Information Science, 
it's Assets, Applications, and Instruments

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**Topic, focus, and goal:**

- **Topic and focus:** Information science comprises the fields of collection, documentation, classification, analysis, manipulation, storage, retrieval, movement, dissemination, and protection of information. The key to information science is a solid understanding of knowledge and its context for day-to-day application.

- **Goal:** The goal of this tutorial is an advanced understanding of information science, knowledge, and its contexts in scientific and technical disciplines, humanities, and management. The tutorial discusses selected topics, scholarly and practical aspects, from the complements of knowledge, information management, and the most important fundaments of education to application scenarios, decision making, long-term aspects, and High End Computing.

- It is intended to have a concluding dialogue with the participants on practical scenarios and experiences.

- This tutorial is addressed to all interested users and creators of knowledge and data, in various disciplines, geosciences, environmental sciences, archaeology, social and life sciences, as well as to users of advanced applications and providers of resources and services, e.g., library sciences and High End Computing. There are no special informatics prerequisites or High End Computing experiences necessary to take part in this tutorial.
What others do: “Technology can create excellent results with any input and staff.”

Let us take a look on what a virtual, “effective” institution will do.

NUTS’ initiative:
- Hire management, administration, and data services, and excellence is at your hands.

NUTS’ strategy:
- Today, research and planning phases are not relevant anymore.
- Any result can be created from Big Data.
- All relevant algorithms can automatically be generated.
- The key asset of any science is its market strategy.

NUTS’ results and recommendations:
- Recognise that any past insight and knowledge has shown useless.
- Only invest in the latest upcoming trends.
- Get rid of activities, which mean years of research and dedication.
- Choose the right apps and staff.
Classical, medieval, modern, . . .

Heron of Alexandria: (greek antique, “Steam Ball”)
⇒ “entertainment” but not used as technology.

Isidore of Seville: (encyclopedic, broad documentation)
⇒ end of medieval phase, not further used.

Polyhistor: (Martin Fogel, broad knowledge)
⇒ broad base, not further used.

Last decades / Internet: (knowledge?)
⇒ huge amounts of knowledge lost (besides contrary claims).

In percentage we nearly know nothing about the past.

- Ancient, historical, and even near history: Objects are mostly lost.
- Ancient, historical, and even near history: Documentation is mostly lost.
- Ancient, historical, and even near history: Technology is not fully understood.
- Context of past objects and applications is not available anymore. . . .
Information Science

Definition

Information Science:

\textit{Information science is the science of information in theory and practice.}

Fundamentals

The essential fundaments of information science are information and philosophy.
Focus

Information science investigates the being of information, information related properties, and information processes.

Information science focuses on theory and methodologies and their application in practice, understanding information related problems, preserving, developing, and making use of information.

Information science primarily tackles systemic problems rather than individual pieces of technology within systems.

Information science comprises ...

Information science comprises the fields of collection, documentation, classification, analysis, manipulation, storage, retrieval, movement, dissemination, and protection of information.
Information science is associated with psychology, computer science, and technology.

Information science is interlinked with cognitive science, archival science, linguistics, museology, management, mathematics, philosophy, commerce, law, public policy, and social sciences.
Information and communication

Information science deals with any information and communication, e.g.:

- knowledge in organisations,
- interaction between people,
- information systems,
- understanding information systems,
- creating, replacing, improving information systems.
Information Science and the fundament of intrinsically tied complements

- **Episteme:**
  refers to ‘knowledge’, ‘understanding’, ‘science’.

- **Techne:**
  “craft”, “art”.

- **Doxa:**
  from “to appear”, “to seem”, “to accept”, “to think”.
Knowledge base:

Knowledge transfer is essential.

Over generations of objects and subjects, this requires:

- Knowledge recognition (expertise).
- Knowledge documentation, for any aspect of nature and society (sciences, literature, technical descriptions, tools, cultural heritage, mythology, songs, media, ...).
- Long-term means.
Assets

- Knowledge (factual, conceptual, procedural, metacognitive, ...)
- Existing plethora of knowledge and insight.
Fundaments

- The fundaments of terminology and of understanding knowledge are layed out by Aristotle being an essential part of ‘Ethics’.
Fundaments

- The fundaments of terminology and of understanding knowledge are layed out by **Aristotle** being an essential part of ‘Ethics’.

