SYSTEMS ANALYSIS
LECTURE 2
SYSTEM IDENTIFICATION

Zuzana Bělinová

Summary
Extended Inductive Definition of System

- $S = (A/F, R/P, M, \gamma, \delta, I)$

Summary - system identification

1. Choice of the level of distinguish
2. Choice / generation of the elements
3. Allocation of the functions to the elements
4. Definition of joined doubles of elements, chaining, introduction of the Structure, Metrics
5. Identification of the external conditions for activation of processes
6. Identifications of processes, finding alternate processes
7. Stating the rules for identification of strong functions / processes and compactness
8. Identification of the system‘s identity

Introduction of metrics

- The distance (d) has to fulfil these conditions:
  - $d(a_i, a_j) = 0 \Leftrightarrow i = j$
  - $d(a_i, a_j) = d(a_j, a_i)$ symmetry
  - $d(a_i, a_k) \leq d(a_i, a_j) + d(a_j, a_k)$ „triangle inequality”
    - (i, j, k are natural numbers).
- The distance of Systems Elements has to be defined for all identified parameters of respective Systems relations.

Types of behaviour

- Equilibrium
  - With Attractor
- Stable
- Divergent – regenerative / degenerative…
- Goal oriented – with attractor / homeostasis…
- Response to the inputs / activated from interior…
- Species oriented (With genetic code) – ideal / standard / adaptive / mutation - failure / catastrophe / self-correction / self-learning

Neighbourhood

- Near
- Far

Model

- Based on object – original
- Model – another object, of different nature, charactristics similar to the original
- Homomorphism
  - reflexive (xRx)
  - transitive ($xRy \cap yRz \Rightarrow xRz$)
- Isomorphism
  - *Also symetrical ($xRy \Leftrightarrow yRx$)*
- Model is simplification of the object (original)

Means of simplification

- Elimination of variables
- States aggregation
- Division to parts

Ways how to record a system

- Natural language
- Tables (of elements, relations, architecture, etc.)
- Figures and schemata (including time diagrams, flowcharts, etc.)
- Logical schemata
- Mathematical methods of description (graphs, functions, matrixes, equations, etc.)
- Use of analogon (similar, equivalent system)

Typical tables to describe a system

- Table of elements, e.g.

Name	**Complexity**	**Previous element**	**Following element**	**Required parameter**	**Offered parameter**	**Timing**	Function	**Other**

  - Complexity of elements based on the input and output relations
    - Non-agressive (IN>>OUT)
    - Important, complex (IN≈OUT, high amount)
    - Simple (IN≈OUT, low amount)
    - Controlling, agressive (IN<<OUT)

Typical tables to describe a system

- Table of relations, e.g.

Parameter	From element	To element	Timing	Carrier	Frequency	Format	Other

- Table of architecture

Subsystem	Contains elements	Superior systém (or systems works with…)	Subordinated systems	Capacity	Other

Recording structure of a system

- Adjacency matrix

	A	B	C	D
A	0	0	0	0
B	1	0	0	0
C	1	0	0	0
D	0	1	1	0

  - Square matrix
  - Elements in rows and also in columns
  - Values – 1 – there exist the relation
    0 – there is no relation

How to choose the way of system recording

- According the object
- According the subject
- According the customer

Soft systems

- Not recognizable structure
- Important influace of humans (living beings)
- E.g. Sociological, economical, ekological, …

System analysis methods

- Method from other science branches
  - E.g. From operational research, graph theory, mathematics, linear programming, …
- Authentic methods
  - Soft systems
  - Computer experimenting
  - General attitude
- Combination of methods

Typical systems analysis tasks

- Based on level of distinguish
  - In the system – partial characteristics, not subject of systems analysis
  - On the system – as a whole, typical system analysis task
  - About the system – as part of higher system

Blackbox

- System with known imputs and outputs
- Unknown structure

Classes of systems analysis tasks

- Establishment of system‘s coherence
  - Ensuring cooperation
  - Solving conflicts – regularization
  - System‘s evolvement or degeneration
- Path problems
  - Finding shortest path, trajectory of certain length, system’s magnitude (as set of all paths),
  - Finding antecedent and precedent (subsequent) elements in system,
- Capacity tasks
- Structural tasks
  - System’s decomposition and integration
  - Feedbacks and their identification

Classes of systems analysis tasks

- System‘s goal
  - Sources of goals
  - Optimization of goals
- System‘s behaviour
  - Efficiency of system
  - Alternative behaviour
  - Typical behaviour
- Tasks on identity
- Other tasks – e.g. on contamination and imunity, ethics, …

Ensuring Systems Existence

- Generalized Kirchhoff laws:
  - $\Sigma \forall i \, (INi+OUTi) = 0$
    - *Nothing neither disappears nor emerges per se in any Systems element or subsystems (with input IN and output OUT).*
  - Σ for every closed path inside the System $(INi - OUTj) = 0$
    - *Nothing can be gained or lost moving on circular path inside the System.*