have been directed by the Office of Management and Budget to use a process called FedRAMP (Federal Risk and Authorization Management Program) to assess and authorise cloud products and services.

A multitude of laws and regulations have forced specific compliance requirements onto many companies that collect, generate or store data. These policies may dictate a wide array of data
storage policies, such as how long information must be retained, the process used for deleting data, and even certain recovery plans. Below are some examples of compliance laws or regulations.

- In the United States, the Health Insurance Portability and Accountability Act (HIPAA) requires a contingency plan that includes data backups, data recovery, and data access during emergencies.

- The privacy laws of the Switzerland demand that private data, including emails, be physically stored in the Switzerland.

- In the United Kingdom, the Civil Contingencies Act of 2004 sets forth guidance for a Business contingency plan that includes policies for data storage.

In a virtualised cloud computing environment, customers may never know exactly where their data is stored. In fact, data may be stored across multiple data centers in an effort to improve reliability, increase performance, and provide redundancies. This geographic dispersion may make it more difficult to ascertain legal jurisdiction if disputes arise.

**Legal**

As with other changes in the landscape of computing, certain legal issues arise with cloud computing, including trademark infringement, security concerns and sharing of proprietary data resources.

The Electronic Frontier Foundation has criticized the United States government for considering during the Megaupload seizure process that people lose property rights by storing data on a cloud computing service.

One important but not often mentioned problem with cloud computing is the problem of who is in "possession" of the data. If a cloud company is the possessor of the data, the possessor has certain legal rights. If the cloud company is the "custodian" of the data, then a different set of rights would apply. The next problem in the legalities of cloud computing is the problem of legal ownership of the data. Many Terms of Service agreements are silent on the question of ownership -

These legal issues are not confined to the time period in which the cloud based application is actively being used. There must also be consideration for what happens when the provider-customer relationship ends. In most cases, this event will be addressed before an application is deployed to the cloud. However, in the case of provider insolvencies or bankruptcy the state of the data may become blurred.

**Vendor lock-in**

Because cloud computing is still relatively new, standards are still being developed. Many cloud platforms and services are proprietary, meaning that they are built on the specific standards, tools and protocols developed by a particular vendor for its particular cloud offering. This can make migrating off a proprietary cloud platform prohibitively complicated and expensive.

Three types of vendor lock-in can occur with cloud computing:

- Platform lock-in: cloud services tend to be built on one of several possible virtualization platforms, for example VMWare or Xen. Migrating from a cloud provider using one platform to a cloud provider using a different platform could be very complicated.
• Data lock-in: since the cloud is still new, standards of ownership, i.e. who actually owns the data once it lives on a cloud platform, are not yet developed, which could make it complicated if cloud computing users ever decide to move data off of a cloud vendor’s platform.

• Tools lock-in: if tools built to manage a cloud environment are not compatible with different kinds of both virtual and physical infrastructure, those tools will only be able to manage data or apps that live in the vendor’s particular cloud environment.

Heterogeneous cloud computing is described as a type of cloud environment that prevents vendor lock-in, and aligns with enterprise data centers that are operating hybrid cloud models. The absence of vendor lock-in lets cloud administrators select his or her choice of hypervisors for specific tasks, or to deploy virtualised infrastructures to other enterprises without the need to consider the flavor of hypervisor in the other enterprise.

A heterogeneous cloud is considered one that includes on-premise private clouds, public clouds and software-as-a-service clouds. Heterogeneous clouds can work with environments that are not virtualized, such as traditional data centers. Heterogeneous clouds also allow for the use of piece parts, such as hypervisors, servers, and storage, from multiple vendors.

Cloud piece parts, such as cloud storage systems, offer APIs but they are often incompatible with each other. The result is complicated migration between backends, and makes it difficult to integrate data spread across various locations. This has been described as a problem of vendor lock-in. The solution to this is for clouds to adopt common standards.

Heterogeneous cloud computing differs from homogeneous clouds, which have been described as those using consistent building blocks supplied by a single vendor. Intel General Manager of high-density computing, Jason Waxman, is quoted as saying that a homogenous system of 15,000 servers would cost $6 million more in capital expenditure and use 1 megawatt of power.

Open source

Open-source software has provided the foundation for many cloud computing implementations, prominent examples being the Hadoop framework and VMware’s Cloud Foundry. In November 2007, the Free Software Foundation released the Affero General Public License, a version of GPLv3 intended to close a perceived legal loophole associated with free software designed to run over a network.

Open standards

Most cloud providers expose APIs that are typically well-documented (often under a Creative Commons license) but also unique to their implementation and thus not interoperable. Some vendors have adopted others’ APIs and there are a number of open standards under development, with a view to delivering interoperability and portability. As of November 2012, the Open Standard with broadest industry support is probably OpenStack, founded in 2010 by NASA and Rackspace, and now governed by the OpenStack Foundation.

Security

As cloud computing is achieving increased popularity, concerns are being voiced about the security issues introduced through adoption of this new model. The effectiveness and efficiency of traditional protection mechanisms are being reconsidered as the characteristics of this innovative deployment
model can differ widely from those of traditional architectures. An alternative perspective on the topic of cloud security is that this is but another, although quite broad, case of "applied security" and that similar security principles that apply in shared multi-user mainframe security models apply with cloud security.

The relative security of cloud computing services is a contentious issue that may be delaying its adoption. Physical control of the Private Cloud equipment is more secure than having the equipment off site and under someone else's control. Physical control and the ability to visually inspect data links and access ports is required in order to ensure data links are not compromised. Issues barring the adoption of cloud computing are due in large part to the private and public sectors' unease surrounding the external management of security-based services. It is the very nature of cloud computing-based services, private or public, that promote external management of provided services. This delivers great incentive to cloud computing service providers to prioritize building and maintaining strong management of secure services. Security issues have been categorised into sensitive data access, data segregation, privacy, bug exploitation, recovery, accountability, malicious insiders, management console security, account control, and multi-tenancy issues. Solutions to various cloud security issues vary, from cryptography, particularly public key infrastructure (PKI), to use of multiple cloud providers, standardisation of APIs, and improving virtual machine support and legal support.

Cloud computing offers many benefits, but is vulnerable to threats. As cloud computing uses increase, it is likely that more criminals find new ways to exploit system vulnerabilities. Many underlying challenges and risks in cloud computing increase the threat of data compromise. To mitigate the threat, cloud computing stakeholders should invest heavily in risk assessment to ensure that the system encrypts to protect data, establishes trusted foundation to secure the platform and infrastructure, and builds higher assurance into auditing to strengthen compliance. Security concerns must be addressed to maintain trust in cloud computing technology.

**Sustainability**

Although cloud computing is often assumed to be a form of green computing, no published study substantiates this assumption. Citing the servers' effects on the environmental effects of cloud computing, in areas where climate favors natural cooling and renewable electricity is readily available, the environmental effects will be more moderate. (The same holds true for "traditional" data centers.) Thus countries with favorable conditions, such as Finland, Sweden and Switzerland, are trying to attract cloud computing data centers. Energy efficiency in cloud computing can result from energy-aware scheduling and server consolidation. However, in the case of distributed clouds over data centers with different source of energies including renewable source of energies, a small compromise on energy consumption reduction could result in high carbon footprint reduction.

**Abuse**

As with privately purchased hardware, customers can purchase the services of cloud computing for nefarious purposes. This includes password cracking and launching attacks using the purchased services. In 2009, a banking trojan illegally used the popular Amazon service as a command and control channel that issued software updates and malicious instructions to PCs that were infected by the malware.

**IT governance**

See also the Wikipedia main article: Corporate governance of information technology
The introduction of cloud computing requires an appropriate IT governance model to ensure a secured computing environment and to comply with all relevant organisational information technology policies. As such, organizations need a set of capabilities that are essential when effectively implementing and managing cloud services, including demand management, relationship management, data security management, application lifecycle management, risk and compliance management. A danger lies with the explosion of companies joining the growth in cloud computing by becoming providers. However, many of the infrastructural and logistical concerns regarding the operation of cloud computing businesses are still unknown. This over-saturation may have ramifications for the industry as whole.

**Consumer end storage**

The increased use of cloud computing could lead to a reduction in demand for high storage capacity consumer end devices, due to cheaper low storage devices that stream all content via the cloud becoming more popular. In a Wired article, Jake Gardner explains that while unregulated usage is beneficial for IT and tech moguls like Amazon, the anonymous nature of the cost of consumption of cloud usage makes it difficult for business to evaluate and incorporate it into their business plans. The popularity of cloud and cloud computing in general is so quickly increasing among all sorts of companies, that in May 2013, through its company Amazon Web Services, Amazon started a certification program for cloud computing professionals.

**Ambiguity of terminology**

Outside of the information technology and software industry, the term "cloud" can be found to reference a wide range of services, some of which fall under the category of cloud computing, while others do not. The cloud is often used to refer to a product or service that is discovered, accessed and paid for over the Internet, but is not necessarily a computing resource. Examples of service that are sometimes referred to as "the cloud" include crowd sourcing, cloud printing, crowd funding, cloud manufacturing.

**Performance interference and noisy neighbours**

Due to its multi-tenant nature and resource sharing, Cloud computing must also deal with the "noisy neighbour" effect. This effect in essence indicates that in a shared infrastructure, the activity of a virtual machine on a neighboring core on the same physical host may lead to increased performance degradation of the VMs in the same physical host, due to issues such as e.g. cache contamination. Due to the fact that the neighboring VMs may be activated or deactivated at arbitrary times, the result is an increased variation in the actual performance of Cloud resources. This effect seems to be dependent also on the nature of the applications that run inside the VMs but also other factors such as scheduling parameters and the careful selection may lead to optimized assignment in order to minimize the phenomenon. This has also led to difficulties in comparing various cloud providers on cost and performance using traditional benchmarks for service and application performance, as the time period and location in which the benchmark is performed can result in widely varied results.

**Monopolies and privatization of cyberspace**

Philosopher Slavoj Žižek points out that, although cloud computing enhances content accessibility, this access is "increasingly grounded in the virtually monopolistic privatization of the cloud which provides this access". According to him, this access, necessarily mediated through a handful of companies, ensures a progressive privatization of global cyberspace. Žižek criticises the argument purported by supporters of cloud computing that this phenomenon is part of the "natural evolution"
of the Internet, sustaining that the quasi-monopolies "set prices at will but also filter the software they provide to give its "universality" a particular twist depending on commercial and ideological interests."
Big Data

This section discusses the concept of Big Data and its relations to concepts like Business Intelligence (BI) and Data Visualisation.

The text is based on the following Wikipedia articles, where you can also find more detailed information and numerous useful references:


**Big Data: definitions and characteristics**

*Big data* is a collection of *data sets* so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications. The challenges include capture, curation, storage, search, sharing, transfer, analysis, and visualisation. The trend to larger data sets is due to the additional information derivable from analysis of a single large set of related data, as compared to separate smaller sets with the same total amount of data, allowing correlations to be found to "spot business trends, determine quality of research, prevent diseases, link legal citations, combat crime, and determine real-time roadway traffic conditions."

Big data usually includes data sets with sizes beyond the ability of commonly used software tools to *capture, curate,* manage, and process the data within a tolerable elapsed time. Big data sizes are a constantly moving target, as of 2012 ranging from a few dozen terabytes to many petabytes of data in a single data set. The target moves due to constant improvement in traditional DBMS technology as well as new databases like *NoSQL* and their ability to handle larger amounts of data. With this difficulty, new platforms of "big data" tools are being developed to handle various aspects of large quantities of data.

Big data is difficult to work with using most relational database management systems and desktop statistics and visualisation packages, requiring instead "massively parallel software running on tens, hundreds, or even thousands of servers". What is considered "big data" varies depending on the capabilities of the organisation managing the set, and on the capabilities of the applications that are traditionally used to process and analyze the data set in its domain. "For some organizations, facing hundreds of gigabytes of data for the first time may trigger a need to reconsider data management options. For others, it may take tens or hundreds of terabytes before data size becomes a significant consideration."

In a 2001 research report and related lectures, META Group (now Gartner) analyst Doug Laney defined data growth challenges and opportunities as being three-dimensional, i.e.

- **volume** (amount of data)
- **velocity** (speed of data in and out)
- **variety** (range of data types and sources)

Gartner, and now much of the industry, continue to use this "3Vs" model for describing big data. In 2012, Gartner updated its definition as follows:
"Big data are high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization."

If Gartner’s definition (the 3Vs) is still widely used, the growing maturity of the concept fosters a more sound difference between Big Data and Business Intelligence, regarding data and their use:

- Business Intelligence uses **descriptive statistics** with data with high information density to measure things, detect trends etc.;
- Big Data uses **inductive statistics** with data with low information density, whose huge volume allow to infer laws (regressions...) and thus giving (with the limits of inference reasoning) to Big Data some predictive capabilities.

Scientists regularly encounter data processing limitations due to large data sets in many areas, including meteorology, genomics, connectomics, complex physics simulations, and biological and environmental research. The limitations also affect Internet search, finance and business informatics. Data sets grow in size in part because they are increasingly being gathered by ubiquitous information-sensing mobile devices, aerial sensory technologies (remote sensing), software logs, cameras, microphones, radio-frequency identification (RFID) readers, and wireless sensor networks.

**Examples of Big Data**

Examples include Big Science, RFID, sensor networks, social networks, big social data analysis (due to the social data revolution), Internet documents, Internet search indexing, call detail records, astronomy, atmospheric science, genomics, biogeochemical, biological, and other complex and often interdisciplinary scientific research, military surveillance, forecasting drive times for new home buyers, medical records, photography archives, video archives, and large-scale e-commerce.

**Big science**

The Large Hadron Collider experiments represent about 150 million sensors delivering data 40 million times per second. There are nearly 600 million collisions per second. After filtering and refraining from recording more than 99.999% of these streams, there are 100 collisions of interest per second.

- As a result, only working with less than 0.001% of the sensor stream data, the data flow from all four LHC experiments represents 25 petabytes annual rate before replication (as of 2012). This becomes nearly 200 petabytes after replication.
- If all sensor data were to be recorded in LHC, the data flow would be extremely hard to work with. The data flow would exceed 150 million petabytes annual rate, or nearly 500 exabytes per day, before replication. To put the number in perspective, this is equivalent to 500 quintillion ($5 \times 10^{20}$) bytes per day, almost 200 times higher than all the other sources combined in the world.

**Science and research**

- When the Sloan Digital Sky Survey (SDSS) began collecting astronomical data in 2000, it amassed more in its first few weeks than all data collected in the history of astronomy. Continuing at a rate of about 200 GB per night, SDSS has amassed more than 140 terabytes of information. When the Large Synoptic Survey Telescope, successor to SDSS, comes online in 2016 it is anticipated to acquire that amount of data every five days.
Decoding the human genome originally took 10 years to process, now it can be achieved in less than a week: the DNA sequencers have divided the sequencing cost by 10,000 in the last ten years, which is a factor 100 compared to Moore's Law.

Computational social science — Tobias Preis et al. used Google Trends data to demonstrate that Internet users from countries with a higher per capita gross domestic product (GDP) are more likely to search for information about the future than information about the past. The findings suggest there may be a link between online behaviour and real-world economic indicators. The authors of the study examined Google queries logs made by Internet users in 45 different countries in 2010 and calculated the ratio of the volume of searches for the coming year ('2011') to the volume of searches for the previous year ('2009'), which they call the 'future orientation index'. They compared the future orientation index to the per capita GDP of each country and found a strong tendency for countries in which Google users enquire more about the future to exhibit a higher GDP. The results hint that there may potentially be a relationship between the economic success of a country and the information-seeking behavior of its citizens captured in big data.

The NASA Center for Climate Simulation (NCCS) stores 32 petabytes of climate observations and simulations on the Discover supercomputing cluster.

**Government**

- In 2012, the Obama administration announced the Big Data Research and Development Initiative, which explored how big data could be used to address important problems facing the government. The initiative was composed of 84 different big data programs spread across six departments.
- Big data analysis played a large role in Barack Obama's successful 2012 re-election campaign.
- The Utah Data Center is a data center currently being constructed by the United States National Security Agency. When finished, the facility will be able to handle yottabytes of information collected by the NSA over the Internet.

**Private sector**

- Amazon.com handles millions of back-end operations every day, as well as queries from more than half a million third-party sellers. The core technology that keeps Amazon running is Linux-based and as of 2005 they had the world’s three largest Linux databases, with capacities of 7.8 TB, 18.5 TB, and 24.7 TB.
- Walmart handles more than 1 million customer transactions every hour, which is imported into databases estimated to contain more than 2.5 petabytes (2560 terabytes) of data -- the equivalent of 167 times the information contained in all the books in the US Library of Congress.
- Facebook handles 50 billion photos from its user base.
- FICO Falcon Credit Card Fraud Detection System protects 2.1 billion active accounts world-wide.
- The volume of business data worldwide, across all companies, doubles every 1.2 years, according to estimates.
- Windermere Real Estate uses anonymous GPS signals from nearly 100 million drivers to help new home buyers determine their typical drive times to and from work throughout various times of the day.

