Generalities on Modeling and Systems

& Help to start your projects!

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Why do we model things?

Mainly, because we can't do otherwise

- ***At the individual level***: our senses are already the result of numerous complex interactions between our bodies and our environnment
  ➔ we interpret signs, we are in fact already « modeling reality » at this scale
- ***At the inter-individual level***: models are our way to exchange generic, shared, and suitable representations of things

So even sciences are models of « reality »?!

- Of course, sciences are done by humans, who cannot do without models.
  Sciences are mainly dedicated to create the best possible models.
  'Best' usually thought as: explaining the maximum number of things with the minimum number of requirements; to eventually make predictions.
- As ***modeling implies doing choices*** (what to consider and what not to consider), it is important to keep in mind that:
  - Culture, Social position, Values (and so on) influence how we formulate problems
  - Which in return, influences what we can imagine as answers to problems

So how to define 'modeling'?

[1] Le Moigne, J-L. La Théorie du Système Général (1977). Ed. 2006..

Modeling is *to conceive* AND *to construct* a corresponding representation of some thing

- To ***conceive*** is the action of organizing and interpreting the varied representations we have about a given thing. All of an individual's intellectual activities are conditioned by a primary system of representation, which determines what can be thought and perceived about this thing.

- With the conception of a thing necessarily goes a ***constructed representation*** (through varied tools) which allows:
  - Testing the conception: is it coherent? Does it account for all considered traits of the object/system? And so on…
  - Communicating the conception to someone else.

Then how to define ‘system’?

[2] Adapted from Section 1.5.2 of SY14 / Document Chapter1.pdf by Eric Châtelet on *moodle.utt.fr*

A *system* is a set of objects organized towards goals and immersed in an environnment

- **Set**: Something which is a coherent unity with a relative autonomy. These features are the foundations of the identity of a system.
- **Objects**: Anything (material or conceptual) considered to be a part of the whole (set of objects) by the modeler.
- **Organized**: Each object of a system may have varied interactions with some other objects of the system; they may have no interactions with some of them. The interactions can be mutual, unidirectionnal, circular (feedback loops), and so on.
- **Goals**: General tendencies of the system to reach certain states. From self-conservation (simple physical objects, like a stone) to complex social functions (technical artifacts or institutions).
- **Environnment**: Everything which is not the considered system. Defining the frontiers of a system consequently defines its near and far environnment (context of the system).

Example of a system definition

[2] Adapted from Section 1.7 of Document Chapter1.pdf by Eric Châtelet on *moodle.utt.fr*

A *cash dispenser* is

- an **automated compact unit** of a **cash box**, a **card lector**, and an **user-interface embedded within** a **metal body**
- generally **near the bank managing it** (material integrity and supply)
- in order to **allow individuals** (with a bank account, withdrawal authorization) to **obtain an amount of money** in **bank notes** of the **local currency**, at **anytime** (electrical alimentation)
- in relatively **secured conditions** (confidential access code, control of authorization)
- while **generating profits** (card subcription, transactions fees, minimal human supervision).

Different systems level

- Indeed, the word « system » does not presuppose any scale. Anything can be considered a system. That is, anything can be modeled in a systemic approach
- 1st use of the word « system » in EV14: we will refer mainly to the **technical system** you have chosen to study in your project. Like in other courses, when teachers ask you to model technical systems.
- But in EV14, the activity of modeling will be focused on the **interactions** between:
  - Humans ⬄ Technical system
  - Technical system ⬄ Nature
  - Nature ⬄ Humans
- 2nd use of the word « system » in EV14: the **upper-system** composed of your technical system and its relations with human and natural spheres. This is what we mean when we talk about having an *holistic perspective* of the impact technical systems have on humans and nature.

Why studying H-S-N interactions, by the way?

Our assumption (based on the founding principles of the Universities of Technology)