- Information science can very much benefit from Aristotle’s fundaments and a knowledge-centric approach (**Anderson and Krathwohl**) but for building holistic and sustainable solutions they need to go beyond the available technology-based approaches and hypothesis as analysed in **Platons’ Phaidon**.
The fundaments of terminology and of understanding knowledge are layed out by Aristotle being an essential part of ‘Ethics’.

Information science can very much benefit from Aristotle’s fundaments and a knowledge-centric approach (Anderson and Krathwohl) but for building holistic and sustainable solutions they need to go beyond the available technology-based approaches and hypothesis as analysed in Platons’ Phaidon.

In consequence, an updated view on the knowledge complements including the creation of interfaces between methods and applications (e.g., based on the methodology of Knowledge Mapping) is addressed in the following excerpts.
Systematical View on Knowledge: FCPM Complements

Complements of Knowledge and Corresponding Sample Implementations:

(Source: Aristotle; Anderson & Krathwohl; SACINAS Delegates’ Summit 2015–2018)

- **Factual Knowledge** ⇔ **Numerical data, data ...**
Complements of Knowledge and Corresponding Sample Implementations:

(Source: Aristotle; Anderson & Krathwohl; SACINAS Delegates’ Summit 2015–2018)

- Factual Knowledge ⇔ Numerical data, data ...
- Conceptual Knowledge ⇔ Classification ...
### Complements of Knowledge and Corresponding Sample Implementations:

(Source: Aristotle; Anderson & Krathwohl; SACINAS Delegates’ Summit 2015–2018)

<table>
<thead>
<tr>
<th>Knowledge Type</th>
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<td>Factual Knowledge</td>
<td>Numerical data, data</td>
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<tr>
<td>Conceptual Knowledge</td>
<td>Classification</td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td>Computing</td>
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</table>
Systematical View on Knowledge: FCPM Complements

Complements of Knowledge and Corresponding Sample Implementations:

(Source: Aristotle; Anderson & Krathwohl; SACINAS Delegates’ Summit 2015–2018)

- Factual Knowledge ⇔ Numerical data, data . . .
- Conceptual Knowledge ⇔ Classification . . .
- Procedural Knowledge ⇔ Computing . . .
- Metacognitive Knowledge ⇔ Experience . . .
- . . .
Knowledge and Computing (Delegates and other contributors)

- “Knowledge is created from a subjective combination of different attainments as there are intuition, experience, information, education, decision, power of persuasion and so on, which are selected, compared and balanced against each other, which are transformed, interpreted, and used in reasoning, also to infer further knowledge. Therefore, not all the knowledge can be explicitly formalised. Knowledge and content are multi- and inter-disciplinary long-term targets and values. In practice, powerful and secure information technology can support knowledge-based works and values.”

- “Computing means methodologies, technological means, and devices applicable for universal automatic manipulation and processing of data and information. Computing is a practical tool and has well defined purposes and goals.”


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Data-centric and Big Data (Delegates and other contributors)

- “The term data-centric refers to a focus, in which data is most relevant in context with a purpose. Data structuring, data shaping, and long-term aspects are important concerns. Data-centricity concentrates on data-based content and is beneficial for information and knowledge and for emphasizing their value. Technical implementations need to consider distributed data, non-distributed data, and data locality and enable advanced data handling and analysis. Implementations should support separating data from technical implementations as far as possible.”

- “The term Big Data refers to data of size and/or complexity at the upper limit of what is currently feasible to be handled with storage and computing installations. Big Data can be structured and unstructured. Data use with associated application scenarios can be categorised by volume, velocity, variability, vitality, veracity, value, etc. Driving forces in context with Big Data are advanced data analysis and insight. Disciplines have to define their ‘currency’ when advancing from Big Data to Value Data.”


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“Qualified Data, especially for an enterprise, represents frozen knowledge or in other words frozen value. The abilities to understand and manage these data is what we call data science. Data results from action, hence, data science can be defined secondary to data. The essence of Data Science is to give qualified access to relevant data to owners and users. Hardware and software and their implementation represent the tertiary level of qualified and high level data.”


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Data Value Definition (Delegates and other contributors)

“Data value is the primary ranked value in scenarios comprised of data and computing context. In general, processing of data, is the cause for computing. In consequence, data, including algorithms and other factual, procedural, and further knowledge, have to be ranked primary on the scale of values whereas machinery for processing data, including computing, are providing means of secondary ranked value. In addition, further values, including economic values, can be associated with consecutive deployment of data and machinery.”