**International development**

Following decades of work in the area of the effective usage of information and communication technologies for development (or ICT4D), it has been suggested that Big Data can make important contributions to international development. On the one hand, the advent of Big Data delivers the
cost-effective prospect to improve decision-making in critical development areas such as health care, employment, economic productivity, crime and security, and natural disaster and resource management. On the other hand, all the well-known concerns of the Big Data debate, such as privacy, interoperability challenges, and the almighty power of imperfect algorithms, are aggravated in developing countries by long-standing development challenges like lacking technological infrastructure and economic and human resource scarcity. "This has the potential to result in a new kind of digital divide: a divide in data-based intelligence to inform decision-making."
Business Intelligence

Business intelligence (BI) is a set of theories, methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information for business purposes. BI can handle large amounts of information to help identify and develop new opportunities. Making use of new opportunities and implementing an effective strategy can provide a competitive market advantage and long-term stability.

BI technologies provide historical, current and predictive views of business operations. Common functions of business intelligence technologies are reporting, online analytical processing (OLAP), analytics, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, predictive analytics and prescriptive analytics.

Though the term business intelligence is sometimes a synonym for competitive intelligence (because they both support decision making), BI uses technologies, processes, and applications to analyse mostly internal, structured data and business processes while competitive intelligence gathers, analyses and disseminates information with a topical focus on company competitors. If understood broadly, business intelligence can include the subset of competitive intelligence.

History

In a 1958 article, IBM researcher Hans Peter Luhn used the term business intelligence. He defined business intelligence as:

- "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal”

Business intelligence as it is understood today is said to have evolved from the decision support systems (DSS) that began in the 1960s and developed throughout the mid-1980s. DSS originated in the computer-aided models created to assist with decision making and planning. From DSS, data warehouses, Executive Information Systems, OLAP and business intelligence came into focus beginning in the late 80s.

In 1989, Howard Dresner proposed "business intelligence" as an umbrella term to describe

- "concepts and methods to improve business decision making by using fact-based support systems”

Business intelligence and data warehousing

Often BI applications use data gathered from a data warehouse or a data mart. A data warehouse is a copy of transactional data so that it facilitates in decision support. However, not all data warehouses are used for business intelligence, nor do all business intelligence applications require a data warehouse.

To distinguish between the concepts of business intelligence and data warehouses, Forrester Research often defines business intelligence in one of two ways:
1. Using a broad definition: "Business Intelligence is a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information used to enable more effective strategic, tactical, and operational insights and decision-making.

When using this definition, business intelligence also includes technologies such as data integration, data quality, data warehousing, master data management, text and content analytics, and many others that the market sometimes lumps into the Information Management segment.

2. Using a narrow definition: Forrester distinguishes between data preparation and data usage as two separate, but closely linked segments of the business intelligence architecture. Forrester defines the latter as just the top layers of the business intelligence architecture. This narrower concept includes reporting, analytics and dashboards.

**Business intelligence and business analytics**

Thomas Davenport argues that business intelligence should be divided into

- querying,
- reporting,
- OLAP, an "alerts" tool, and
- business analytics.

In this definition, business analytics is the subset of BI based on statistics, prediction, and optimisation.

**BI applications in an enterprise**

Business intelligence can be applied to the following business purposes, in order to drive business value.

1. **Measurement** – program that creates a hierarchy of performance metrics (see also Metrics Reference Model) and benchmarking that informs business leaders about progress towards business goals (business process management).

2. **Analytics** – program that builds quantitative processes for a business to arrive at optimal decisions and to perform business knowledge discovery. Frequently involves: data mining, process mining, statistical analysis, predictive analytics, predictive modeling, business process modeling, complex event processing and prescriptive analytics.

3. **Reporting/enterprise reporting** – program that builds infrastructure for strategic reporting to serve the strategic management of a business, not operational reporting. Frequently involves data visualisation, executive information system and OLAP.

4. **Collaboration/collaboration platform** – program that gets different areas (both inside and outside the business) to work together through data sharing and electronic data interchange.

5. **Knowledge management** – program to make the company data driven through strategies and practices to identify, create, represent, distribute, and enable adoption of insights and
experiences that are true business knowledge. Knowledge management leads to learning management and regulatory compliance.

In addition to above, business intelligence also can provide a pro-active approach, such as ALARM function to alert immediately to end-user. There are many types of alerts, for example if some business value exceeds the threshold value the color of that amount in the report will turn RED and the business analyst is alerted. Sometimes an alert mail will be sent to the user as well. This end to end process requires data governance, which should be handled by the expert.

Prioritising and increasing the benefits of business intelligence projects

It is often difficult to provide a positive business case for business intelligence initiatives and often the projects must be prioritized through strategic initiatives. Here are some hints to increase the benefits for a BI project.

- Determine the tangible benefits such as eliminated cost of producing legacy reports.
- Enforce access to data for the entire organization. In this way even a small benefit, such as a few minutes saved, makes a difference when multiplied by the number of employees in the entire organisation.
- Consider letting the BI project be driven by other business initiatives with excellent business cases. To support this approach, the organisation must have enterprise architects who can identify suitable business projects.
- Use a structured and quantitative methodology to create defensible prioritisation in line with the actual needs of the organisation, such as a weighted decision matrix.

Success factors of implementation

There are three critical areas that you need to assess within your organisation before getting ready to do a BI project:

1. The level of commitment and sponsorship of the project from senior management
2. The level of business need for creating a BI implementation
3. The amount and quality of business data available

Management commitment

The commitment and sponsorship of senior management is probably the most important success factor of a BI project. Having strong management backing helps overcome shortcomings elsewhere in the project. Even the most elegantly designed DW/BI system cannot overcome a lack of business management sponsorship.

It is important that personnel who participate in the project have a vision and an idea of the benefits and drawbacks of implementing a BI system. The best business sponsor should have organisational clout and should be well connected within the organisation. It is ideal that the business sponsor is demanding but also able to be realistic and supportive if the implementation runs into delays or drawbacks. The management sponsor also needs to be able to assume accountability and to take responsibility for failures and setbacks on the project. Support from multiple members of the management ensures the project does not fail if one person leaves the steering group. However, having many managers work together on the project can also mean that there are several different interests that attempt to pull the project in different directions, such as if different departments want to put more emphasis on their usage. This issue can be countered by an early and specific
analysis of the business areas that benefit the most from the implementation. All stakeholders in project should participate in this analysis in order for them to feel ownership of the project and to find common ground.

Another management problem that should be encountered before start of implementation is if the business sponsor is overly aggressive. If the management individual gets carried away by the possibilities of using BI and starts wanting the DW or BI implementation to include several different sets of data that were not included in the original planning phase. However, since extra implementations of extra data may add many months to the original plan, it's wise to make sure the person from management is aware of his actions.

**Business needs**

Because of the close relationship with senior management, another critical thing that must be assessed before the project begins is whether or not there is a business need and whether there is a clear business benefit by doing the implementation. The needs and benefits of the implementation are sometimes driven by competition and the need to gain an advantage in the market. Another reason for a business-driven approach to implementation of BI is the acquisition of other organizations that enlarge the original organisation it can sometimes be beneficial to implement DW or BI in order to create more oversight.

Companies that implement BI are often large, multinational organizations with diverse subsidiaries. A well-designed BI solution provides a consolidated view of key business data not available anywhere else in the organization, giving management visibility and control over measures that otherwise would not exist.

**Amount and quality of available data**

Without good data, it does not matter how good the management sponsorship or business-driven motivation is. Without proper data, or with too little quality data, any BI implementation fails. Before implementation it is a good idea to do data profiling. This analysis identifies the *content, consistency* and *structure* of the data. This should be done as early as possible in the process and if the analysis shows that data is lacking, put the project on the shelf temporarily while the IT department figures out how to properly collect data.

When planning for business data and business intelligence requirements, it is always advisable to consider specific scenarios that apply to a particular organisation, and then select the business intelligence features best suited for the scenario.

Often, scenarios revolve around distinct business processes, each built on one or more data sources. These sources are used by features that present that data as information to knowledge workers, who subsequently act on that information. The business needs of the organisation for each business process adopted correspond to the essential steps of business intelligence. These essential steps of business intelligence includes:

1. Go through business data sources in order to collect needed data
2. Convert business data to information and present appropriately
3. Query and analyse data
4. Act on those data collected
User aspects

Some considerations must be made in order to successfully integrate the usage of business intelligence systems in a company. Ultimately the BI system must be accepted and utilised by the users in order for it to add value to the organization. If the usability of the system is poor, the users may become frustrated and spend a considerable amount of time figuring out how to use the system or may not be able to really use the system. If the system does not add value to the users’ mission, they simply don’t use it.

To increase user acceptance of a BI system, it can be advisable to consult business users at an early stage of the DW/BI lifecycle, for example at the requirements gathering phase. This can provide an insight into the business process and what the users need from the BI system. There are several methods for gathering this information, such as questionnaires and interview sessions.

When gathering the requirements from the business users, the local IT department should also be consulted in order to determine to which degree it is possible to fulfill the business's needs based on the available data.

Taking on a user-centered approach throughout the design and development stage may further increase the chance of rapid user adoption of the BI system.

Besides focusing on the user experience offered by the BI applications, it may also possibly motivate the users to utilise the system by adding an element of competition. For example, one may implement a function on the BI portal website where reports on system usage can be found. By doing so, managers can see how well their departments are doing and compare themselves to others and this may spur them to encourage their staff to utilise the BI system even more.

BI chances of success can be improved by involving senior management to help make BI a part of the organisational culture, and by providing the users with necessary tools, training, and support. Training encourages more people to use the BI application.

Providing user support is necessary to maintain the BI system and resolve user problems. User support can be incorporated in many ways, for example by creating a website. The website should contain great content and tools for finding the necessary information. Furthermore, helpdesk support can be used. The helpdesk can be manned by power users or the DW/BI project team.

BI Portals

A Business Intelligence portal (BI portal) is the primary access interface for Data Warehouse (DW) and Business Intelligence (BI) applications. The BI portal is the users first impression of the DW/BI system. It is typically a browser application, from which the user has access to all the individual services of the DW/BI system, reports and other analytical functionality. The BI portal must be implemented in such a way that it is easy for the users of the DW/BI application to call on the functionality of the application.

The BI portal's main functionality is to provide a navigation system of the DW/BI application. This means that the portal has to be implemented in a way that the user has access to all the functions of the DW/BI application.
The most common way to design the portal is to custom fit it to the business processes of the organization for which the DW/BI application is designed, in that way the portal can best fit the needs and requirements of its users.

The BI portal needs to be easy to use and understand, and if possible have a look and feel similar to other applications or web content of the organisation that the DW/BI application is designed for (consistency).

The following is a list of desirable features for web portals in general and BI portals in particular:

- **Usable**: User should easily find what they need in the BI tool.
- **Content Rich**: The portal is not just a report printing tool, it should contain more functionality such as advice, help, support information and documentation.
- **Clean**: The portal should be designed so it is easily understandable and not over complex as to confuse the users.
- **Current**: The portal should be updated regularly.
- **Interactive**: The portal should be implemented in a way that makes it easy for the user to use its functionality and encourage them to use the portal. Scalability and customization give the user the means to fit the portal to each user.
- **Value Oriented**: It is important that the user has the feeling that the DW/BI application is a valuable resource that is worth working on.

**Marketplace**

There are a number of business intelligence vendors, often categorised into
- the remaining independent "pure-play" vendors and
- consolidated "megavendors" that have entered the market through a recent trend of acquisitions in the BI industry.

Buyers of BI software also have to choose between two strategies:
- **best-of-breed**: combining specialised products from different vendors
- **full-service**: purchasing one comprehensive integrated solution

**Structured, semi-structured, and unstructured data**

A lot of business data are structured data, typically stored in relational databases, where the data are stored in the cells of tables, consisting of columns and rows. However, businesses also create a huge amount of valuable data in the form of e-mails, memos, notes from call-centers, news, user groups, chats, reports, web-pages, presentations, image-files, video-files, and marketing material and news. These data are semi-structured or unstructured.

BI uses both structured and unstructured data, but the former is easy to search, and the latter contains a large quantity of the information needed for analysis and decision making. Because of the difficulty of properly searching, finding and assessing unstructured or semi-structured data, organisations may not draw upon these vast reservoirs of information, which could influence a particular decision, task or project. This can ultimately lead to poorly informed decision making. Therefore, when designing a business intelligence/DW-solution, the specific problems associated with semi-structured and unstructured data must be accommodated for as well as those for the structured data.
Unstructured and semi-structured data have different meanings depending on their context. In the context of relational database systems, unstructured data cannot be stored in predictably ordered columns and rows. One type of unstructured data is typically stored in a BLOB (binary large object), a catch-all data type available in most relational database management systems.

Unstructured data may also refer to irregularly or randomly repeated column patterns that vary from row to row within each file or document.

Many of these data types, however, like e-mails, word processing text files, PPTs, image-files, and video-files conform to a standard that offers the possibility of metadata. Metadata can include information such as author and time of creation, and this can be stored in a relational database. Therefore it may be more accurate to talk about this as semi-structured documents or data, but no specific consensus seems to have been reached.

Unstructured data can also simply be the knowledge that business users have about future business trends. Business forecasting naturally aligns with the BI system because business users think of their business in aggregate terms. Capturing the business knowledge that may only exist in the minds of business users provides some of the most important data points for a complete BI solution.

There are several challenges to developing BI with semi-structured and unstructured data, for example:

1. Accessing unstructured data – unstructured data are stored in a huge variety of formats.
2. Terminology – There is a need to develop standardised concepts and terms.
3. Volume of data – It has been suggested that 85% of all data are unstructured or semi-structured.

The use of metadata

To solve problems with searchability and assessment of data, it is necessary to know something about the content. This can be done by adding context through the use of metadata, data about data. Many systems already capture some metadata (e.g. filename, author, size, etc.), but more useful would be metadata about the actual content – e.g. summaries, topics, people or companies mentioned. Two technologies designed for generating metadata about content are automatic categorisation and information extraction.
Visualisation

Here we combine the topics of data visualisation, information visualisation, and information graphics (infographics) from the following Wikipedia articles:


Definition and purpose of data visualisation and information visualisation

According to Friedman (2008) the main goal of data visualisation is to communicate information clearly and effectively through graphical means. It does not mean that data visualisation needs to look boring to be functional or extremely sophisticated to look beautiful. To convey ideas effectively, both aesthetic form and functionality need to go hand in hand, providing insights into a rather sparse and complex data set by communicating its key-aspects in a more intuitive way. Yet designers often fail to achieve a balance between form and function, creating gorgeous data visualisations which fail to serve their main purpose — to communicate information.

Data visualisation is closely related to information graphics, information visualisation, scientific visualisation, and statistical graphics. In the new millennium, data visualisation has become an active area of research, teaching and development. According to Post et al. (2002), it has united scientific and information visualisation.

Brian Willison (2008) has demonstrated that data visualisation has also been linked to enhancing agile software development and customer engagement.

Information visualisation

Information visualisation is the study of (interactive) visual representations of abstract data to reinforce human cognition. The abstract data include both numerical and non-numerical data, such as text and geographic information.

The field of information visualisation has emerged “from research in human-computer interaction, computer science, graphics, visual design, psychology, and business methods. It is increasingly applied as a critical component in scientific research, digital libraries, data mining, financial data analysis, market studies, manufacturing production control, and drug discovery”; Bederson&Shneiderman (2003).

Information visualisation presumes that "visual representations and interaction techniques take advantage of the human eye’s broad bandwidth pathway into the mind to allow users to see, explore, and understand large amounts of information at once. Information visualisation focused on the creation of approaches for conveying abstract information in intuitive ways.”; Thomas&Cook (2005).

Data analysis is an indispensable part of all applied research and problem solving in industry. The most fundamental data analysis approaches are visualisation (histograms, scatter plots, surface plots, tree maps, parallel coordinate plots, etc.), statistics (hypothesis test, regression, PCA, etc.), data mining (association mining, etc.), and machine learning methods (clustering, classification, decision trees, etc.). Among these approaches, information visualisation, or visual data analysis, is the most...
reliant on the cognitive skills of human analysts, and allows the discovery of unstructured actionable insights that are limited only by human imagination and creativity. The analyst does not have to learn any sophisticated methods to be able to interpret the visualisations of the data. Information visualisation is also a hypothesis generation scheme, which can be, and is typically followed by more analytical or formal analysis, such as statistical hypothesis testing.

Definition and analysis of infographics

Information graphics or infographics are graphic representations of information, data, or knowledge intended to present complex information quickly and clearly; Newsom & Haynes (2004), Smiciklas (2012). They can improve cognition by utilising graphics to enhance the human visual system’s ability to see patterns and trends; Heer et al (2010), Card (2009).

Indeed, Fernanda Viegas and Martin M. Wattenberg have suggested that an ideal visualisation should not only communicate clearly, but stimulate viewer engagement and attention; Viegas & Wattenberg (2011).

Overview

Infographics have been around for many years and recently the proliferation of a number of easy-to-use, free tools have made the creation of infographics available to a large segment of the population. Social media sites such as Facebook and Twitter have also allowed for individual infographics to be spread among many people around the world.

In newspapers, infographics are commonly used to show the weather, as well as maps, site plans, and graphs for statistical data. Some books are almost entirely made up of information graphics, such as David Macaulay’s The Way Things Work. The Snapshots in USA Today are also an example of simple infographics used to convey news and current events.

Modern maps, especially route maps for transit systems, use infographic techniques to integrate a variety of information, such as the conceptual layout of the transit network, transfer points, and local landmarks. Public transportation maps, such as those for the Washington Metro and the London Underground, are well-known infographics. Public places such as transit terminals usually have some sort of integrated "signage system" with standardised icons and stylised maps.

Analysis

The three parts of all infographics are the visual, the content, and the knowledge; Spyrestudios (2011):

- The visual part consists of colors and graphics. There are two different types of graphics – theme and reference. Theme graphics are included in all infographics and represent the underlying visual representation of the data. Reference graphics are generally icons that can be used to point to certain data, although they are not always found in infographics.