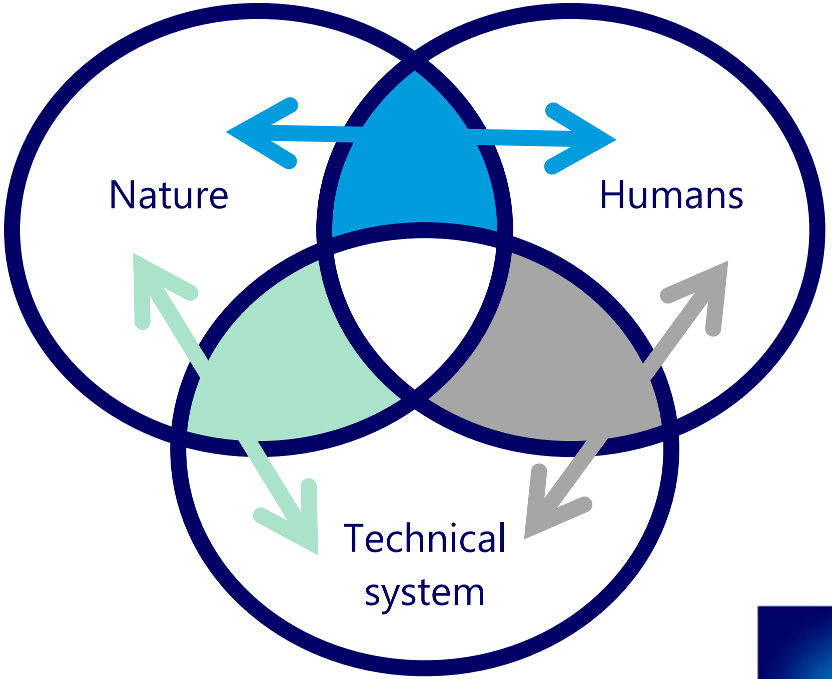
A deep understanding of bio-geo-chemical cycles and biodiversity principles

+

A good knowledge of varied aspects of humans's societies (needs, social structures, and so on)

⬇

Is necessary to allow enginners to design technical systems relevant to the Anthropocene



How do we start the project? 1/3

[2] Adapted from FIGURE1,4 of SY14 / Document Chapter1.pdf by Eric Châtelet on *moodle.utt.fr*

Having your technical system in mind, ask yourself those primary questions

How these different questions relate to each other?

What does it « want »? / What is its use?

Where is it?

Achronic description *(without consideration of time)*

What does it do?

What is it?

Synchronic description *(time considered in relation to the system's functioning, in specific situations)*

From where does it come from?

What does it become?

Diachronic description *(evolution of the technical system through time)*

How do we start the project? 2/3

[2] Adapted from FIGURE1,4 of SY14 / Document Chapter1.pdf by Eric Châtelet on *moodle.utt.fr*

Try to elaborate as broad and varied answers as possible to get a first systemic conception of your technical system

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Example of the *cash dispenser*

[3] Adapted from Section 1.7 of Document Chapter1.pdf by Eric Châtelet on *moodle.utt.fr*

How did we get the system definition proposed in p. 4?
(See how dimensions/colors are actually intertwined?)

An automated compact unit

Distribute amounts of money in local currency to clients, in secured conditions while generating profits

Near a bank & connected to an electrical alimentation

Take and restitute a card, ask an confidential code, control withdrawal authorization

A cash box, a card lector, a user interface, embedded within a metal body

Fabricated in a specialized factory (individual object).
No dependance on human working hours, practicality in core use for most clients (social conditions).

Deteriorates overtime, repaired by manufacturer, dismantled, partial recycling in existing circuits (individual object).
Competed by direct card or smartphone payment, modified for new uses (social conditions).

An automated compact unit

How do we start the project? 3/3

And then?

- At that point, you will normally start to understand the ramification of interdependancies giving the conditions of possibility for the existence of your technical system.

- You can then research information on your system (in particular, LCA – Life Cycle Assessments)

- After that, you'll have to formally define the steps of life cycle you'll be using in your synthetic table (cf. Introduction video to EV14):
  - the parts (physical objects, feeds and processes) of your system
  - the main materials and feeds used for each of theses parts

- In parallel, you'll have to conduct an historical enquiry on the technical evolutions involved with your system:
  - Major technical innovations?
  - Conditions allowing appearence of these technical innovations

Bibliography

Good references to deepen your understanding of systemic theories (in French, for accessibility)

- For a complete introduction, there is a course, here at UTT, dedicated to Systemic theories and System's Dynamics (SY14). On moodle, you can find all the course's ressources. In particular, the course's handout (in construction could be especially pratical for you on the basic methodological principles we presented here.
- The SY14 course's handout have a very good bibiography, and we'd like to strongly recommand the reading of this very accessible text:
  - Donnadieu G., Durand D., Neel D., Nunez E., Saint-Paul L., *L'approche systémique : de quoi s'agit-il ?*, Synthèse du groupe AFSCET " Diffusion de la pensée systémique", 2003. Consultable ici : http://www.afscet.asso.fr/SystemicApproach.pdf
- If you're interested, the less accessible, but more in-depth:
  - Le Moigne, J-L. *La Théorie du Système Général : théorie de la modélisation* (1977). Ed. 2006. *[General point of view].*
  - Rosnay (de) J. *Le Macroscope : vers une vision globale* (1975). *[Applied point of view].*
- And for philosophical stakes:
  - Morin E. *La Méthode* (6 volumes : 1977, 1980, 1986, 1991, 2001, 2004)