This is unaffected by varying views and attributions, including quality. Nevertheless, different views can scale values.

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Application scenarios

- Knowledge creation.
- Valorisation.
- Integration.
- ...
Where knowledge is . . .

Knowledge is created from a subjective combination of different attainments as there are intuition, experience, information, education, decision, power of persuasion and so on, which are selected, compared and balanced against each other, which are transformed and interpreted.

And the consequences . . .

Authentic knowledge therefore does not exist, it always has to be enlived again. Knowledge must not be confused with information or data which can be stored. Knowledge cannot be stored nor can it simply exist, neither in the Internet, nor in computers, databases, programs or books.
Processes

- Knowledge base creation,
- Knowledge base transfer over generations,
- Documentation of requirements respective algorithms,
- Documentation of context respective architectures,
- Usage development within tender processes.
Wrong terms can be very persistent:

- Sunrise (earth is flat?),
- Sunset (from dusk till dawn?),
- Malaria (and prejudice is ahead of scientific results?).
- ...
Examples

- Depiction, traffic signs and their description different.
- Companies do try critical products in countries with reduced privacy perception.
- Overall personal security will mean insecurity for society.
- Color perception is different by society.

Description

- “Standardisation” and “internationalisation”.
- Foreign word “privacy”.
- Trend for hidden security.
- Words for new colors have been added to languages and perception.
Knowledge: Cultural Background

International and other differences

- Privacy perception,
- Different terminology,
- Legal regulations,
- Legal frameworks.
Theory and practice

- Structural deficits.
- Content can be described and even signed to a certain extend.
- Context cannot be handled to a comparable extent. (Users can sign a PDF document, but what about signing it's context?)
- Long-term issues are mostly out of sight. (What will signature validity mean to archiving and reuse?)
- What does this in general mean to long-term knowledge-based processes?
Application scenarios and decision making support

The following case studies show simplified, practical application scenarios for

- separating essential knowledge (e.g., knowledge resources, structure)
- creating knowledge based components (e.g., Active Source)
- supporting increased decision potential (e.g., UDC classification)
- integrating high end resources (e.g., compute and storage)
Multi-disciplinary status

- Medical Informatics,
- Geoinformatics,
- Legal Informatics,
- Geoforensics,
- Archaeology and Digital Archaeology,
- Medical Geology,
- Digital Forensics,

...
Content

- Overall information is widely distributed.
- Sometimes very difficult and a long lasting challenge not only to create information but even to get access to a few suitable information sources.
- Digital and realia objects.
- All participating disciplines, services, and resources have to be prepared for challenges as big data, critical data, accessibility, longevity, and usability.

... digital and long-term issues

- Even best practice cannot preserve realia and data context.
- Context is often destroyed.
- Long-term issues.
- Currently neither a standard being used for one discipline nor an international standard.
- ...
**Goal**

- Need integrated knowledge base for archaeological and natural sciences.
- Necessary to collect data from central data centers or registers. Examples archaeological and geophysical data:
  - North American Database of Archaeological Geophysics (NADAG).
  - Center for Advanced Spatial Technologies (CAST).
  - Archaeology Data Service (ADS).
  - Records as with Center of Digital Antiquity.
  - Records as with the Digital Archaeological Record (tDAR).
- An integrated “Collaboration house” framework is designed to consider all aspects and to handle any kind of object.
... digital and long-term issues

- Documentation.
- Natural sciences data integration?
- Catalogs (International Classification / Catalog of Diseases, ICD).
- Classification (Universal Decimal Classification, UDC).
- Data security.
- Privacy.
- Anonymity.
- ...
... digital and long-term issues

- Documentation.
- Catalogues.
- Classification (Universal Decimal Classification, UDC). Today about 150000 libraries are using UDC classification and implementing information systems herewith.
- Referencing.
- Search.
- Licensing.
Decision making is the fundamental base for any process as well as decision making is a process and result itself.

Nevertheless it is very common

- to have deficits in decision making processes.
- to underestimate the value of knowledge creation.
- to have opposition due to historical and social development.

Aware of!