- Statistics and facts usually serve as the content for infographics, and can be obtained from any number of sources, including census data and news reports.

- One of the most important aspects of infographics is that they contain some sort of insight into the data that they are presenting – this is the knowledge.
Infographics are effective because of their visual element. Humans receive input from all five of their senses (sight, touch, hearing, smell, taste), but they receive significantly more information from vision than any of the other four; McCandless (2010). Fifty percent of the human brain is dedicated to visual functions, and images are processed faster than text. The brain processes pictures all at once, but processes text in a linear fashion, meaning it takes much longer to obtain information from text; Smiciklas (2012). Furthermore, it is estimated that 65% of the population are visual learners (as opposed to auditory or kinesthetic), so the visual nature of infographics caters to a large portion of the population; Smiciklas (2012). Entire business processes or industry sectors can be made relevant to a new audience through a guidance design technique that leads the eye. The page may link to a more complete report, but the infographic primes the reader making the subject-matter more accessible; Turnbull (2012).

When designing the visual aspect of an infographic, a number of considerations must be made to optimize the effectiveness of the visualisation. The six components of visual encoding are spatial, marks, connection, enclosure, retinal properties, and temporal encoding; Card (2009). Each of these can be utilised in its own way to represent relationships between different types of data. However, studies have shown that spatial position is the most effective way to represent numerical data and leads to the fastest and easiest understanding by viewers; Heer et al (2010). Therefore, the designers often spatially represent the most important relationship being depicted in an infographic.

There are also three basic provisions of communication that need to be assessed when designing an infographic – appeal, comprehension, and retention; Lankow et al (2012):

- **Appeal** is the idea that the communication needs to engage its audience.
- **Comprehension** implies that the viewer should be able to easily understand the information that is presented to them.
- **Retention** means that the viewer should remember the data presented by the infographic.

The order of importance of these provisions depends on the purpose of the infographic. If the infographic is meant to convey information in an unbiased way, such as in the domains of academia or science, comprehension should be considered first, then retention, and finally appeal. However, if the infographic is being used for commercial purposes, then appeal becomes most important, followed by retention and comprehension. When infographics are being used for editorial purposes, such as in a newspaper, appeal is again most important, but is followed first by comprehension and then retention.

When the varieties of factors listed above are taken into consideration when designing infographics, they can be a highly efficient and effective way to convey large amounts of information in a visual manner.

**Scope of data visualisation**

There are different approaches on the scope of data visualisation. One common focus is on information presentation, such as Friedman (2008) presented it. In this way Friendly (2008) presumes two main parts of data visualisation: **statistical graphics**, and **thematic cartography**. In this line the "Data Visualisation: Modern Approaches" (2007) article gives an overview of seven subjects of data visualisation:

- **Mindmaps**
- Displaying **news**
• Displaying data
• Displaying connections
• Displaying websites
• Articles & resources
• Tools and services

All these subjects are closely related to graphic design and information representation.

On the other hand, from a computer science perspective, Frits H. Post et al (2002) categorised the field into a number of sub-fields:

• Visualisation algorithms and techniques
• Volume visualisation
• Information visualisation
• Multiresolution methods
• Modelling techniques and
• Interaction techniques and architectures

Different types of visualisations

There are many types of visualisations that can be used to represent the same set of data. Therefore it is crucial to identify the appropriate visualisation for the data set by taking into consideration graphical features such as position, size, shape, and color. According to Heer et al (2010), there are primarily five types of visualisation categories – time-series data, statistical distributions, maps, hierarchies, and networking.

Time-series

Time-series data is one of the most common forms of data visualisation. It documents sets of values over time. Examples of graphics in this category include index charts, stacked graphs, small multiples, and horizon graphs.

Index charts are ideal to use when raw values are less important than relative changes. It is an interactive line chart that shows percentage changes for a collection of time-series data based on a selected index point. For example, stock investors could use this because they are less concerned with the specific price and more concerned with the rate of growth.

Stacked graphs are area charts that are stacked on top of each other, and depict aggregate patterns. They allow viewers to see overall patterns and individual patterns. However, they do not support negative numbers and make it difficult to accurately interpret trends.

Small multiples is an alternative to stacked graphs. Instead of stacking each area chart, each series is individually shown so the overall trends of each sector are more easily interpreted.

Horizon graphs are a space efficient method to increase the data density of a time-series while preserving resolution.

Statistical distributions

Statistical distributions reveal trends based on how numbers are distributed. Common examples include histograms and box-and-whisker plots, which convey statistical features such as

146
mean, median, and outliers. In addition to these common infographics, alternatives include stem-and-leaf plots, Q-Q plots, scatter plot matrices (SPLOM) and parallel coordinates.

For assessing a collection of numbers and focusing on frequency distribution, stem-and-leaf plots can be helpful. The numbers are binned based on the first significant digit, and within each stack binned again based on the second significant digit.

On the other hand, Q-Q plots compare two probability distributions by graphing quantiles against each other. This allows the viewer to see if the plot values are similar and if the two are linearly related.

SPLOM is a technique that represents the relationships among multiple variables. It uses multiple scatter plots to represent a pairwise relation among variables. Another statistical distribution approach to visualize multivariate data is parallel coordinates. Rather than graphing every pair of variables in two dimensions, the data is repeatedly plotted on a parallel axis and corresponding points are then connected with a line. The advantage of parallel coordinates is that they are relatively compact, allowing many variables to be shown simultaneously.

Maps

Maps are a natural way to represent geographical data. Time and space can be depicted through the use of flow maps. Line strokes are used with various widths and colors to help encode information. Choropleth maps, which encode data through color and geographical region, are also commonly used. Graduated symbol maps are another method to represent geographical data. They are an alternative to choropleth map and use symbols, such as pie charts for each area, over a map. This map allows for more dimensions to be represented using various shapes, size, and color. Cartograms, on the other hand, completely distort the shape of a region and directly encode a data variable. Instead of using a geographic map, regions are redrawn proportionally to the data. For example, each region can be represented by a circle and the size/color is directly proportional to other information, such as population size.

Hierarchies

Many data sets, such as spatial entities of countries or common structures for governments, can be organised into natural hierarchies. Node-link diagrams, adjacency diagrams, and enclosure diagrams are all types of infographics that effectively communicate hierarchical data. Node-link diagrams are a popular method due to the tidy and space-efficient results. A node-link diagram is similar to a tree, where each node branches off into multiple sub-sections. An alternative is adjacency diagrams, which is a space-filling variant of the node-link diagram. Instead of drawing a link between hierarchies, nodes are drawn as solid areas with sub-sections inside of each section. This method allows for size to be easily represented than in the node-link diagrams. Enclosure diagrams are also a space-filling visualisation method. However, they uses containment rather than adjacency to represent the hierarchy. Similar to the adjacency diagram, the size of the node is easily represented in this model.

Networks

Network visualisation explores relationships, such as friendships and cliques. Three common types are force-directed layout, arc diagrams, and matrix view.
**Force-directed layouts** are a common and intuitive approach to network layout. In this system, nodes are similar to charged particles, which repel each other. Links are used to pull related nodes together.

**Arc diagrams** are one-dimensional layouts of nodes with circular arcs linking each node. When used properly, with good order in nodes, cliques and bridges are easily identified in this layout.

**Matrix views** is an alternative often used by mathematicians and computer scientists. Each value has an (x,y) value in the matrix that corresponds to a node. By using color and saturation instead of text, values associated with the links can be perceived rapidly. While this method makes it hard to view the path of the nodes, there are no line crossings, which in a large and highly connected network can quickly become too cluttered.

While all of these visualisations can be effectively used on their own, many modern infographics combine multiple types into one graphic, along with other features, such as illustrations and text. Some modern infographics do not even contain data visualisation, and instead are simply a colorful and succinct ways to present knowledge. According to Van Slembrouck (2012), fifty-three percent of the 30 most-viewed infographics on the infographic sharing site visual.ly did not contain actual data.

**Visualisation tools**

Visualisations, or infographics, can be created by hand using simple everyday tools such as graph paper, pencils, markers, and rulers. However, today they are more often created using computer software, which is often both faster and easier. They can be created with general illustration software, such as Adobe Illustrator or the freeware Inkscape.

There are also a number of specialised websites and tools that can be used to construct visualisations, for example Infogr.am, Piktochart and Easel.ly. Those are sites that allows users to create infographics from pre-designed templates, add custom data and share infographics and charts on the web or download as pictures for placing in presentations:

- **Infogr.am** is a free service that generates interactive, javascript based online infographics and charts.

- **Piktochart** is a site that allows users to create infographics using pre-defined themes that allow customisation. Users can publish an infographic online in HTML5 and/or export an image of their infographic. Free access is limited to a number of templates to choose from, but a paid subscription allows users to access 100+ templates, as well as get rid of 'Piktochart' watermark.

- **Easel.ly** is another free infographic creation site utilising themes. Users have a canvas that they can drag themes and customisable graphics onto in order to personalise the look of their infographic.

Diagrams can be manually created and drawn using Creately, which can be downloaded for the desktop or used online. It also includes a number of templates to get users started on their diagrams. Additionally, it allows users to collaborate on diagrams in real time over the Internet. Gliffy is a similar diagram creation tool that requires a paid subscription to use.

**Tableau Public** is a downloadable program that automatically parses datasets when users upload them. It then suggests visualisations of the data and allows the user to customize the infographic.
using a simple drag-and-drop interface. Users may also simultaneously make a number of infographics using different parts of the same dataset. It provides users with HTML of their infographic so that they can share it on the web.

**ManyEyes** is a tool developed by IBM that allows users to create visualisations from either their own or other users’ uploaded datasets. They can then share their visualisations with all the other users, who can comment on and modify the visualisation. It is meant as a sharing and collaboration platform for infographics, allowing them to change over time based on input from numerous people.

A wealth of global data from sources such as the [OECD](https://www.oecd.org) and [World Bank](https://www.worldbank.org) are built into the website and desktop program developed by **Gapminder**. Users can view and customise infographics of world data such as [birth rates](https://www.gapminder.org/data/datasets/birth-rates/) and [GDP](https://www.gapminder.org/data/datasets/gdp/). It was built on a platform called **Trendalyzer**, which was sold to [Google](https://www.google.com) in 2007. This explains some of the similarities between Gapminder and [Google Public Data Explorer](https://developers.google.com/public-data), which is a large online repository of publicly available data from resources such as the [U.S. Census Bureau](https://www.census.gov), the [World Resources Institute](https://www.wri.org), and [Eurostat](https://ec.europa.eu/eurostat). Users can also upload their own datasets. Users can select specific data from a set, and the site will create visualisations of the data in the form of different graphs, such as bar and line graphs. There are a number of options for users to tailor the visualisation by changing the scale, axes, and other variables.

There are also numerous tools to create very specific types of visualisations. The Photo Stats App and InFoto can be used to create a visualisation based on embedded data in the photos on a user’s smartphone. Users can create an infographic of their resume using visualize.me or a “picture of their digital life” using [Intel’s What About Me?](https://whataboutme.com) The site [Wordle](https://wordle.net) allows users to provide text and create [word clouds](https://en.wikipedia.org/wiki/Word_cloud) from it.

**Related fields**

**Data acquisition**

Data acquisition is the sampling of the real world to generate data that can be manipulated by a computer. Sometimes abbreviated [DAQ](https://en.wikipedia.org/wiki/Data_acquisition) or [DAS](https://en.wikipedia.org/wiki/Data_acquisition_system), data acquisition typically involves acquisition of signals and waveforms and processing the signals to obtain desired information. The components of data acquisition systems include appropriate sensors that convert any measurement parameter to an electrical signal, which is acquired by data acquisition hardware.

**Data analysis**

Data analysis is the process of studying and summarising data with the intent to extract useful information and develop conclusions.

Data analysis is closely related to [data mining](https://en.wikipedia.org/wiki/Data_mining), but data mining tends to focus on larger data sets with less emphasis on making inference, and often uses data that was originally collected for a different purpose.


Types of data analysis are:
• Exploratory data analysis (EDA): an approach to analyzing data for the purpose of formulating hypotheses worth testing, complementing the tools of conventional statistics for testing hypotheses.

• Qualitative data analysis (QDA) or qualitative research is the analysis of non-numerical data, for example words, photographs, observations, etc.

Data governance

Data governance encompasses the people, processes and technology required to create a consistent, enterprise view of an organisation's data in order to:

• Increase consistency & confidence in decision making
• Decrease the risk of regulatory fines
• Improve data security
• Maximize the income generation potential of data
• Designate accountability for information quality

Data management

Data management comprises all the academic disciplines related to managing data as a valuable resource. The official definition provided by DAMA is that "Data Resource Management is the development and execution of architectures, policies, practices, and procedures that properly manage the full data lifecycle needs of an enterprise." This definition is fairly broad and encompasses a number of professions that may not have direct technical contact with lower-level aspects of data management, such as relational database management.

Data mining

Data mining is the process of sorting through large amounts of data and picking out relevant information. It is usually used by business intelligence organisations, and financial analysts, but is increasingly being used in the sciences to extract information from the enormous data sets generated by modern experimental and observational methods.

It has been described by Frawley et al (1992) as "the nontrivial extraction of implicit, previously unknown, and potentially useful information from data" and by Hand et al (2001) as "the science of extracting useful information from large data sets or databases." In relation to enterprise resource planning, according to Monk&Wagner (2006), data mining is "the statistical and logical analysis of large sets of transaction data, looking for patterns that can aid decision making".

Data presentation architecture

Data presentation architecture (DPA) is a skill-set that seeks to identify, locate, manipulate, format and present data in such a way as to optimally communicate meaning and proffer knowledge.


Objectives

DPA has two main objectives:
1. To use data to provide knowledge in the most effective manner possible (provide relevant, timely and complete data to each audience member in a clear and understandable manner that conveys important meaning, is actionable and can affect understanding, behavior and decisions)

2. To use data to provide knowledge in the most efficient manner possible (minimise noise, complexity, and unnecessary data or detail given each audience's needs and roles)

**Scope**

With the above objectives in mind, the actual work of data presentation architecture consists of:

- Defining important meaning (relevant knowledge) that is needed by each audience member in each context
- Finding the right data (subject area, historical reach, breadth, level of detail, etc.)
- Determining the required periodicity of data updates (the currency of the data)
- Determining the right timing for data presentation (when and how often the user needs to see the data)
- Utilising appropriate analysis, grouping, visualisation, and other presentation formats
- Creating effective delivery mechanisms for each audience member depending on their role, tasks, locations and access to technology

**Visualisation of statistical data: four examples**

Statistics is important for knowledge creation. The picture below gives an overview of the process in using data. Four different tools for interactive visualisation of public data and statistics are presented. The purpose is to give an idea how these tools work and how they can be used for presentations in different media with the end to create the knowledge that is needed for good decisions in different contexts.
The tools are

1. Trendalyzer
2. Statistics Explorer
3. The factlab
4. Google Public Data Explorer

Tim Berners-Lee: The next Web of open, linked data
[Linked Data: It's not a top-down system, Berners-Lee and OpenGov](https://www.slideshare.net/timbernerslee/the-next-web-of-open-linked-data)

Example 1. Trendalyzer, Gapminder

"The Joy of Stats" (video)
Example 2. **Statistics eXplorer**, NcomVA

**YouTube-video**
Regional development storytelling by this tool from the City of Gothenburg:

- [http://www.samhallsutvecklingen.se/explorer/](http://www.samhallsutvecklingen.se/explorer/)
- [http://www.samhallsutvecklingen.se/80/svensk-aldreboom/](http://www.samhallsutvecklingen.se/80/svensk-aldreboom/)
Example 3. **The factlab**, Mike Andersson

Presentation

Background material:

*The factlab video*

*The factlab documentation*
Example 4. **Google Public Data Explorer**, Ola Rosling

Logan Symposium: Google Public Data Explorer
Berkeley Graduate School of Journalism

Most popular public data categories in US

1. School comparisons
2. Unemployment
3. Population
4. Sales tax
5. Salaries
6. Exchange rates
Crime (crime conditions)
DB courses
Cost of living
Energy-related prices
CPI, inflation
Mortality
GDP

#26 Solar energy
#27 Income
#28 Life expectancy
#29 Learning disabilities
#30 Budget
#31 Consumer spending
#32 Cancer
#33 Global warming
#34 Foreign direct investment
#35 Acid rain
#36 Divorce
#37 Health
#38 Public debt
#39 Disabilities
#40 Voter turnout
#41 Literacy rates
#42 International trade
#43 Wind energy
#44 Urbanization
#45 Commodity price
#46 Human Development Index
#47 Official development assistance
#48 Social security tax
#49 Landfills
#50 Diesel price


Infrastructures


Regardless of whether e-services are provided by public or private actors, there is a need for reliable infrastructures in order to ensure the proper functioning, good quality, and safety of the services provided. The infrastructures may be technical, information system oriented, legal, and organizational. The infrastructures need to be managed in an efficient and non-corrupt way, and this is ultimately the responsibility of the government with its principles, systems, and practices of governance.