- No decision is an influence to the “selection”, too!
- To shorten planned decision making processes means significant interaction.
## About Decisions

**Lemma 1:**

- It is easy to do any decision without expertise.

**Lemma 2:**

- A decision (making process) should be **fast and perfectly correct**.

  In case a decision cannot be fast **and** perfect, it should be fast **or** perfect.

  In **no** case should a decision be slow and wrong.
Essential relation:

Decision making! $\iff$ Selection making!

Essential complement to decision:

Making a choice!
Description:

- Performance analysis (current status / resulting status),
- Problem / target identification (e.g., deviations from performance standard, causes, change of distinctive feature),
- Problem / target description,
- Distinguishing marks between what has been effected by a cause and what has not,
- Deduction of causes from relevant changes found with the problem analysis (identification),
- Cause to a problem is most likely the one that exactly explains the sum of facts.
Example Decision Making Process

**Description:**

- Establishing the objectives,
- Classification of objectives,
- Place classified objectives in order of importance,
- Development of alternative actions,
- Evaluation of alternatives against all the objectives,
- The tentative decision is that alternative being is able to achieve all the objectives,
- Evaluation of the tentative decision for possible consequences,
- Take decisive actions, take additional actions (prevent adverse consequences from becoming problems)
- Start problem analysis and decision making process iteratively,
- Steps for decision model in order to determine an optimal production plan and reduce conflict potential.
Decision Planning Process

Description:
For best practice, introduce a decision planning process to important decisions in order to result in the following benefits:

1. Establish independent goals.
   That means a conscious and directed series of choices.

2. Aim to a standard of measurement.
   The measurement should provide information on the distance to the goal.

3. Convert values to action.
   The resulting information should be used to support the planning.

4. Commit limited resources in an orderly way.
   Planning and commitments for any kind of resources, e.g., staff, money, time.
Example Decision Making Phases

**Phases:**

**Orientation stage:** Starting with kick-off or warm-up, exchange with all parties.

**Conflict stage:** Dispute, arguments, working on common denominators and positions.

**Emergence stage:** Vague positions and opinions being discussed.

**Reinforcement stage:** Decision making and justification.
Selected Decision Making Techniques

**Techniques:**

**Rational decision making:** List the pro and contra (advantages and disadvantages) of each option. Contrast the costs and benefits of alternatives.

**Elimination by aspects:** Choosing alternatives by “mathematical psychology”. Covert elimination process, comparing the available alternatives by aspects. Choose an aspect and eliminate the alternatives without the aspect. Repeat until one alternative remains.

**Simple prioritisation:** Choosing an alternative showing the highest probability-weighted utility from all alternatives, resulting from the decision analysis process.

**Satisficing:** The examination of alternatives is stopped as soon as an acceptable alternative is found.
**Instruments, examples**

- Knowledge Resources, ...
- Universal Decimal Classification (UDC), ...
- Unified Modeling Language (UML), ...
- High End Computing (HEC), ...
- Open Archives Initiative (OAI) and OAI-Protocol for Metadata Harvesting (OAI-PMH), ...
- ...

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Universal Decimal Classification (UDC)

The Universal Decimal Classification (UDC) is a general plan for the knowledge classification. UDC is a hierarchical decimal classification system that divides the main knowledge fields into 10 main categories (numbered from 0 to 9). Each field is in turn divided into 10 subfields, each subfield is in turn divided into 10 subsubfields, and so on. A more extensive classification code in general describes a more specific subject.

Faceted and multi-disciplinary context

“Facetted” and “multi-disciplinary” is synonym to the Universal Decimal Classification (UDC), http://www.udcc.org. UDC uses a “(...)” notation in order to indicate aspect. These descriptions are called facets. In multi-disciplinary object context a faceted classification does provide advantages over enumerative concepts. The classification deployed for a universal documentation must be able to describe any object with any relation, structure, and level of detail. Objects include any media, textual documents, illustrations, photos, maps, videos, sound recordings, as well as realia, physical objects such as museum objects.
Documentation and Form

Form (UDC, excerpt, English)