Both in traditional societies and in e-societies, well functioning infrastructures are of vital importance for efficient services of high quality. In the traditional society the infrastructures were mainly “physical”, so-called hard infrastructures, for example road and railroad networks. In modern information-based societies, hard infrastructures are still important, for example telecommunication networks, but another type of infrastructures, so-called soft infrastructures, are becoming more and more important. The soft infrastructures include:

- **Databases, registers, and information systems**, often serving a wide range of different customers and purposes
- **Standards and rules and tools** for efficient exchange of information between users and systems, and between systems, for example standards for identification and authentication, and standard formats and procedures for data interchange

Governments and government administrations in any society have to provide relevant and well functioning infrastructures, resources that are of great importance for most, or at least many of the actors in the society, and which have to be organised and financed collectively in order to reach their full potential. Here we shall focus on such infrastructures which are of particular importance for a well functioning e-society.

Definitions and characteristics

**Infrastructure systems** include both the fixed assets, and the control systems and software required to operate, manage and monitor the systems, as well as any accessory buildings, plants, or vehicles that are an essential part of the system. Also included are fleets of vehicles operating according to schedules such as public transit buses and garbage collection, as well as basic energy or communications facilities that are not usually part of a physical network, such as oil refineries, radio, and television broadcasting facilities.

**Infrastructure** is basic physical and organisational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function. It can be generally defined as the set of interconnected structural elements that provide framework supporting an entire structure of development. It is an important term for judging a country or region’s development.

The term typically refers to the technical structures that support a society, such as roads, bridges, water supply, sewers, electrical grids, telecommunications, and so forth, and can be defined as
"the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions"

Viewed functionally, infrastructure facilitates the production of goods and services, and also the distribution of finished products to markets, as well as basic social services such as schools and hospitals; for example, roads enable the transport of raw materials to a factory. In military parlance, the term refers to the buildings and permanent installations necessary for the support, redeployment, and operation of military forces. To make it simple, infrastructure is anything that is needed everyday, an everyday item.

**Hard and soft infrastructures**

It is common to distinguish between hard and soft infrastructures. “Hard infrastructure” typically refers to the large physical networks necessary for the functioning of a modern society.

Roads and railroads are examples of hard infrastructures. They are communication networks. In e-society, telecommunication networks are particularly important, carrying the Internet among other things.

"Soft infrastructure” refers to all the institutions, systems, and services which are required to maintain the economic, health, cultural, and social standards of a country, such as the financial system, the education system, the health care system, the system of government, and law enforcement, as well as emergency services.

The importance of relevant and efficient soft infrastructures (often in symbiosis with hard infrastructures) is growing rapidly in e-society. Some examples are:

- Central registers, based on unique identifiers
- Mechanisms and procedures for secure identification, authentication, and authorisation
- Strategic information systems, partly based on registers
- Strategic e-services, partly based on central registers and information systems, serving all actors in a modern e-society: citizens, businesses, and administrations
- Security systems and systems ensuring the functioning of important society functions in the case of emergencies and crises
- Relevant standards based on international cooperation

**Hard infrastructures**

Examples of hard infrastructures:

- **Transport infrastructures**, e.g. roads, railways, canals, seaports, airports
- **Energy infrastructures**, e.g. electrical power networks, oil and gas pipelines
- **Water management infrastructures**, e.g. drinking water supply systems, sewage collection and disposal systems, drainage systems
- **Communications infrastructures**, e.g. postal services, telecommunication networks, television and radio transmission systems, cable distribution networks, the Internet
- **Solid waste management systems**
- **Earth monitoring and measurement networks**, e.g. meteorological and seismic monitoring networks
Soft infrastructures

Soft infrastructures include both physical assets, such as highly specialised buildings and equipment, as well as non-physical assets, such as the body of rules and regulations governing the various systems, the financing of these systems, as well as the systems and organisations by which highly skilled and specialised professionals are trained, advance in their careers by acquiring experience, and are disciplined if required by professional associations (professional training, accreditation and discipline).

Unlike hard infrastructure, the essence of soft infrastructure is the delivery of specialised services to people. Unlike much of the service sector of the economy, the delivery of those services depend on highly developed systems and large specialised facilities or institutions that share many of the characteristics of hard infrastructure.

Governance infrastructures

Some examples:

- **The system of government and law enforcement**, including the political, legislative, law enforcement, justice and penal systems, as well as specialised facilities (government offices, courthouses, prisons, etc.), and specialised systems for collecting, storing and disseminating data, laws, and regulations

- **Emergency services**, such as police, fire protection, and ambulances, including specialised vehicles, buildings, communications and dispatching systems

- **Military infrastructure**, including military bases, arms depots, training facilities, command centres, communication facilities, major weapons systems, fortifications, specialised arms manufacturing, strategic reserves

Economic infrastructures

Some examples:

- **The financial system**, including the banking system, financial institutions, the payment system, exchanges, the money supply, financial regulations, as well as accounting standards and regulations

- **Major business logistics facilities and systems**, including warehouses as well as warehousing and shipping management systems

- **Manufacturing infrastructure**, including industrial parks and special economic zones, mines and processing plants for basic materials used as inputs in industry, specialised energy, transportation and water infrastructure used by industry, plus the public safety, zoning and environmental laws and regulations that govern and limit industrial activity, and standards organisations

- **Agricultural, forestry and fisheries infrastructure**, including specialised food and livestock transportation and storage facilities, major feedlots, agricultural price support systems (including agricultural insurance), agricultural health standards, food inspection, experimental farms and agricultural research centres and schools, the system of licensing and quota management, enforcement systems against poaching, forest wardens, and fire fighting
Social infrastructure

- **The health care system**, including hospitals, the financing of health care, including health insurance, the systems for regulation and testing of medications and medical procedures, the system for training, inspection and professional discipline of doctors and other medical professionals, public health monitoring and regulations, as well as coordination of measures taken during public health emergencies such as epidemics

- **The educational and research system**, including elementary and secondary schools, universities, specialised colleges, research institutions, the systems for financing and accrediting educational institutions

- **Social welfare systems**, including both government support and private charity for the poor, for people in distress or victims of abuse

Cultural, sports and recreational infrastructure

Some examples:

- **Sports and recreational infrastructure**, such as parks, sports facilities, the system of sports leagues and associations

- **Cultural infrastructure**, such as concert halls, museums, libraries, theatres, studios, and specialised training facilities

- **Business travel and tourism infrastructure**, including both man-made and natural attractions, convention centres, hotels, restaurants and other services that cater mainly to tourists and business travellers, as well as the systems for informing and attracting tourists, and travel insurance

Organising and managing registers, databases, and information systems

Governments have the overall responsibility for the infrastructures within their domains of authority. Thus a central government of a country has the overall responsibility for the development and maintenance of infrastructures within the country. Traditionally the infrastructures are so-called “hard infrastructures” like roads, railroads, electricity networks, and telecommunication networks. These infrastructures continue to be very important in modern e-societies as well, but there are nowadays also equally important “soft infrastructures”, like information systems used by most actors in today’s society: citizens, businesses and other organisations, as well as the government itself. These actors have a double role: they both produce and use the information in the information systems.

The information system infrastructure of a society is typically created around a backbone, consisting of a number of basic registers and databases, containing information about important objects in society, both active objects, called actors or subjects, such as persons and organisations, and passive objects, concrete or abstract “things” or “assets”, like real estate objects (land, buildings, dwellings), cars, natural resources, and financial assets.

Registers and databases

A basic, orthodox definition of a register is the following one:
• A register is an authorised, up-to-date list of all objects belonging to a certain population

• The objects listed in the register are uniquely identified by an authorised identifier, such as person number for persons, organisation number for organisations, etc

• In addition to the identifier, a register may contain additional basic and up-to-date information about the objects, such as name (not necessarily unique) and location and other contact information, e.g. address and telephone number

Example: A person register is an authorised list of persons belonging to a certain population, e.g. all persons living in a certain country at a certain point of time.

A **core set of registers for the administration** of a country may contain (at least)

• a register of persons
• a register of organisations
• a register of real estate objects: houses, dwellings, localities

Registers of this nature and status are sometimes called **base registers**. They define both semantically (by means of inclusion rules) and pragmatically/operationally (by means of enumeration) some basic object types and populations of fundamental importance for the administration of a modern society, as well as for official statistics.

**Links between registers**
The base registers should also be linked to each other, thus materialising important relations between the basic object types, e.g. “the dwelling were a person lives”, “the organisation where a person works”, “the locality where an organisation is located”.

**Unique and informationless identifiers**
The identifiers of the objects in a register must be unique and stable over time. The safest way of ensuring stability of identifiers over time is to make them informationless. If an identifier contains information, there is always the risk that this information changes, either because the information turns out to be wrong, or because the status of the object really changes.

For example, person identifiers sometimes contain information about the birth date of the person. This information is believed to be stable, but sometimes it is discovered that the information is wrong and has to be corrected. However, if the information about the birth date is corrected, it will also cause the identify of the person to change, which will inevitably cause a lot of problems, both for the person concerned and for others.

The identifiers of the objects in a register must be unique (over time) within the population covered by the register.

**Standard definitions of registered objects**
The definition of a person is relatively straightforward, but for many other objects it is not. For example, there are many possible definitions of an organisation or an enterprise. Different definitions may be suitable for different purposes. As far as administrative purposes are concerned, the legal status of an organisation is often important. On the other hand, for statistical purposes, one may more interested in an organisation in the sense of an establishment that conducts a certain type of business (kind-of-activity) in a certain place (locality), whereas the legal status of the establishment is not so important.
Administrative registers and statistical registers

One may distinguish between administrative registers and statistical registers:

- An **administrative register** is a register used for administrative purposes
- A **statistical register** is a register used for statistical purposes

Administrative registers are typically created and maintained in order to facilitate certain administrative processes, for example taxation of people and businesses. They are also needed for ensuring the legitimacy and correctness of certain transactions, for example transfers of ownership. If you are going to buy a house or a car, you need to be sure that the seller is the legitimate owner of the object that you intend to purchase. Registers are also important in order to ensure that the right persons and organisations get the right services from the government and its agencies, for example education and health care.

A statistical register may be created from one or more administrative registers, possibly in combination with data from other sources, such as traditional statistical surveys.

Traditionally, registers are used in official statistics as frames for surveys. When conducting a statistical survey, one has to create a frame, or a register, of the objects in the population to be investigated by the survey. When conducting a sample survey, a sample of the objects in the frame is drawn, and then these objects are observed by some kind of measurement method and measurement instrument, e.g. mailed questionnaires or telephone interviews.

In order to be useful for statistical purposes, a register should contain contact information for all objects in the register, that is, name, postal address, physical address, email address, phone number, etc, for the object itself and/or a human respondent representing the object.

It is also useful if a statistical register contains classification variables that makes it easy to create strata and subpopulations (domains) to be used in the design, production, presentation, and analysis of survey data.

**Links to other registers and data sources; satellite registers**

As has been mentioned already, a register should contain links to other registers, thus representing relations between object types and between populations of objects. Such links between registers effectively multiplies the amount of information contained in a system of registers. For example, by linking persons with their dwellings, we indirectly associate persons with variables and properties of their dwellings, e.g. “persons living in one-family houses”, “persons living in the same dwelling” (possibly forming a household), etc.

Furthermore, a register may be linked to other databases or files containing data about special subdomains (subpopulations) of the population of objects contained in the register. Such data sets are sometimes regarded as **satellite registers** to the registers that they are linked to; they may or may not fulfill the strict definition of a register stated above. For example, a person register may have satellite registers like “student registers” and “patient registers”. Satellite registers are sometimes named after some important (type of) variable in the registers, e.g. “income registers” and “education registers”.

A register extended with other data concerning the objects in the register, which can be used in combination with, or instead of, data collected by surveys. Such register data may reduce the response burden and improve the quality and efficiency of official statistics.
Event registers
Some registers contain event type objects, e.g. road accidents and crimes. Such registers are cumulative in the sense that they contain all events of a certain kind that have occurred since the time when the registration of such events started.

Base registers containing all basic objects of a certain kind, e.g. all persons living in a country, are often closely associated with one or more event registers, containing information about certain types of events that the basic objects are involved in, e.g. birth and death events, migration events, marriages and divorces, etc.

Life history registers
Base registers in combination with event registers may be used for forming life histories of the basic objects in a base register (or objects belonging to a certain subpopulation, registered in a satellite register), e.g. the life histories of patients or criminals. Life history registers, or life history databases, may be used for longitudinal studies.

Metadata and conceptual models

Metadata are “data about data”. Metadata may describe:

- the sources of data, for example
  - a data collection process that is part of an operative, administrative process, for example an e-service process
  - a statistical survey
  - some existing register or database, based on other data sources, which may again be administrative processes or statistical surveys or other registers or databases
- the measurement instruments that have been used for collecting the original data, for example questionnaires (paper, online, etc)
- the contents and meaning of the data: the objects, variables (attributes), and relations informed about by the data
- the quality of the data: relevance, accuracy, timeliness, accessibility, comparability, etc
- the physical representation of the data: technical aspects
- the processes that the data have undergone: data collection, checking and correction, combination with other data, derivations, aggregations and estimations, etc

The contents and meaning of the data is of particular importance for judging the relevance of the data for a particular purpose (which may be different from the purpose for which the data were originally collected). The definitions of the contents and meaning of the data used and produced by administrative processes in governments are often based on concepts defined in the legislation behind these processes, that is, laws and regulations.

In order to get an understandable and informative overview of the contents and meaning of a set of data and the underlying concepts, it is often useful to develop a so-called conceptual model.

A conceptual model may be built from three basic concepts:

- Objects: objects are informed about by the data, e.g. persons, organisations
- Variables: variables and their values inform about properties of the objects, e.g. sex, age, income
- Relations: relations relate objects to each other, e.g. employment between person and company

Objects may be categorised into:
• **Active objects**, also called actors or subjects, e.g. persons, organisations
• **Passive objects**, concrete or abstract, also called things or utilities, e.g. dwellings, educations
• **Complex objects**, based on relations between objects, e.g. trade transactions

**Literature**

Registers, databases, and information systems, as well as the concepts of metadata and conceptual models are treated in many publications by Bo Sundgren, see [this link](#). See also Sundgren (2013f).

**More about the concept of “infrastructure”**

We shall discuss:

• Uses of the term “infrastructure”
• Typical attributes of infrastructures

**Uses of the term “infrastructure”**

**Engineering and construction**

Engineers generally limit the use of the term "infrastructure" to describe fixed assets that are in the form of a large network, in other words, "hard" infrastructure. Recent efforts to devise more generic definitions of infrastructure have typically referred to the network aspects of most of the structures, and to the accumulated value of investments in the networks as assets. One such effort defines infrastructure as

• the network of assets "where the system as a whole is intended to be maintained indefinitely at a specified standard of service by the continuing replacement and refurbishment of its components"

**Civil defence and economic development**

Civil defence planners and developmental economists generally refer to both hard and soft infrastructure, including public services such as schools and hospitals, emergency services such as police and fire fighting, and basic financial services. The notion of Infrastructure-based development combining long-term infrastructure investments by government agencies at central and regional levels with public private partnerships has proven popular among Asian – notably Singaporean and Chinese – European, and Latin American economists.

**Military**

Military strategists use the term infrastructure to refer to all building and permanent installations necessary for the support of military forces, whether they are stationed in bases, being deployed or engaged in operations, such as barracks, headquarters, airfields, communications facilities, stores of military equipment, port installations, and maintenance stations.

**Critical infrastructure**

The term critical infrastructure has been widely adopted to distinguish those infrastructure elements that, if significantly damaged or destroyed, would cause serious disruption of the dependent system or organisation.

Storm, deluge, or earthquake damage leading to loss of certain transportation routes in a city, for example bridges crossing a river, could make it impossible for people to evacuate, and for emergency
services to operate; these routes would be deemed critical infrastructure. Similarly, an on-line booking system might be critical infrastructure for an airline.

**Urban infrastructure**

Urban or municipal infrastructure refers to hard infrastructure systems generally owned and operated by municipalities, such as streets, water distribution, and sewers. It may also include some of the facilities associated with soft infrastructure, such as parks, public pools and libraries.

**Green infrastructure**

Green infrastructure is a concept that highlights the importance of the natural environment in decisions about land use planning. In particular there is an emphasis on the "life support" functions provided by a network of natural ecosystems, with an emphasis on interconnectivity to support long-term sustainability.

Examples include clean water and healthy soils, as well as the more anthropocentric functions such as recreation and providing shade and shelter in and around towns and cities. The concept can be extended to apply to the management of stormwater runoff at the local level through the use of natural systems, or engineered systems that mimic natural systems, to treat polluted runoff.

**Other uses**

In other applications, the term infrastructure may refer to information technology, informal and formal channels of communication, software development tools, political and social networks, or beliefs held by members of particular groups. Still underlying these more conceptual uses is the idea that infrastructure provides organizing structure and support for the system or organization it serves, whether it is a city, a nation, a corporation, or a collection of people with common interests.

Examples include IT infrastructure, research infrastructure, terrorist infrastructure, and tourism infrastructure.

**Typical attributes of infrastructures**

Hard infrastructure generally has the following attributes:

**Capital assets that provide services**

These are physical assets that provide services. The people employed in the hard infrastructure sector generally maintain, monitor, and operate the assets, but do not offer services to the clients or users of the infrastructure. Interactions between workers and clients are generally limited to administrative tasks concerning ordering, scheduling, or billing of services.

**Large networks**

These are large networks constructed over generations, and are not often replaced as a whole system. The network provides services to a geographically defined area, and has a long life because its service capacity is maintained by continual refurbishment or replacement of components as they wear out.

**Historicity and interdependence**

The system or network tends to evolve over time as it is continuously modified, improved, enlarged, and as various components are rebuilt, decommissioned or adapted to other uses. The system components are interdependent and not usually capable of subdivision or separate disposal, and consequently are not readily disposable within the commercial marketplace. The system inter-dependency may limit a component life to a lesser period than the expected life of the component itself.
Natural monopoly
The systems tend to be natural monopolies, insofar that economies of scale means that multiple agencies providing a service are less efficient than would be the case if a single agency provided the service. This is because the assets have a high initial cost and a value that is difficult to determine. Once most of the system is built, the marginal cost of servicing additional clients or users tends to be relatively inexpensive, and may be negligible if there is no need to increase the peak capacity or the geographical extent of the network.

In public economics theory, infrastructure assets such as highways and railways tend to be public goods, in that they carry a high degree of non-excludability, where no household can be excluded from using it, and non-rivalry, where no household can reduce another from enjoying it. These properties lead to externality, free ridership, and spillover effects that distort perfect competition and market efficiency. Hence, government becomes the best actor to supply the public goods.
Bibliography

Chandrajit Bajaj, Bala Krishnamurthy (1999). *Data Visualization Techniques.*


Blais, Joline; Ippolito, Jon (2006). *At the Edge of Art.* Thames and Hudson.


W. Frawley and G. Piatetsky-Shapiro and C. Matheus (Fall 1992). "Knowledge Discovery in Databases: An Overview". *AI Magazine* pp. 213–228. ISSN 0738-4602


Michael Friendly (2009). "Milestones in the history of thematic cartography, statistical graphics, and data visualization".


MacQuarrie, Ashley, “Infographics in Education”, July 10, 2012


David McCandless (2010). The Beauty of Data Visualization. TED Talk


Information Visualization at the Open Directory Project

InfoVis:Wiki, a community that collects infoviz techniques, publications and events in wiki format.

Visual Complexity, unified resource space for anyone interested in the visualization of complex networks

Peer-reviewed definition of Data Visualization with commentaries

We Love Infographics

The data visualization academy [http://bigdataviz.dk/](http://bigdataviz.dk/)


"What is an Infographic", [http://www.customermagnetism.com](http://www.customermagnetism.com)

Periodic Table of Visualization Methods

Society for Newsdesign
E-learning, net-based learning, and self-learning

New methods and forms of higher education, enabled by modern, web-based information technologies and new pedagogical models, are a hot topic at universities today. Many of us have a strong belief in many of these new forms of education, and the students are definitely attracted by them and often choose them when they are available.

On the other hand there are many university teachers, who are sceptical to the new methods and forms of education, and many students are also critical to some aspects of them. There are definitely needs to improve all forms of higher education in order to achieve better results in more efficient ways, both from a producer’s and from a customer/student’s perspective.

There is a lot of prejudice about e-learning. For example, many people, including some politicians and some teachers, suggest that e-learning, or distance education, is per se of lower quality than conventional, campus-based education, delivered ex cathedra. There is a tendency among these critics of e-learning to compare ideal conventional courses, given by the best teachers, with mediocre online courses produced by mediocre teachers with their main focus on low costs, rather than on high quality and other features meeting the demands of students.

On the other hand, there are also enthusiasts and bureaucrats who believe that net-based learning will automatically rationalise and lower the costs of producing courses, increasing the productivity drastically, since the same lectures and education material can be reused over and over again for huge masses of students. This may sometimes be true, but one should not underestimate the costs of designing and producing high-quality online courses.

So far there have been relatively few serious studies, focusing on facts, and aiming at fact-based evaluations and comparisons of different modes of teaching and learning, including so-called blended approaches, combining the best aspects of different models.

Some visions for the future:

- The demand from students will continue to grow for new methods and forms of higher education, enabled by modern, web-based information technologies and new pedagogical models.
- The new methods and forms of higher education will continue to be improved, taking advantage of technical as well as pedagogical innovations, often in combination.
- Disruptive phenomena like Open Education Resources (OER), Massive Open Online Courses (MOOC), and Open Access (OA) publishing will continue to grow rapidly, creating great opportunities for democratising distance education and self-learning, giving underprivileged groups of students access to advanced knowledge and skills, instrumental for a good life.
- The new methods and forms of higher education will lead to improvements of quality, cost-efficiency, and student satisfaction.
- Universities will develop and intensify cooperation and organise joint virtual educations and virtual universities, engaging the best teachers and resources, wherever they are physically located.

An overview of concepts and terms

There are a lot of terms overlapping in meaning with the term “e-learning”, e.g. online learning, net-based learning, distance education/learning, flexible learning, next generation learning (NGL). Within the Swedish education system the term “distance education” seems to dominate, especially among education bureaucrats. Here we shall focus on education/learning on university level, where the
communication via the Internet is an extremely important technical enabler. However, so-called blended learning modes are definitely not excluded. For a deeper discussion of basic concepts, see Sundgren (2012) and Sundgren (2013).

**Next Generation Learning (NGL or NxGL)**
The concept of Next Generation Learning (NGL or NxGL) seems to come from some American organisations (Carnegie Corporation of New York, The Opportunity Equation, The Parthenon Group, Stupski Foundation) working in cooperation with a network of state-owned schools in the United States, the Council of Chief State School Officers (CCSSO). CCSSO is a nonpartisan, nationwide, non-profit organisation of public officials who head departments of elementary and secondary education in some American states. CCSSO provides leadership, advocacy, and technical assistance on major educational issues. The Council seeks member consensus on major educational issues and expresses their views to civic and professional organisations, federal agencies, Congress, and the public.

According to CCSSO (2011) and the New Hampshire Department of Education (2011) the critical attributes of Next Generation Learning are:

- Personalizing learning, which calls for a data-driven framework to set goals, assess progress, and ensure students receive the academic and developmental supports they need;
- Comprehensive systems of learning supports, which address social, emotional, physical, and cognitive development along a continuum of services to ensure the success of all students;
- World-class knowledge and skills, which require achievement goals to sufficiently encompass the content knowledge and skills required for success in a globally-oriented world;
- Performance-based learning, which puts students at the center of the learning process by enabling the demonstration of mastery based on high, clear, and commonly-shared expectations;
- Anytime, everywhere opportunities, which provide constructive learning experiences in all aspects of a child’s life, through both the geographic and the Internet-connected community; and
- Authentic student voice, which is the deep engagement of students in directing and owning their individual learning and shaping the nature of the education experience among their peers.

According to Stupski Foundation et al (2011) next generation learning models will necessarily rest on three building blocks: 1) knowing the student through frequent diagnosis and assessment facilitated by data platforms and learning algorithms, 2) modular, unbundled content and learning activities pegged to world-class standards, and 3) a variety of delivery methods. In combination, these components can potentially bring high levels of personalization to student learning. See Figure 1 below.
According to the Swedish Agency of Higher Education (Högskoleverket) and Dalarna University College:

“The concept of “next generation learning” communicates two pedagogically interesting meanings. On the one hand it is about the future generation’s learning – on the other hand it is about the new ways of learning emerging with the assistance of an accelerating technical development.”

**Flexible learning**

Flexible Learning is a set of educational philosophies and systems, concerned with providing learners with increased choice, convenience, and personalisation to suit the learner. In particular, flexible learning provides learners with choices about where, when, and how learning occurs. Sometimes also referred to as personalised learning. Flexible learning is a term often used in New Zealand and Australia; see Shurville et al (2008).

Flexible learning approaches are often designed using a full range of teaching and learning theories, philosophies and methods to provide students with opportunities to access information and expertise, contribute ideas and opinions, and correspond with other learners and mentors. This may occur through the use of internet-based tools such as Virtual Learning Environments (VLEs) or Learning Management Systems (LMSes), discussion boards or chat rooms; and may be designed as
a "blended" approach, with content available electronically and remotely, as well as "face-to-face" classroom tutorials and lectures.

While the majority of flexible learning programs to date have taken advantage of computer-based systems ("E-learning"), the rapidly increase in the processing power and popularity of mobile digital devices has recently caused considerable interest in mobile learning - the use of mobile devices such as mobile phones, iPods, and Personal Digital Assistants (PDAs) to increase the mobility of learners and correspondingly enhance the flexibility of their learning.

**Distance education and distance learning**

Distance education or distance learning is a field of education that focuses on teaching methods and technology with the aim of delivering teaching, often on an individual basis, to students who are not physically present in a traditional educational setting such as a classroom. It has been described as "a process to create and provide access to learning when the source of information and the learners are separated by time and distance, or both"; Honeyman& Miller (1993).

Distance education courses that require a physical on-site presence for any reason (including taking examinations) are referred to as hybrid or blended education. Internet-based distance education is referred to as netbased learning.

The Swedish Agency for Higher Education, Högskoleverket (HSV) has adopted an official definition of distance education; Högskoleverket (2011):

In Swedish: Utbildning där lärare och studenter i huvudsak är åtskilda i tid och/eller rum.

In English: Education where teachers and students are mostly separated in time and/or space.

The types of available technologies used in distance education are divided into two groups: synchronous learning and asynchronous learning.

**Synchronous learning** is a mode of delivery where all participants are "present" at the same time. It resembles traditional classroom teaching methods despite the participants being located remotely. It requires a timetable to be organised. Web conferencing and videoconferencing are examples of synchronous technology.

**Asynchronous learning** is a mode of delivery where participants access course materials on their own schedule and so is more flexible. Students are not required to be together at the same time. Mail correspondence, which is the oldest form of distance education, is an asynchronous delivery technology and others include message board forums, e-mail, video and audio recordings, print materials, voicemail and fax.

The two methods can be combined in the delivery of one course. For example, some courses offered by The Open University in the UK use periodic sessions of residential or day teaching to supplement the remote teaching.

Four major benefits of distance learning have been identified by Oblinger (2000):

- **Expanding access**: Distance education can assist in meeting the demand for education and training demand from the general populace and businesses, especially because it offers the possibility of a flexibility to accommodate the many time-constraints imposed by personal responsibilities and commitments.
- **Alleviate capacity constraints**: Being mostly or entirely conducted off-site, the system reduces the demand on institutional infrastructure such as buildings.
- **Making money from emerging markets**: there is an increasing acceptance of the value of lifelong learning. Institutions can benefit financially from this by adopting distance education.
- **Catalyst for institutional transformation**: The competitive modern marketplace demands rapid change and innovation, for which distance education programs can act as a catalyst.

Whereas NGL is explicitly directed towards the future, distance education has a long and successful historical tradition.

Distance education dates to at least as early as 1728, when Caleb Phillips, “Teacher of the new method of Short Hand” was seeking students for lessons to be sent weekly.

Modern distance education initially relied on the development of postal services in the 19th century and has been practised at least since Isaac Pitman taught shorthand in Great Britain via correspondence in the 1840s. The University of London claims to be the first university to offer distance learning degrees, establishing its External Programme in 1858.

More recently, in 1969, The Open University was established in the UK, which initially relied on radio and television broadcasts for much of its delivery. All open universities, which now exist in many places around the world, use distance education technologies as delivery methodologies and some have grown to become mega-universities, a term coined to denote institutions with more than 100,000 students.

**E-learning**


- **E-learning** comprises all forms of electronically supported learning and teaching. The information and communication systems, whether networked learning or not, serve as specific media to implement the learning process. The term will still most likely be utilised to reference out-of-classroom and in-classroom educational experiences via technology, even as advances continue in regard to devices and curriculum.
- E-learning is essentially the computer and network-enabled transfer of skills and knowledge. E-learning applications and processes include web-based learning, computer-based learning, virtual education opportunities and digital collaboration. Content is delivered via the Internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM. It can be self-paced or instructor-led and includes media in the form of text, image, animation, streaming video and audio.
- Abbreviations like CBT (Computer-Based Training), IBT (Internet-Based Training) or WBT (Web-Based Training) have been used as synonyms to e-learning. Today one can still find these terms being used, along with variations of e-learning such as elearning, Elearning, and eLearning.

**Networked learning**


- **Networked learning** is a process of developing and maintaining connections with people and information, and communicating in such a way so as to support one another's learning.
- The central term in this definition is connections. It takes a relational stance in which learning takes place both in relation to others and in relation to learning resources.\[1\]
Salmon (2001) wrote "learning is built around learning communities & interaction, extending access beyond the bounds of time and space, but offering the promise of efficiency and widening access. Think of individuals as nodes on a network!"

Networked learning can be practiced in both informal and formal educational settings. In formal settings the learning achieved through networked communication is formally facilitated, assessed and/or recognised by an educational organisation. In an informal setting, individuals maintain a learning network for their own interests, for learning "on-the-job", or for research purposes.

Collaborative learning

Collaborative learning is a situation in which two or more people learn or attempt to learn something together. Unlike individual learning, people engaged in collaborative learning capitalize on one another’s resources and skills (asking one another for information, evaluating one another’s ideas, monitoring one another’s work, etc.). More specifically, collaborative learning is based on the model that knowledge can be created within a population where members actively interact by sharing experiences and take on asymmetry roles. Put differently, collaborative learning refers to methodologies and environments in which learners engage in a common task where each individual depends on and is accountable to each other. These include both face-to-face conversations and computer discussions (online forums, chat rooms, etc).

Collaborative learning is commonly illustrated when groups of students work together to search for understanding, meaning, or solutions or to create an artifact or product of their learning. Further, collaborative learning redefines traditional student-teacher relationship in the classroom which results in controversy over whether this paradigm is more beneficial than harmful. Collaborative learning activities can include collaborative writing, group projects, joint problem solving, debates, study teams, and other activities. The approach is closely related to cooperative learning.

Virtual education

Virtual education is a term describing online education using the Internet. This term is often used in to refer to cyber schools, and in higher education, where so-called Virtual Universities have been established. A virtual program (or a virtual course of studies) is a study program in which all courses, or at least a significant portion of the courses, are virtual courses, whether in synchronous (i.e. real time) or asynchronous (i.e. self-paced) formats.

Virtual courses – a synonym is online courses – are courses delivered on the Internet. "Virtual" is used here to characterize the fact that the course is not taught in a classroom face-to-face but through some substitute mode that can be associated with classroom teaching. That means people do not have to go to the real class to learn.

Although there is a long and varied history of distance education, the current intersection of technology as a means to facilitate real-time communication with community-centered interaction, and the increasing acceptance and employment of those developments in the broader culture, have uniquely positioned virtual schools in a position of significant innovation and responsibility.

Many virtual study programs are mainly text based, using HTML, PowerPoint, or PDF documents. Any attempt to personalize the educational experience is essential in that students respond to personal
attention and feedback. Today a wide spectrum of instruction modes is available, including the following:

- **Virtual Classroom:** Live teacher instruction and feedback online that enables real-time voice interaction, whiteboard sharing, and breakout sessions to enhance a student’s learning experience. This provides students an opportunity to interact with the teacher as well as classmates by oral and written communication.

- **Virtual operating room:** giving students a space to learn the basic induction procedure before stepping foot in the real-life operating room. III

- **Hypertext courses:** Structured course material is used as in a conventional distance education program. However, all material is provided electronically and can be viewed with a browser. Hyperlinks connect text, multimedia parts and exercises.

- **Video-based courses** are like face-to-face classroom courses, with a lecturer speaking and PowerPoint slides or online examples used for illustration. Video-streaming technologies is used. Students watch the video by means of freeware or plug-ins.

- **Audio-based courses** are similar but instead of moving pictures only the sound track of the lecturer is provided. Often the course pages are enhanced with a text transcription of the lecture.

- **Animated courses:** Enriching text-oriented or audio-based course material by animations is generally a good way of making the content and its appearance more interesting. Animations are created using Macromedia Flash or similar technologies.

- **Web-supported textbook courses** are based on specific textbooks. Students read and reflect on the chapters by themselves. Review questions, topics for discussion, exercises, case studies, etc. are given chapterwise on a website and discussed with the lecturer. Class meetings may be held to discuss matters in a chatroom, for example.

- **Peer-to-peer courses** are courses taught "on-demand" and without a prepared curriculum. A new field of online education has emerged in 2007 through new online education platforms.

- **Social Networking:** Using Web 2.0 technologies in virtual classrooms promotes increased social interaction, student-centered instruction and a problem solving curriculum. Students can address a problem that is oriented to a cross curriculum activity. Teachers will act as guides and resources, but it is up to the students to collaborate, discuss, review ideas, and present solutions.

Students in synchronous mode virtual education acquire knowledge in a uni-directional manner (e.g. by studying a video, reading a textbook chapter), this would be known as asynchronous instruction. Subsequent discussions of problems, solving exercises, case studies, review questions, etc. help the students to understand better what they learned before. This learning is delivered at the students pace, not instructed live by a teacher. Although asynchronous courses are student driven, teachers are often needed to act as a guide. Therefore teacher facilitators are often available to provide any assistance that may be needed throughout the course. Communication with teacher facilitators is accomplished through discussion boards and email. This communication may be needed at times to better explain a specific topic or make grade corrections.

Students enrolled in virtual classrooms or synchronous courses still acquire the content via real life instruction. A real teacher in real time delivers virtual classroom instruction. The virtual classroom teacher uses the computer screen as the board delivering instruction by using videos, PowerPoints, or podcasts in conjunction with audio of the teacher’s voice. Students enrolled in the virtual classroom have opportunities for immediate teacher feedback and input while logged into class, just as they would in a traditional classroom. Students can also interact with other students via notes, texts, and emoticons. Additionally, many conferencing platforms used by virtual educators allow for students to work in small groups during classtime, thus again mirroring the look and feel of a
traditional classroom. Electronic media like a discussion forum, chat room, voice mail, e-mail, etc. are often employed for communication in both synchronous and asynchronous courses.