1. (0.02) Documents according to physical, external form
2. (0.03) Documents according to method of production
3. (0.034) Machine-readable documents
4. (0.04) Documents according to stage of production
5. (0.05) Documents for particular kinds of user
6. (0.06) Documents according to level of presentation and availability
7. (0.07) Supplementary matter issued with a document
8. (0.08) Separately issued supplements or parts of documents
9. (01) Bibliographies
10. (02) Books in general
11. (03) Reference works
12. (04) Non-serial separates. Separata
13. (041) Pamphlets. Brochures
14. (042) Addresses. Lectures. Speeches
15. (043) Theses. Dissertations
17. (045) Articles in serials, collections etc. Contributions
18. (046) Newspaper articles
21. (049) Other non-serial separates
22. (05) Serial publications. Periodicals
23. (06) Documents relating to societies, associations, organizations
24. (07) Documents for instruction, teaching, study, training
26. (09) Presentation in historical form. Legal and historical sources
27. (091) Presentation in chronological, historical form. Historical presentation.
28. (092) Biographical presentation
29. (093) Historical sources
30. (094) Legal sources. Legal documents
### Languages, natural and artificial (UDC, excerpt, English)

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<th>Number</th>
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<tr>
<td>5</td>
<td>=14 Greek (Hellenic)</td>
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<td>6</td>
<td>=15 Celtic languages</td>
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<td>7</td>
<td>=16 Slavic languages</td>
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<tr>
<td>8</td>
<td>=17 Baltic languages</td>
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<td>High level languages</td>
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<tr>
<td>004.451</td>
<td>Operating systems</td>
</tr>
<tr>
<td>004.462</td>
<td>Data handling</td>
</tr>
<tr>
<td>004.47</td>
<td>Computer networks</td>
</tr>
<tr>
<td>004.71</td>
<td>Computer communication hardware</td>
</tr>
<tr>
<td>004.738.5</td>
<td>Internet</td>
</tr>
<tr>
<td>004.774</td>
<td>HTTP application. World Wide Web in the strict sense. Web resources / content</td>
</tr>
<tr>
<td>004.82</td>
<td>Knowledge representation</td>
</tr>
<tr>
<td>004.89</td>
<td>Artificial intelligence application systems. Intelligent knowledge-based systems</td>
</tr>
<tr>
<td>004.932</td>
<td>Image processing</td>
</tr>
<tr>
<td>004.94</td>
<td>Simulation</td>
</tr>
</tbody>
</table>
UDC Operations

Standardised operations with UDC are, e.g.,

<table>
<thead>
<tr>
<th>Operation</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>“+”</td>
</tr>
<tr>
<td>Consecutive extension</td>
<td>“/”</td>
</tr>
<tr>
<td>Relation</td>
<td>“:”</td>
</tr>
<tr>
<td>Subgrouping</td>
<td>“[”</td>
</tr>
<tr>
<td>Non-UDC notation</td>
<td>“*”</td>
</tr>
<tr>
<td>Alphabetic extension</td>
<td>“A-Z”</td>
</tr>
</tbody>
</table>

besides place, time, nationality, language, form, and characteristics.

Examples

1. (0.02/.08) Special auxiliary subdivision for document form
2. =1/=8 Natural languages
3. =1/=2 Indo-European languages
4. =9/=93 Artificial languages
5. 59+636 Zoology and animal breeding
6. (7):(4) Europe referring to America
7. 311:[622+669](485) statistics of mining and metallurgy in Sweden
8. 004.382.2:[902+550.8] CPR Supercomputers ref. to archaeology and geosciences, CPR author
Obstacles reducing success and efficiency with the processes

- Time consumption (e.g., staff, project timelines),
- Documentation (e.g., low percentage of reusability),
- Classification (e.g., limited views),
- Tools (e.g., changing repeatedly),
- “Standards” (e.g., changing repeatedly),
- ...
### Structure
- Must be able to contain and refer to any content.

### Full text and keywords
- Groups, regular expressions, search functions, ...

### Soundex
- Algorithm for calculating codes from text strings, representing phonetic properties.
- Originally only used for names, in English.
- The original algorithm mainly encodes consonants.
- Goal is to encode homophones with the same representation, minor spelling differences do result in the same representation.
- Various modifications for any language, topics, any kind of words, support for many programming environments.
Helpers – you always need

Staff and resources

- Quantity of Staff and Resources depends.
- Quality of Data (QoD) can optimise requirements for staff and resources.
Unified Modeling Language (UML)

The Unified Modeling Language (UML) can be used for various purposes with information sciences, software development, and even independent from information sciences, e.g. in economics and business context:

- “business model”
- classes
- messages, objects in their timing sequence
  - coarse overview
  - dynamic
  - parallel processes
  - distributed systems
### UML Diagrams

- Use-case diagram
- Class diagram
- Package diagram
- Interaction diagram
- State diagram
- Activity diagram
- Implementation diagram
**Use-case diagram**

**Diagram:** Use-Case

**Phase:** Requirements, predefinition, application design – building, delivery

**Operational area:** business processes, common
Use-case diagram

Diagram: Use-Case
Phase: Requirements, predefinition, application design – building, delivery
Operational area: business processes, common

Class diagram

Diagram: class diagram
Phase: predefinition, application design – building
Operational area: anywhere, the class diagram is the most important UML diagram.
### Use-case diagram

**Diagram:** Use-Case  
**Phase:** Requirements, predefinition, application design – building, delivery  
**Operational area:** business processes, common

### Class diagram

**Diagram:** class diagram  
**Phase:** predefinition, application design – building  
**Operational area:** anywhere, the class diagram is the most important UML diagram.

### Package diagram

**Diagram:** package diagram  
**Phase:** application design – building  
**Operational area:** overall orientation purposes, which classes in which modules. partitioning into sub-projects, libraries, translation units.
### Interaction diagram

**Diagram:** interaction diagram  

**Phase:** Requirements, predefinition, application design – building, delivery

**Operational area:** shows the message flow and therefore the cooperation of objects in timing sequence.

Special interaction diagrams are:

- Sequence diagram: timing call structure with few classes.
- Collaboration diagram: timing call structure with few messages.
Interaction diagram

Diagram: interaction diagram
Phase: Requirements, predefinition, application design – building, delivery
Operational area: shows the message flow and therefore the cooperation of objects in timing sequence.

Special interaction diagrams are:
- Sequence diagram: timing call structure with few classes.
- Collaboration diagram: timing call structure with few messages.

State diagram

Diagram: state diagram
Phase: Requirements, predefinition, application design – building, delivery
Operational area: presentation of dynamical behaviour
Activity diagram and Implementation Diagram

**Activity diagram**

- **Diagram:** activity diagram
- **Phase:** predefinition, application design – building
- **Operational area:** various purposes.

**Implementation diagram**

- **Diagram:** Implementation diagram
- **Phase:** predefinition, application design – building, delivery
- **Operational area:** especially for presentation of distributed applications and components; in general: presentation of implementation aspects (translations units, executable programs, hardware structure)

Special implementation diagrams are:
- **Component diagram:** coherence of software.
- **Deployment diagram:** hardware structure.
Activity diagram

**Diagram:** activity diagram

**Phase:** predefinition, application design – building

**Operational area:** various purposes.

Implementation diagram

**Diagram:** Implementation diagram

**Phase:** predefinition, application design – building, delivery

**Operational area:** especially for presentation of distributed applications and components; in general: presentation of implementation aspects (translations units, executable programs, hardware structure)

Special implementation diagrams are:

- **component diagram:** coherence of software.
- **deployment diagram:** hardware structure.
Basics and prerequisites

- Real goals. Define the goals, different views.
- Need for basic understanding and knowledge base for HEC.
- Prominent HEC and collaboration aspects decision making processes are necessary for.
- Separate the topics (disciplines, resources, ...).
- Gather the real requirements for the analysis.
- Up-to-date resource policies in theory and practice.
- Interesting fields of application are processes within disciplines.
- Future deployment of integration and classification with components of complex systems.
Components (all areas, no sort order):

- Architecture,
- Operating System,
- Applications,
- Programming languages,
- Tools,
- System modeling,
- Vendors,
- Strategy,
- Targets,
- Staff,
- Operation,
- Services,
- System management,
- Complex licensing,
- Policies,
- Governance,
- ...
Components (all areas, no sort order):

- Components (all areas) with strong focus on
  - Applicability, efficiency,
  - Architecture applicability,
  - Operating System applicability,
  - Efficient applications,
  - Programming languages,
  - Tools,
  - System modeling,
  - Vendors,
  - Strategy,
  - Targets,
  - Staff,
  - Operation,
  - Services,
  - System management,
  - Complex licensing,
  - Policies,
  - Governance,
  - ...
Process fundamentals:

- Knowledge and experience are more important than hierarchy.
- Find the essential information.
- Rational problem analysis and decision planning.
- Add forensics to all possible information.
- The decision making process needs to define the focus.
- The decision making process needs to define goals.
- There should be only one final instance for selection processes.
- Multiple views for a process must be allowed and supported.
- Define results.
- Define service and responsibilities.
- List requirements and parts.
- Tools are needed for making the selection.
- Keep the tools simple.
- Best practice should be used in order to support the process.
Essential aspects:

- Dissemination.
- Scientific research and consultancy.
- Service and operation.
- Transparency for legal issues.
- Written definition of goals, acknowledged by all parties.
- Quality of Data counts, aware of long-term usage.
- Support structuring the application scenarios with architecture/disciplines.
- Support essential knowledge to be long-term persistent (structure, UDC, OEN, CEN, ...).
- Try to support dynamical application scenarios.
- Acknowledge that for some party prestige and presentation might be an aspect with any system.
Decision on:

- User (scientific and industry) requirements,
- Content,
- Context,
- Operation lifecycle,
- Staff and operation,
- Services,
- Architecture (specification, networks),
- Policies,
- Goals (of the system/service),
- Dissemination,
- (Funding).
Needs and requirements from disciplines classically are in contrast with how resources and services are managed and operated. Building services on this base typically polarises interests of participated groups. From this point of view, most building processes regarding computing environments reveal a very small grade of efficiency.
In almost all cases the percentage of re-used knowledge over system generations is very small, leading to perpetuous “re-invention” and “re-discussion” for every cycle.

The suggested rate of re-use is below 10 percent.
Services differ by physics and intention, especially:

- **Latencies and bandwidth**: Low segment: Latency 100 $\mu$s to several milliseconds (distributed), latency 1–2 $\mu$s (local), bandwidth 1.5–4 GB/s (local).

- **Distributed data transfer**: Data transfer for supercomputing is essential with any big (volume) data, physics provide limitation to economical distributed solution.

- **Distributed memory usage**: Shared memory usage for supercomputing is essential with shared memory algorithms, physics provide limitation to economical distributed solution.
View: Providers

Requirements

- Economical environment.
- Efficient operation.
- Sustainable investment.
- Defined policies.
- ...
Which architecture?

- Standalone / workstation,
- Cluster,
- Grid,
- Cloud,
- High Performance Computing (HPC),
- Other.
How do you provision services or resources?

- Institute,
- Alliance,
- Hosting,
- Housing,
- Other.
Which type?

- Research
- Industry
- Mix
- Other
Which kind of usage?

- Interactive
- Batch
- Hybrid
- Other
How can the architecture be used efficiently?

- MPP (Massively Parallel Processing),
- SMP (Shared-Memory Parallel),
- Other.
Which model?

- Low Level: MPI (Message Passing Interface),
- Low Level: OpenMP,
- High Level: PGAS (Partitioned Global Address Space),
- Virtualisation: PVM (Parallel Virtual Machine),
- Other.
Example Information and Archives

- Open Archives Initiative (OAI), http://www.openarchives.org/
  - An initiative aimed at defining an open interface for the exchange of metadata. OAI permits continuous synchronisation of large amounts of data.
- Institution: German National Library

Examples, OAI, Gallica, Bibliothèque nationale de France (BnF)

- Gallica is one of the major digital libraries available for free via the Internet.
- URL: https://gallica.bnf.fr/accueil/en/content/accueil-en?mode=desktop
- URL: https://gallica.bnf.fr/services/engine/search/advancedSearch/?lang=en
Lessons learned:

- Improve long-term creation of knowledge complements.
- Improve Quality of Data.
Lessons learned:

- Improve long-term creation of knowledge complements.
- Improve Quality of Data.
- Foster the creation and application of best practice.
- Foster multi-disciplinary education and work.
- Create knowledge-centric, modular implementations.
Lessons learned:

- Improve long-term creation of knowledge complements.
- Improve Quality of Data.
- Foster the creation and application of best practice.
- Foster multi-disciplinary education and work.
- Create knowledge-centric, modular implementations.
- Create and provide instruments based on standards.
Conclusions

– Information Science –

Assets:
Knowledge complements are the assets of information science!

Applications:
... provide solutions to application scenarios!

Instruments:
... provide fundaments for creating instruments!
References and acknowledgements, see:


Thank you for your attention!