Homework assignments are normally submitted electronically, e.g. as an attachment to an e-mail or uploaded to the LMS system in a view complete. When help is needed, lecturers, tutors, or fellow students, or a help desk are available, just like in a real university. The difference is that all communication occurs via electronic media.

Virtual teachers are encouraged to use technology more in the classroom. they are also motivated to share their ideas and lesson plans with other teachers through wikis, blogs, FaceBook, etc.

Communication in the synchronous virtual classroom is a collaborative learning experience. Students are encouraged to interact with peers through web-conferencing technologies. Small-group and whole-group collaboration is a suggested platform for virtual education.

Communication can take place in real-time, i.e. during a class session. A small-group session is often referred to as a “Breakout Room.” This is a platform that allows real-time, social interaction between students. Students collectively work on a learning task designed by the virtual classroom instructor. Individual microphones, whiteboard tools (drawing rights for the group board), and/or notes are suggested ways students communicate with one another during live “Breakout Rooms.” Outside of the virtual classroom setting collaborative communication may also occur through various technologies; blogs, wikis, and/or multi-media tools.

Virtual campus

European Commission


Although the phrase virtual campus is an important concept in the field of education, there is no generally accepted theoretical framework for it among researchers. In this chapter we search for a contemporary definition. To do this we have gathered definitions from more than 10 European Countries. Based on these results, we have developed a theoretical framework for the phrase virtual campus.

When defining a virtual campus, the European Commission stresses cooperation among higher education institutions in the field of e-learning, especially regarding joint curricula development by several universities. Indicators may include agreements for the evaluation, validation and recognition of acquired competences, subject to national procedures; large-scale experiments of virtual mobility in addition to physical mobility; and development of innovative dual mode curricula, based on both traditional and online learning methods.

This broad definition involves many issues from partnerships between traditional and/or distance universities and other higher education providers, with a view to offering joint certifications (for undergraduate and/or postgraduate levels) and cooperation with learning support services. This might also include collaborative activities in strategic areas of education or research through cooperation involving researchers, academics, students, management, administrators and technical personnel. At the e-learningeuropa.info portal, virtual campus is defined as “Part of a university or faculty that offers educational facilities at any time or, in theory, any place, by Internet”.

Wikipedia

http://en.wikipedia.org/wiki/Virtual_campus:
A **virtual campus** refers to the online offerings of a college or university where college work is completed either partially or wholly online, often with the assistance of the teacher, professor, or teaching assistant.

The majority of students using virtual campuses to obtain online degrees are adults students for three main reasons:

- **Flexibility** - Adults with full-time jobs and families would find it impossible to attend daily at a traditional school setting. Online classes allow students to work at their own pace and work around their busy lives.
- **Cost** - The cost of an online degree is relatively cheaper than at a traditional college setting. Obtaining your degree online eliminates costs such as classroom costs and facility upkeep costs that traditional students are required to pay because they are using the campus. However, the cheaper cost of an online degree does not diminish the value of the degree.
- **Broad Choices** - Students can remain at home and have availability to degrees that may not be offered by universities or colleges nearby.

Schools use a variety of tools for conducting classes - typically called **Learning Management Systems** (LMS) or **Course Management Systems** (CMS), e.g. Moodle, Sakai, Serco, Blackboard, Sharepoint, WebCT, Angel, Alphastudy, it’s learning, Desire2Learn, EdMastery, Elluminate and eCollege.

Some of the aspects that go under virtual campus includes various types of learning activities such as lectures, homework, discussions, readings, assignments. Classes are usually self paced using online documents and databases that might be available to them. Tests and other assignments are available online in specific programs used for online classes such as Elluminate, Blackboard, etc. Other methods used in virtual campus are live sessions, videoconferencing, discussing and sharing various applications to name a few. Individuals are able to access the materials any time they want under the teacher’s control and are able to access anywhere online where they’re able to access internet usage. Email is a big part of the virtual campuses and is often used before, during and after sessions. This aids individuals in exchanging information and or point them to the right direction that would be useful in increasing and understanding various methods available to them via documents and online sources.

**Virtual university**


- **A virtual university** provides higher education programs through electronic media, typically the Internet. Some provide online learning as part of their extended university courses while others solely offer online courses. They are regarded as a form of distance education. The goal of virtual universities is to provide access to the part of the population who would not be able to attend a physical campus, for reasons such as distance - where students live too far from a physical campus to attend regular classes; and the need for flexibility – some students need the flexibility to study at home whenever it is convenient for them to do so.

- Some of these organisations exist only as loosely tied combines of universities, institutes or departments that together provide a number of courses over the Internet, television or other media, that are separate and distinct from programs offered by the single institution outside of the combine. Others are individual organisations with a legal framework, yet are named "virtual" because they appear only on the Internet, without a physical location aside from their administration units.
Open universities

The term *open university* or *open universities* usually refers to a university with an open-door academic policy, i.e. no entry requirements.

The term “open university” may also refer a specific university, **The Open University** in the UK.

Open Educational Resources (OER)

**Open educational resources (OER)** are digital materials that can be re-used for teaching, learning, research and more, made available for free through *[open licenses](http://en.wikipedia.org/wiki/Open_licenses)*, which allow uses of the materials that would not be easily permitted under *[copyright](http://en.wikipedia.org/wiki/Copyright)* alone; Hylén (2007). As a mode for content creation and sharing, OER materials are beginning to get integrated into *[open education](http://en.wikipedia.org/wiki/Open_education)* and *[distance education](http://en.wikipedia.org/wiki/Distance_education)*.

OER include different kinds of digital assets. Learning content includes courses, course materials, content modules, *[learning objects](http://en.wikipedia.org/wiki/Learning_object)*, collections, and journals. Tools include software that supports the creation, delivery, use and improvement of open learning content, searching and organisation of content, content and learning management systems, content development tools, and on-line learning communities. Implementation resources include intellectual property licenses that govern open publishing of materials, design-principles, and localization of content. They also include materials on best practices such as stories, publication, techniques, methods, processes, incentives, and distribution.

If properly designed, certain types of open education resources, often called *[learning objects](http://en.wikipedia.org/wiki/Learning_object)*, cannot only easily be shared by many students and course providers, they can also be reused as components or services of other learning objects and courses. This idea resembles the idea of building information systems by reusing already designed and developed software services – *[service-oriented architectures](http://en.wikipedia.org/wiki/Service-oriented_architecture)* (SOA).

Open Educational Resources could be seen as a generalisation of the concepts of *[Open Access](http://en.wikipedia.org/wiki/Open_Access)* (OA), *[Open Archives](http://en.wikipedia.org/wiki/Open_Archives)*, and *[self-archiving](http://en.wikipedia.org/wiki/Self-archiving)*, phenomena of rapidly growing importance for efficient publishing and dissemination of scientific work (articles, journals, books, etc.).

Massive Open Online Courses (MOOC)

A **massive open online course (MOOC)** is an online course aiming at large-scale interactive participation and open access via the web. In addition to traditional course materials such as videos, readings, and problem sets, MOOCs provide interactive user forums that help build a community for the students, professors, and teaching assistants.

Some famous *[TED talks](http://www.ted.com)* about MOOC:

**Shimon Schocken**, *The self-organizing computer course*, October 2012
**Daphne Koller**, *What we’re learning from online education*, June 2012
**Peter Norvig**, *The 100,000-student classroom* February 2012
**Salman Khan**, *Let’s use video to reinvent education*, March 2011
**Self-learning**
Possibly the most revolutionary aspect of OER and MOOC is its potential to provide free or inexpensive and efficient access to valuable knowledge and skills for self-learning for those who cannot afford to attend traditional university courses. This is an important possibility not only for gifted students in poor countries, but also for gifted but poor students in rich countries, like the United States, where traditional education is very expensive. According to the U.S. Bureau of Labor Statistics, quoted by Koller (2012), the prices of higher education have grown twice as fast as the prices of medical care since 1985, and four times as fast as the prices of all items. See Figure 2 below.

![Price Changes Since 1985](image)

*Figure 2. Rapidly rising prices for education in the United States.*

**Application**

E-learning is increasingly being utilized by students who may not want to go to traditional brick and mortar schools due to severe allergies or other medical issues, fear of school violence and school bullying and students whose parents would like to homeschool but do not feel qualified. Cyber schools create a safe haven for students to receive a quality education while almost completely avoiding these common problems. Cyber charter schools also often are not limited by location, income level or class size in the way brick and mortar charter schools are.

National private schools are also available online. These provide the benefits of e-learning to students in states where charter cyber schools are not available. They also may allow students greater flexibility and exemption from state testing.

**Higher education**
In the United States and many other countries, including Sweden, e-learning has become a predominant form of post-secondary education. Enrolments for fully online learning increased by an
average of 12–14 percent annually between 2004–2009, compared with an average of approximately 2 per cent increase per year in enrolments overall. In 2006, 3.5 million students participated in online learning at higher education institutions in the United States. Almost a quarter of all students in post-secondary education were taking fully online courses in 2008. In 2009, 44 percent of post-secondary students in the USA were taking some or all of their courses online, this figure is projected to rise to 81 percent by 2014. During the fall 2011 term, 6.7 million students enrolled in at least one online course. Over two-thirds of chief academic officers believe that online learning is critical for their institution. The Sloan report, based on a poll of academic leaders, indicated that students are as satisfied with on-line classes as with traditional ones.

Corresponding statistics for Sweden have been published by the Swedish Agency for Higher Education (Högskoleverket). See Sundgren (2012).

Although a large proportion of for-profit higher education institutions now offer online classes, only about half of private, non-profit schools do so. Private institutions may become more involved with on-line presentations as the costs decrease. Properly trained staff must also be hired to work with students on-line. These staff members need to understand the content area, and also be highly trained in the use of the computer and Internet. Online education is rapidly increasing, and online doctoral programs have even developed at leading research universities.[60]

Massively open online courses (MOOCs) have significantly expanded: MIT, Stanford and Princeton University offer classes to a global audience, but not for college credit.

Corporate and professional
E-learning has now been adopted and used by various companies to inform and educate both their employees and customers. Companies with large and spread out distribution chains use it to educate their sales staff as to the latest product developments without the need of organizing physical onsite courses. Compliance has also been a big field of growth with banks using it to keep their staff’s CPD levels up.

Teaching teaching & Understanding understanding

Please take a look at these three films:

1. http://www.youtube.com/watch?v=iMZA80XpP6Y
3. http://www.youtube.com/watch?v=w6rx-GBBwVg

Each one of them is less than 7 minutes. Note in particular the relationships between:

- clearly stated course goals
- teaching
- learning: what the students do themselves as a result of the teaching
- understanding
- examination tasks and examination results
E-business and e-commerce

Sources:


**E-business**, may be defined as the application of information and communication technologies (ICT) in support of all the activities of business. Commerce constitutes the exchange of products and services between businesses, groups and individuals and can be seen as one of the essential activities of any business. E-commerce focuses on the use of ICT to enable the external activities and relationships of the business with individuals, groups and other businesses.

E-business methods enable companies to link their internal and external data processing systems more efficiently and flexibly, to work more closely with suppliers and partners, and to better satisfy the needs and expectations of their customers. The internet is a public through way. Firms use more private and hence more secure networks for more effective and efficient management of their internal functions.

In practice, e-business is more than just e-commerce. While e-business refers to more strategic focus with an emphasis on the functions that occur using electronic capabilities, e-commerce is a subset of an overall e-business strategy. E-commerce seeks to add revenue streams using the Internet to build and enhance relationships with clients and partners and to improve efficiency. Often, e-commerce involves the application of knowledge management systems.

E-business involves business processes spanning the entire value chain: electronic purchasing and supply chain management, processing orders electronically, handling customer service, and cooperating with business partners. Special technical standards for e-business facilitate the exchange of data between companies. E-business software solutions allow the integration of intra and inter firm business processes. E-business can be conducted using the Internet, intranets, extranets, or some combination of these.

**E-commerce**, is basically the process of buying, transferring, or exchanging products, services, and/or information via computer networks, including the internet. E-commerce can also be beneficial from many perspectives including business process, service, learning, collaborative, community. E-commerce draws on technologies such as

- mobile commerce,
- electronic funds transfer,
- supply chain management,
- Internet marketing,
- online transaction processing,
- electronic data interchange (EDI),
- inventory management systems, and
- automated data collection systems.

Modern electronic commerce typically uses the World Wide Web at least at one point in the transaction’s life-cycle, although it may encompass a wider range of technologies such as e-mail, mobile devices, social media, and telephones as well.
E-commerce is generally considered to be the sales aspect of e-business. It also consists of the exchange of data to facilitate the financing and payment aspects of business transactions.

**The difference between e-business and e-commerce**

Source: Bartels (2000).

Computerworld - E-business and e-commerce are terms that are sometimes used interchangeably, and sometimes they're used to differentiate one vendor's product from another. But the terms are different, and that difference matters to today's companies.

In both cases, the e stands for "electronic networks" and describes the application of electronic network technology - including Internet and electronic data interchange (EDI) - to improve and change business processes.

E-commerce covers outward-facing processes that touch customers, suppliers and external partners, including sales, marketing, order taking, delivery, customer service, purchasing of raw materials and supplies for production and procurement of indirect operating-expense items, such as office supplies. It involves new business models and the potential to gain new revenue or lose some existing revenue to new competitors.

It's ambitious but relatively easy to implement because it involves only three types of integration: vertical integration of front-end Web site applications to existing transaction systems; cross-business integration of a company with Web sites of customers, suppliers or intermediaries such as Web-based marketplaces; and integration of technology with modestly redesigned processes for order handling, purchasing or customer service.

E-business includes e-commerce but also covers internal processes such as production, inventory management, product development, risk management, finance, knowledge management and human resources. E-business strategy is more complex, more focused on internal processes, and aimed at cost savings and improvements in efficiency, productivity and cost savings.

An e-business strategy is also more difficult to execute, with four directions of integration: vertically, between Web front- and back-end systems; laterally, between a company and its customers, business partners, suppliers or intermediaries; horizontally, among e-commerce, enterprise resource planning (ERP), customer relationship management (CRM), knowledge management and supply-chain management systems; and downward through the enterprise, for integration of new technologies with radically redesigned business processes. But e-business has a higher payoff in the form of more efficient processes, lower costs and potentially greater profits.

E-commerce and e-business both address these processes, as well as a technology infrastructure of databases, application servers, security tools, systems management and legacy systems. And both involve the creation of new value chains between a company and its customers and suppliers, as well as within the company itself.

All companies should have an e-commerce strategy. (Governments should have an e-public service strategy.) Electronic networks in general and the Internet in particular are too important for firms to ignore if they want to interact with customers, suppliers or distribution partners.
But some companies need to move beyond e-commerce and form e-business strategies - especially large companies that already have links to EDI networks or have completed major ERP implementations. These companies have already reaped some of the biggest benefits from e-commerce strategies. They’re also likely to experience organizational pain as conflicts develop among their ERP, EDI, supply-chain management and e-commerce strategies. And last, they have enough experience and knowledge in electronic-network technologies - and in process redesign and integration - that they have a chance of being successful in an e-business strategy.

Still, the coordination and organizational obstacles to developing an e-business strategy are formidable. It involves major and potentially disruptive organizational change. The risks of failure and the consequences from limited success are higher in an e-business strategy than in an e-commerce strategy. Being a leader in e-business can contribute to long-term success, but the stresses and strains of business transformation can cause near-term damage.

A wise company may decide to consolidate its gains and complete the work involved in its existing and largely separate e-commerce, ERP, CRM or supply-chain initiatives before making the big leap to becoming an e-business. Jumping too soon can be as disastrous as moving too late.

**Classifications of e-business and e-commerce**

**Internal/external**

Applications can be divided into three categories:

1. Internal business systems:
   - Customer Relationship Management (CRM)
   - Enterprise Resource Planning (ERP)
   - Document Management System (DMS)
   - Human Resources Management (HRM)

2. Enterprise communication and collaboration:
   - VoIP
   - Content Management System
   - E-mail
   - Voicemail
   - Web Conferencing
   - Digital work flows (or business process management)

   - internet shop
   - supply chain management
   - online marketing
   - offline marketing

**Business applications**

Some common applications related to electronic commerce are the following:

- Document automation in supply chain and logistics
- Domestic and international payment systems
- Enterprise content management
- Group buying
- Automated online assistants
- Instant messaging
- Newsgroups
- Online shopping and order tracking
- Online banking
- Online office suites
- Shopping cart software
- Teleconferencing
- Electronic tickets

**Business models**

When organizations go online, they have to decide which e-business models best suit their goals. Timmers (2000) defines a business model as the organisation of product, service and information flows, and the source of revenues and benefits for suppliers and customers. The concept of e-business model is the same but used in the online presence. The following is a list of the currently most adopted e-business models such as:

- E-shops
- E-commerce
- E-procurement
- E-mails
- E-auctions
- Virtual Communities

**Provider/consumer**

Roughly dividing the world into providers/producers and consumers/clients one can classify e-businesses into the following categories:

- business-to-business (B2B)
- business-to-consumer (B2C)
- business-to-employee (B2E)
- business-to-government (B2G)
- government-to-business (G2B)
- government-to-government (G2G)
- government-to-citizen (G2C)
- consumer-to-consumer (C2C)
- consumer-to-business (C2B)

It is notable that there are comparably less connections pointing "upwards" than "downwards" (few employee/consumer/citizen-to-X models).

**Governmental regulations**

In the United States, some electronic commerce activities are regulated by the Federal Trade Commission (FTC). These activities include the use of commercial e-mails, online advertising and consumer privacy. The CAN-SPAM Act of 2003 establishes national standards for direct marketing over e-mail. The Federal Trade Commission Act regulates all forms of advertising, including online advertising, and states that advertising must be truthful and non-deceptive. Using its authority under Section 5 of the FTC Act, which prohibits unfair or deceptive practices, the FTC has brought a number of cases to enforce the promises in corporate privacy statements, including promises about the
security of consumers’ personal information. As result, any corporate privacy policy related to e-commerce activity may be subject to enforcement by the FTC.

The Ryan Haight Online Pharmacy Consumer Protection Act of 2008, which came into law in 2008, amends the Controlled Substances Act to address online pharmacies.

Internationally there is the International Consumer Protection and Enforcement Network (ICPEN), which was formed in 1991 from an informal network of government consumer fair trade organisations. The purpose was stated as being to find ways of co-operating on tackling consumer problems connected with cross-border transactions in both goods and services, and to help ensure exchanges of information among the participants for mutual benefit and understanding. From this came econsumer, as an initiative of ICPEN since April 2001. www.econsumer.gov is a portal to report complaints about online and related transactions with foreign companies.

There is also Asia Pacific Economic Cooperation (APEC) was established in 1989 with the vision of achieving stability, security and prosperity for the region through free and open trade and investment. APEC has an Electronic Commerce Steering Group as well as working on common privacy regulations throughout the APEC region.

In Australia, Trade is covered under Australian Treasury Guidelines for electronic commerce,[22] and the Australian Competition and Consumer Commission regulates and offers advice on how to deal with businesses online, and offers specific advice on what happens if things go wrong.

Also Australian government ecommerce website provides information on e-commerce in Australia.

In the United Kingdom, The FSA (Financial Services Authority) is the competent authority for most aspects of the Payment Services Directive (PSD). The UK implemented the PSD through the Payment Services Regulations 2009 (PSRs), which came into effect on 1 November 2009. The PSR affects firms providing payment services and their customers. These firms include banks, non-bank credit card issuers and non-bank merchant acquirers, e-money issuers, etc. The PSRs created a new class of regulated firms known as payment institutions (PIs), who are subject to prudential requirements. Article 87 of the PSD requires the European Commission to report on the implementation and impact of the PSD by 1 November 2012.

Global trends

In 2010, the United Kingdom had the biggest e-commerce market in the world when measured by the amount spent per capita, even higher than the USA.

Amongst emerging economies, China's e-commerce presence continues to expand. With 384 million internet users, China's online shopping sales rose to $36.6 billion in 2009 and one of the reasons behind the huge growth has been the improved trust level for shoppers. The Chinese retailers have been able to help consumers feel more comfortable shopping online- E-commerce is also expanding across the Middle East. Having recorded the world’s fastest growth in internet usage between 2000 and 2009, the region is now home to more than 60 million internet users. Retail, travel and gaming are the region’s top e-commerce segments, in spite of difficulties such as the lack of region-wide legal frameworks and logistical problems in cross-border transportation. E-Commerce has become an important tool for businesses worldwide not only to sell to customers but also to engage them.

Impact on markets and retailers
Economists have theorized that e-commerce ought to lead to intensified price competition, as it increases consumers' ability to gather information about products and prices. Research by four economists at the University of Chicago has found that the growth of online shopping has also affected industry structure in two areas that have seen significant growth in e-commerce, bookshops, and travel agencies. Generally, larger firms have grown at the expense of smaller ones, as they are able to use economies of scale and offer lower prices. The lone exception to this pattern has been the very smallest category of bookseller, shops with between one and four employees, which appear to have withstood the trend.

See also

- Alternative Payments
- Mobile commerce
- Comparison of shopping cart software
- Digital economy
- Electronic bill payment
- Electronic money
- E-commerce credit card payment system
- List of free and open source eCommerce software
- Multichannel ecommerce
- Non-store retailing
- Online marketplace
- Paid content
- Payments as a service
- Payment card
- Virtual economy
- Wire transfer

Potential concerns

While much has been written of the economic advantages of Internet-enabled commerce, there is also evidence that some aspects of the internet may serve to reinforce economic inequality and the digital divide.

Security

E-Business systems naturally have greater security risks than traditional business systems, therefore it is important for e-business systems to be fully protected against these risks. A far greater number of people have access to e-businesses through the internet than would have access to a traditional business. Customers, suppliers, employees, and numerous other people use any particular e-business system daily and expect their confidential information to stay secure. Hackers are one of the great threats to the security of e-businesses. Some common security concerns for e-Businesses include keeping business and customer information private and confidential, authenticity of data, and data integrity. Some of the methods of protecting e-business security and keeping information secure include physical security measures as well as data storage, data transmission, anti-virus software, firewalls, and encryption to list a few.

Privacy and confidentiality

Confidentiality is the extent to which businesses makes personal information available to other businesses and individuals. With any business, confidential information must remain secure and only be accessible to the intended recipient. However, this becomes even more difficult when dealing with e-businesses specifically. To keep such information secure means protecting any electronic
records and files from unauthorized access, as well as ensuring safe transmission and data storage of such information. Tools such as encryption and firewalls manage this specific concern within e-business.

**Authenticity**

E-business transactions pose greater challenges for establishing authenticity due to the ease with which electronic information may be altered and copied. Both parties in an e-business transaction want to have the assurance that the other party is who they claim to be, especially when a customer places an order and then submits a payment electronically. One common way to ensure this is to limit access to a network or trusted parties by using a virtual private network (VPN) technology. The establishment of authenticity is even greater when a combination of techniques are used, and such techniques involve checking "something you know" (i.e. password or PIN), "something you need" (i.e. credit card), or "something you are" (i.e. digital signatures or voice recognition methods). Many times in e-business, however, "something you are" is pretty strongly verified by checking the purchaser's "something you have" (i.e. credit card) and "something you know" (i.e. card number).

**Data integrity**

Data integrity answers the question "Can the information be changed or corrupted in any way?" This leads to the assurance that the message received is identical to the message sent. A business needs to be confident that data is not changed in transit, whether deliberately or by accident. To help with data integrity, firewalls protect stored data against unauthorized access, while simply backing up data allows recovery should the data or equipment be damaged.

**Non-repudiation**

This concern deals with the existence of proof in a transaction. A business must have assurance that the receiving party or purchaser cannot deny that a transaction has occurred, and this means having sufficient evidence to prove the transaction. One way to address non-repudiation is using digital signatures. A digital signature not only ensures that a message or document has been electronically signed by the person, but since a digital signature can only be created by one person, it also ensures that this person cannot later deny that they provided their signature.

**Access control**

When certain electronic resources and information is limited to only a few authorized individuals, a business and its customers must have the assurance that no one else can access the systems or information. Fortunately, there are a variety of techniques to address this concern including firewalls, access privileges, user identification and authentication techniques (such as passwords and digital certificates), Virtual Private Networks (VPN), and much more.

**Availability**

This concern is specifically pertinent to a business' customers as certain information must be available when customers need it. Messages must be delivered in a reliable and timely fashion, and information must be stored and retrieved as required. Because availability of service is important for all e-business websites, steps must be taken to prevent disruption of service by events such as power outages and damage to physical infrastructure. Examples to address this include data backup, fire-suppression systems, Uninterrupted Power Supply (UPS) systems, virus protection, as well as making sure that there is sufficient capacity to handle the demands posed by heavy network traffic.

**Common security measures**

Many different forms of security exist for e-businesses. Some general security guidelines include areas in physical security, data storage, data transmission, application development, and system administration.
Physical security

Despite e-business being business done online, there are still physical security measures that can be taken to protect the business as a whole. Even though business is done online, the building that houses the servers and computers must be protected and have limited access to employees and other persons. For example, this room should only allow authorized users to enter, and should ensure that "windows, dropped ceilings, large air ducts, and raised floors" do not allow easy access to unauthorized persons. Preferably these important items would be kept in an air-conditioned room without any windows.

Protecting against the environment is equally important in physical security as protecting against unauthorized users. The room may protect the equipment against flooding by keeping all equipment raised off of the floor. In addition, the room should contain a fire extinguisher in case of fire. The organization should have a fire plan in case this situation arises.

In addition to keeping the servers and computers safe, physical security of confidential information is important. This includes client information such as credit card numbers, checks, phone numbers, etc. It also includes any of the organization's private information. Locking physical and electronic copies of this data in a drawer or cabinet is one additional measure of security. Doors and windows leading into this area should also be securely locked. Only employees that need to use this information as part of their job should be given keys.

Important information can also be kept secure by keeping backups of files and updating them on a regular basis. It is best to keep these backups in a separate secure location in case there is a natural disaster or breach of security at the main location.

"Failover sites" can be built in case there is a problem with the main location. This site should be just like the main location in terms of hardware, software, and security features. This site can be used in case of fire or natural disaster at the original site. It is also important to test the "failover site" to ensure it will actually work if the need arises.

State of the art security systems, such as the one used at Tidepoint's headquarters, might include access control, alarm systems, and closed-circuit television. One form of access control is face (or another feature) recognition systems. This allows only authorized personnel to enter, and also serves the purpose of convenience for employees who don't have to carry keys or cards. Cameras can also be placed throughout the building and at all points of entry. Alarm systems also serve as an added measure of protection against theft.

Data storage

Storing data in a secure manner is very important to all businesses, but especially to e-businesses where most of the data is stored in an electronic manner. Data that is confidential should not be stored on the e-business' server, but instead moved to another physical machine to be stored. If possible this machine should not be directly connected to the internet, and should also be stored in a safe location. The information should be stored in an encrypted format.

Any highly sensitive information should not be stored if it is possible. If it does need to be stored, it should be kept on only a few reliable machines to prevent easy access. Extra security measures should be taken to protect this information (such as private keys) if possible. Additionally, information should only be kept for a short period of time, and once it is no longer necessary it should be deleted to prevent it from falling into the wrong hands. Similarly, backups and copies of information should be kept secure with the same security measures as the original information. Once a backup is no longer needed, it should be carefully but thoroughly destroyed.
Data transmission and application development

All sensitive information being transmitted should be encrypted. Businesses can opt to refuse clients who can't accept this level of encryption. Confidential and sensitive information should also never be sent through e-mail. If it must be, then it should also be encrypted.

Transferring and displaying secure information should be kept to a minimum. This can be done by never displaying a full credit card number for example. Only a few of the numbers may be shown, and changes to this information can be done without displaying the full number. It should also be impossible to retrieve this information online.

Source code should also be kept in a secure location. It should not be visible to the public. Applications and changes should be tested before they are placed online for reliability and compatibility.

System administration

Security on default operating systems should be increased immediately. Patches and software updates should be applied in a timely manner. All system configuration changes should be kept in a log and promptly updated.

System administrators should keep watch for suspicious activity within the business by inspecting log files and researching repeated logon failures. They can also audit their e-business system and look for any holes in the security measures. It is important to make sure plans for security are in place but also to test the security measures to make sure they actually work. With the use of social engineering, the wrong people can get a hold of confidential information. To protect against this, staff can be made aware of social engineering and trained to properly deal with sensitive information.

E-businesses may use passwords for employee logons, accessing secure information, or by customers. Passwords should be made impossible to guess. They should consist of both letters and numbers, and be at least seven to eight digits long. They should not contain any names, birth dates, etc. Passwords should be changed frequently and should be unique each time. Only the password's user should know the password and it should never be written down or stored anywhere. Users should also be locked out of the system after a certain number of failed logon attempts to prevent guessing of passwords.

Security solutions

When it comes to security solutions, there are some main goals that are to be met. These goals are data integrity, strong authentication, and privacy.

Access and data integrity

There are several different ways to prevent access to the data that is kept online. One way is to use anti-virus software. This is something that most people use to protect their networks regardless of the data they have. E-businesses should use this because they can then be sure that the information sent and received to their system is clean. A second way to protect the data is to use firewalls and network protection. A firewall is used to restrict access to private networks, as well as public networks that a company may use. The firewall also has the ability to log attempts into the network and provide warnings as it is happening. They are very beneficial to keep third-parties out of the network. Businesses that use Wi-Fi need to consider different forms of protection because these networks are easier for someone to access. They should look into protected access, virtual private networks, or internet protocol security. Another option they have is an intrusion detection system.
This system alerts when there are possible intrusions. Some companies set up traps or "hot spots" to attract people and are then able to know when someone is trying to hack into that area.

**Encryption**

Encryption, which is actually a part of cryptography, involves transforming texts or messages into a code which is unreadable. These messages have to be decrypted in order to be understandable or usable for someone. There is a key that identifies the data to a certain person or company. With public key encryption, there are actually two keys used. One is public and one is private. The public one is used for encryption, and the private for decryption. The level of the actual encryption can be adjusted and should be based on the information. The key can be just a simple slide of letters or a completely random mix-up of letters. This is relatively easy to implement because there is software that a company can purchase. A company needs to be sure that their keys are registered with a certificate authority.

**Digital certificates**

The point of a digital certificate is to identify the owner of a document. This way the receiver knows that it is an authentic document. Companies can use these certificates in several different ways. They can be used as a replacement for user names and passwords. Each employee can be given these to access the documents that they need from wherever they are. These certificates also use encryption. They are a little more complicated than normal encryption however. They actually used important information within the code. They do this in order to assure authenticity of the documents as well as confidentiality and data integrity which always accompany encryption. Digital certificates are not commonly used because they are confusing for people to implement. There can be complications when using different browsers, which means they need to use multiple certificates. The process is being adjusted so that it is easier to use.

**Digital signatures**

A final way to secure information online would be to use a digital signature. If a document has a digital signature on it, no one else is able to edit the information without being detected. That way if it is edited, it may be adjusted for reliability after the fact. In order to use a digital signature, one must use a combination of cryptography and a message digest. A message digest is used to give the document a unique value. That value is then encrypted with the sender’s private key.

**Web browser discrimination**

Vendors of e-commerce are able to determine the type of browser that is used by the customer. Some vendors offer different pricing which they determine based on the browser that the customer is using.
Health care and e-health

Health is a sector of society which is very complex and which really requires very advanced good governance. The complexity is due to the following factors, *inter alia*:

- We live longer and need more health care towards the end of our lives.
- Scientific progress results in more an better knowledge about health, and new and better treatments become available all the time.
- Thanks to the scientific progress some new treatments are more efficient than those treatments that they replace, but typically the exploitation of new treatments and new drugs results in higher costs, partly because the new treatments and drugs are expensive, partly because it becomes meaningful and desirable to treat new groups of patients, for which there was no cure before.
- The resources available for health care are limited, regardless of whether the costs are paid by the tax-payers, and/or via insurances, and/or by the patients themselves.
- Thus it is necessary to economise with scarce resources. This can be done in many ways, but the principles and procedures for this include many complex problems, both economical and ethical. Difficult trade-offs and prioritisations have do be done in cooperation between politicians and experts.
- One trade-off is between central, specialised care and decentralised, local care, performed by nurses and general practitioners. Specialists are scarce and expensive, but nurses and general practitioners at local health centers may not have the necessary knowledge and experience to make correct diagnoses, understanding how to treat a patient, or being able to determine when a patient has to be sent to a specialist.
- Another trade-off is between preventive care, to avoid future health problems, and care when diseases have already manifested themselves. Preventive care may be expensive, if a lot of people are treated who would never become ill anyhow, but this must be weighed against the possibilities of saving lives and suffering for those who would become ill without the preventive treatment.

All the difficult decisions, prioritisations, and trade-offs that politicians, administrations, and medical professionals and experts have to make all the time certainly require a lot of information, so that the decisions can be made on the basis of the best available scientific knowledge, well established facts, and proven experiences. E-society with all its modern technology should be in a good position to provide advanced information systems and tools for supporting these decisions in an efficient way. Modern information systems should also be well suited for rationalising all the administrative processes that are involved in health care: planning medical investigations and treatments, booking patients, scheduling doctors and nurses, ordering equipment and drugs, managing logistics, etc.

However, so far it has turned out to be very difficult to design optimal information systems solutions for health care, for all kinds of care, and on all levels. Actually the most difficult problem seems to be all the coordination activities that have to take place, and have to be supported by well integrated information systems, so that the outcomes will be optimal for all stakeholders involved: the patient (who should always be in focus of course), the medical staff, and those responsible for political decisions and budgets on different levels.

It has also turned out to be difficult to provide the medical professionals with all the relevant information about individual patients that is needed, for example, when a doctor is going to make a diagnosis and decide about a suitable treatment. The patient may be treated simultaneously, for
different health problems, by different doctors, and different doctors may prescribe drugs without knowing about drugs that other doctors have prescribed for the same patient, etc.

There seems to be an obvious requirement for easily accessible and well integrated information systems in order to give the patient an optimal treatment. However, there are both technical and legal problems in this context, not least the patient’s legitimate desire for privacy. Here is another difficult trade-off that needs to be made, and where ethics is involved.

**What is e-health?**

References:


**E-health** is a relatively recent term for healthcare practice supported by electronic processes and communication. Usage of the term varies: some would argue it is interchangeable with health informatics with a broad definition covering electronic/digital processes in health, while others use it in the narrower sense of healthcare practice using the Internet.

E-health can encompass a range of services or systems that are at the edge of medicine/healthcare and information technology, including:

- **Electronic health records**: enabling the communication of patient data between different healthcare professionals (general practitioners, specialists etc)

- **Telemedicine**: physical and psychological treatments at a distance

- **Consumer health informatics**: use of electronic resources on medical topics by healthy individuals or patients

- Health knowledge management: for example overviews of latest medical journals, best practice guidelines or epidemiological tracking (examples include physician resources such as Medscape and MDLinx)

- Virtual healthcare teams: consisting of healthcare professionals who collaborate and share information on patients through digital equipment (for transmural care)

- m-Health: includes the use of mobile devices in collecting aggregate and patient level health data, providing healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vitals, and direct provision of care (via mobile telemedicine)

- Medical research using Grids: powerful computing and data management capabilities to handle large amounts of heterogeneous data

- **Healthcare Information Systems**: also often refer to software solutions for appointment scheduling, patient data management, work schedule management and other administrative tasks surrounding health.

Several authors have noted the variable usage in the term, from being specific to the use of the Internet in healthcare to being generally around any use of computers in healthcare. Various authors
have considered the evolution of the term and its usage and how this maps to changes in health informatics and healthcare generally. Oh et al (2005) makes a systematic review of the term’s usage, offering the definition of eHealth as a set of technological themes in health today, more specifically based on commerce, activities, stakeholders, outcomes, locations, or perspectives.

One thing that all sources seem to agree on is that e-Health initiatives do not originate with the patient; see also e-Patient.

E-health data exchange

One of the factors blocking the use of e-Health tools from widespread acceptance is the concern about privacy issues regarding patient records, most specifically the EPR (Electronic patient record). This main concern has to do with the confidentiality of the data. There is also concern about non-confidential data however. Each medical practice has its own jargon and diagnostic tools. To standardise the exchange of information, various coding schemes may be used in combination with international medical standards. There are roughly two types of e-health data exchange:

- front-end data exchange
- back-end data exchange

Front-end data exchange typically involves the patient, while back-end exchange does not. A common example of a rather simple front-end exchange is a patient sending a photo taken by mobile phone of a healing wound and sending it by email to the family doctor for control. Such actions may avoid the cost of an expensive visit to the hospital.

A common example of a back-end exchange is when a patient on vacation visits a doctor who then may request access to the patient’s health records, such as medicine prescriptions, x-ray photographs, or blood test results. Such an action may reveal allergies or other prior conditions that are relevant to the visit.

Successful e-health initiatives such as e-Diabetes have shown that for data exchange to be facilitated either at the front-end or the back-end, a common thesaurus is needed for terms of reference. Various medical practices in chronic patient care (such as for diabetic patients) already have a well defined set of terms and actions, which makes standard communication exchange easier, whether the exchange is initiated by the patient or the caregiver.

Early adopters

Chronic patients over time often acquire a high level of knowledge about the processes involved in their own care, and often develop a routine in coping with their condition. For these types of routine patients, front-end e-health solutions tend to be relatively easy to implement.

Mental health

E Mental Health refers to the delivery of mental health services via the internet through video-conferencing, chat, or email web applications. E Mental Health encompasses online talk therapy, online pharmaceutical therapy, online counseling, computer-based interventions, cyber mental health approaches, and online life coaching. This form of psychological intervention modality offers a series of benefits as well as challenges to providers and clients. Most notable of all challenges is online security.
Cybermedicine

Cybermedicine is the use of the Internet to deliver medical services, such as medical consultations and drug prescriptions. It is the successor to telemedicine, wherein doctors would consult and treat patients remotely.

Cybermedicine is already being used in small projects where images are transmitted from a primary care setting to a medical specialist, who comments on the case and suggests which intervention might benefit the patient. A field that lends itself to this approach is dermatology, where images of an eruption are communicated to a hospital specialist who determines if referral is necessary.

A Cyber Doctor, or Cyber Physician, is a medical professional who does consultation via the Internet, treating virtual patients, who may never meet face to face. This is a new area of medicine which is offering online consultations to patients before making their decision to travel for unique medical treatment only offered at a particular medical facility.

See also

- e-Patient
- European Institute for Health Records
- European Health Telematics Association
- EUDRANET
- Enabledoc
- Health 2.0
- Health blog
- Health Informatics
- mHealth
- eHealth Ontario
- Technology and mental health issues
- eHealthInsurance
- Telemedicine
3D-printing –
Towards a 3D-modelling and manufacturing revolution in e-society

Based on an assignment by Anders Näslund for the course “E-society – evolution or revolution”.

This report will summarise the recent developments in 3D printing technology in a few key selected areas. These areas are where I think 3D-printing will be the foundation for a revolution in the e-society for regular consumers.

Background of 3D printing, what it is and what it does

3D printing, also called additive manufacturing is a procedure where a digital model is made physical through a machine who lays several thin layers of material, often plastics, one at the time in virtually any three dimensional shape that a designer can make through a digital software [Barnatt, 2013]. It is called additive manufacturing because in relation to traditional drilling or cutting methods, it is adding material in the desired shape rather than removing material for the same purpose. Materials that can be constructed in a 3D printer can be plastics/polymers, ceramics or metals (Hsu, 2013). There are even some 3D printers that can print using glass, titanium and even biometric material such as chocolate, cheese, and icing (Moscaritolo, 2012). Software that often follows with the machine turns a digital model/drawing into several different layers; these layers combine and create the contour and shape of the object to print. The shape is then hardened to its final form. (Barnatt, 2013)

The first functioning and commercial 3D printer was made by Chuck Hull of 3D systems Corp. in 1986. Its technology used laser to solidify an ultraviolet-sensitive polymer material and is called stereolithography (Hsu, 2013). Until recently, 3D printing has been used in manufacturing over the past 20 years to create prototypes and models. In recent years the 3D printing has made entry into the home of consumers who can now afford the less expensive 3D printers.

There are some different ways of going about printing in 3D. First of all, the model must be made in a computer, often by using a CAD (Computer Aided Design) –model (Anon, 2011). Many physical and mechanical things can be intrinsically designed in the model but there is another way to create the model. Using a CAT-scan type device, a user can “reverse engineer” physical properties and put them into a digital file. This of course needs more expensive equipment and is limited to those studios with those capabilities, such as Captured Dimensions, set in Texas (Captured Dimensions, 2013). Either a consumer can own a printer himself, or he can contract the services of a business facilitating a 3D printer.

There is a myriad of start-ups and companies who now offer 3D printing services. There are too many to go through but they shall at least be named: Stores such as Cubify, Sculpteo, i.materialize, and Shapeways offer a service where they can 3D print at user’s request. A consumer can order a design from their shop, or create their own design from their services and order that (Barnatt, 2013).

Exciting new applications and changing research climate

President Barack Obama’s administration awarded $30 million in 2012 to create an institute called National Additive Manufacturing Innovation Institute (NAMII). The Institute is made up of universities and companies who will strive to develop 3D printing technology further in the manufacturing sector (Hsu, 2013).

Commercially available 3D printing is not yet a replacement method for traditional manufactures (Barnatt, 2013). 3D printing is able to create unique objects which are tailored for specific purposes. In
a lot of industries, 3D printing has provided the means for them to create new and specialized objects which would be hard to process with traditional manufacturing methods. For example the military and NASA has used the technology to make replacement parts and specific things they need on site. Because of their often remote location, 3D printing allows for fast delivery of vital equipment. In the medical industry, prosthetics for hands, skull and feet for instance can be tailored to specifically fit a person in need (Hsu, 2013). A woman in 2012 received an entire transplanted jaw created using a 3D printer. It was tailored for her face after a battle with a bone infection in her lower jaw (Moscaritolo, 2012). Experts say that it might be the stepping stone to implement 3D printing of other transplanted parts.

The 3D printing technology in use today is limited by only one type of material, which after printing must be augmented by other material to build a finished prototype. However, Optomec, a production company in New Mexico, and Neotech Services has made it possible to print 3D circuit boards directly on to surfaces (Optomec, 2013).The system can handle shapes with an inclination of up to 60 degrees and even more if modifications are made, on a 5-axis 3D system rig. Their technology uses what they call “Aerosol Jet Printing” to print for instance antennas in mobile devices. Both active and passive components such as conductors, resistors, dielectrics/insulators and semiconductors can be emulated in the design which reduces weight, size and makes it easy to implement electronics without the need for a separate circuit board (Hedges and Marin, 2013). Right now the manufacturer has targeted the markets in automotive, industrial and aerospace industries and not for consumers since the machinery needed is quite complex.

**Upheaval of patents**

The subject of patenting and Intellectual Property (IP) in regards to 3D printing is hotly debated (Banwatt, 2013A). Several patents regarding 3D printing are expiring and will expire in the coming year. There is one camp who feels the patents have created innovation in regards to how 3D printing can be done because innovators have been forced to find new ways of printing. Others feel that patents have held back the technology by allowing too much money be poured into the wrong pockets. The patents are still ending for some techniques but are still surviving on technicalities of “improvements” (Banwatt, 2013B).

The big issue with patents is that it may stifle improvements which can benefit the end user. However it is a much needed law which ensures that the right holder of innovation gets credit. Right now there is an ongoing movement which seems to be accelerated by the ends of patents which push the boundaries of what 3D printing could achieve in the future. The debate over good and bad patents will unfortunately continue since no definite line can be drawn. The question should be moved to who should benefit from the technology. Consumers who now begins to be empowered by cheaper and cheaper 3D printing technologies is what I feel is an exciting discussion which have potential to bring about big change in the economic landscape.

**What 3D printing means for consumers**

A study done by Wittbrodt, et al. (2013) at Michigan Technological University have found that a 3D printer in the average home can save them from buying hundreds to thousands of dollars per year if they only make around twenty products a year. The product would pay for itself in as little as a few months to 2 years. The study conducted a life-cycle economic analysis or open source 3D printing on the average American household. They report that the open source 3D printing is a economically viable investment for the average U.S household. As the open source 3D printers continue to drop in
price, become more reliable, and the exponentially growing availability of these easy-to-make designs, Open source 3D printing will become a mass-market device (Wittbrodt, et al., 2013).

**A new business model is facilitated / Maker movement / Open Source**

The boom that 3D printing has brought has the potential to disrupt the production market and the way we as consumers can have custom made objects in our home! The interesting aspect with 3D printers is that it facilitates both the brain power and brawn power in the same package. The investment costs and maintenance costs are both cheap, and therein lay its disruptive power (Sundgren, 2010). The concept of E-commerce in relation to 3D printing can be seen as being shifted towards facilitating the spread and innovation regarding simple products. Simple in the sense that they can be 3D printed. Many websites have sprung up as of late which allow users to upload and make money off of digital blueprints. The web service of transferring the blueprints are dependent on the business model the users agree upon. However the costs associated with producing digital models are continuously reducing. Open source 3D software and even open source 3D printer projects such as RepRap (http://www.reprap.org/wiki/Main_Page) and Fab@Home (http://www.fabathome.org/) allows for cheap production and dissemination, as well as marketing for both consumer and user (Barnatt, 2013). The non-rivalry and non-excludability characteristics of 3D products and blueprints further segments the benefits of this service (Sundgren, 2010).

Although the cheap 3D printers lack some of the detail of fine traditional production workmanship, the readability of minor “things” for consumers creates an entirely open and expansive world of satisfiable needs, needs which other consumers as well as companies and designers can fulfill. The 3D printer lowers the cost of entry for small scale producers/designers who wish to make things for others enjoyment or for their own profit. The important factor is that it is open and free to do so with a 3D printer. Instead of setting up an expensive and expansive production value chain covering many people and maybe even countries, Producers/designers can simply deal with all of the production themselves. It is less risky and much cheaper alternative (Anon, 2011). It also lowers the cost of testing and improving their own products and designs by making small test batches and see if they are well received. In this way young new artists are empowered to share, collaborate, and earn income from designing products from their home. Rather than paying for shipping and import taxes, sellers can arrange to print at nearest printing facility to the buyer, if they do not own a 3D printer (Barnatt, 2013).

The digital product is easily transferrable through digital means and it’s fast and easy to publish it on a website. There is a huge audience that wants something they can download and manufacture at their whim. Unique and customized products are getting less and less expensive to make since they can be improved upon and exist as digital drawings that is easily improved or changed upon. The piracy issue will always be prevailing and it will be interesting to see how the 3D market handles it. There is still a need to introduce a business model that handles the intellectual property and author rights in regards to digital wares (Sundgren, 2010). The volatility of digital/physical products relationship mean there will need to be protective measures to combat piracy. 3D printing suddenly gives merit to the tagline “you wouldn’t steal a car” from the anti-piracy campaign from 2004. A man in Auckland has been reported as having created the bodywork of a car from a fan-made model of a 1961 Aston Martin DB4 (Vincent, 2013).
3D printers and the dangers that come with it

The free and open landscape of design opens up the path for well intended as well as malicious content to be created. Security experts may be worried that 3D printing’s ability could magnify the effects of digital piracy and share knowledge that may be dangerous in the wrong hands (Hsu, 2013). Is the 3D-printing community the next breeding grounds for terrorists and psychopaths who perform school massacres? I personally would hope this is not the case but free and open often includes in a sense allowance of the “bad stuff” to. That is not to say that I condone of any illegal activities. The debate this brings is “who’s responsible?” and it seems to be the forums and site owners themselves according to journalist Lisa L. Kirchner (2013).

She interviewed the people behind MakerBot, a seller of 3D printers. They also own an online forum called Thingiverse where users share blueprint designs with each other. On this forum there are policies that state that it is a violation to upload, transmit or otherwise display or distribute content that promotes or contributes to the creation of weapons. She also talked with a spokesperson for Shapeways who states that they cannot determine if every uploaded design, of which there are many each day, are in fact a weapon or a part of one. The debate is driven further here to the point where instances of malicious 3D printed weapons are used, will the creators and benefactor of the 3D printer be held liable and responsible? Should they? Surely this debate will continue on in the coming years.

However, I wish to state one simile I feel is justified. Internet with its open nature has attracted people with so called “deviant” behaviours. The technology is said to facilitate and enable their access to each other and strengthen their behaviours (McDonald, et al. 2009). The risk factors are there to guide control and response to these groups. However I believe that Fire fighting issues and maintaining a structure for damage control in all aspects of society is something that we all accept since the benefits of having an open and democratic social system outweighs the negative ones. Barriers and banishments of what is deemed to be deviant will not solve nor defeat deviant behaviour. The technology is never at fault, and should not become the scapegoat for how it is used. That is my personal opinion.

A person by the name of Matthew successfully made a plastic firearm. He demonstrates this through several videos and is continually making improvements to its rather unreliable structure. The weapon is dubbed “the grizzly 2.0” and developed several cracks during testing (Franzen, 2013). “Matthew” is however using an industrial level 3D printer. And no one can say when commercial printers can achieve the same level of detail. He claims to let the blueprints be accessible but I don’t know where.

The blueprints for the gun is the main issue, with it, anyone with a sufficiently detailed 3D printer could print a firearms design and create it without serial numbers nor metal parts which could be detectable in metal detectors. This is of course alarming and on top of that the legislature to ban the production of the weapon is perhaps not the best course of action. Recent research has been able to introduce material-based tags that embed information inside digitally fabricated artefacts (Willis and Wilson, 2013). This technology would enable identification and tracking capabilities to created objects which would help combat piracy and crime.

Conclusion/Discussion

I think that the phases that Sundgren (2010) identifies in his paper are well deserved for an additional phase. Namely the revolution of the ease of access and introduction of information technology into manufacturing processes. Suddenly now there is a tangible barrier where it is possible to transfer physical products through the information layer and facilitate support for consumers in both leisure
and work. 3D printing has the potential to change how we think about merchandise and physical/digital things. It challenges our view on the tangible nature of design. Iterative prototyping has several benefits which are further expanded in the openness of the internet, where improvements and innovation is spread easily. Authors are empowered since they are freely able to be a part of the creative process. With the removal of many patents, 3D printing technology will change the manufacturing market, and with it, the ever increasing user base will help steer it to a better tomorrow.

An interesting discussion is what 3D printing could mean for third world countries. Will it impact the global economy by moving labour and entrepreneurial investment to the consumers? Cheap manufacturing labour will perhaps change over time when need and supply turns to be more decentralized-based. And what about the empowerment of remote villages who only need access to a repository of digital designs, which they can then utilize to care for their citizens and village as long as they have the minimum required elements for printing. It could mean a huge difference for the quality of life in these civilizations.

With the combination of printed board technology and the ever cheaper access to open source 3D printing, I see a future where consumers and hobbyists can create wonderful technologies at home, paving the way for new applications where before thought not possible. Changing the way we think of integrated digital and physical where everything can be custom made and fitted to user needs which might bring other needs with it, which others can improve, make available and sell to others wherever they are in the world. I think it is an exciting empowered world I’m looking at which hopefully is brought in with good intentions. The discussion regarding the limits on the digital as well as product landscape in response to piracy and crime is a very important one. The discussion and deliberative decision that takes place regarding weapons will hopefully lead to more structurally sound manufacturing limits. The research regarding tags in digitally produced objects is hopefully a step in the right direction, leaving the market for 3D printing open, while managing its sometimes dangerous output.

I want to leave with an honorable quote from the founder of the first commercially available 3D printer and his company, who is celebrating 30 years since the first printed part (3dsystems.com, 2013):

“We are excited by, and committed to, democratising [sic] access to 3D printing for both the non-expert professional user and the hobbyist/consumer market over time. This means that we will need to play a major role in collaborating, developing and delivering 3D content tools that allow a non-technical person to capture, create, share and print their 3D files.”

Sources


Franzen, Carl,. 2013.”Worlds first 3D printed rifle gets update, fires 14 shots”. The Verge.


201