Models, Modeling Process and Modeling Tools

PA116 – L8

INVESTMENTS IN EDUCATION DEVELOPMENT

Topics

- Process of modeling,
- Models
- Modeling Tools
- IS as modeling tool
- Ability to model – Modeling Capability
- Problems of the modeling tools infinite sequence
- Top-down approach to MT construction

Review: Bottom-up building MT

- MT is created for specific particular problem
- … according to current needs and requirements
- … without any analyse of a position of a problem within other problems (already modeled or worthy to be modeled)
- It is a pragmatic and in the given specific situation effective approach.

Review: Facts and consequences

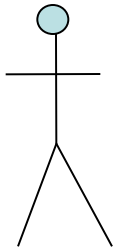
- Bottom-up approach is not supported by any theory of measuring or more precisely comparing modeling capabilities of built tools.
- It leads to tools, which are not able to solve in advance unexpected problems.
- These tools are “products” but not “Service Systems” or a “good components of Service Systems”.

Review: Evaluation

- Available MTs (modeling tools) are not satisfactory for needs of current service oriented business.
- When we extend concept of MT also to company's IS (such IS models reality of the company's business), the situation is pitiful.
- Current MTs always encounter boundaries of their usefulness!!!
- There is strong need to look for new and different ways.

Let’s start with deep understanding of the “modeling process”

Process of modeling



Model maker

Focus on objects
>>base of categories

Focus on relationships
>>list of relationships

Simulation of behaviour
>>list of operations

Statements of consistency
>>list of rules

MODEL

Process of modeling (1)

- There exist an actor – modeler, who wants to describe a part of a real world for some specific purpose (to understand/manage business, implementation of IS, …)
- Modeler focuses his attention to a set of relevant objects, chooses ***categories*** and identifies objects by concepts (focused by these categories). Every category is a container for objects identified by those focused concepts. The set of all needed arranging categories constitutes „a base of categories“ -- CAT.
- Taking into account the specific purpose of the modeling process the modeler identifies ***connections*** between objects, which are again arranged to connection categories or he/she identifies directly these connection categories. Connection categories are recorded into a list CNN.

Process of modeling (2)

- In case the modeler wants to simulate behavior of described reality in his model, or to record states of described reality in his model, he creates so-called ***operations***, which allow manipulate objects within the model by defined way. This leads to a list of operations OPE.
- Using elements of CAT, CNN and OPE modeler formulates consistency statements (***rules*** for filling the model properly). Rules make a list RUL.
- Execution of mentioned steps blends together. Results of these steps are recorded in combination of graphical, chart and textual form, which caries the information and has unique interpretation.
- The result of the process described here is what we call ***model***.

Model (definition)

- By ***model*** is understood a tuple (CAT, CNN, OPE, RUL), where
  CAT is a finite list of categories, it means containers for objects of interest;
  CNN is a finite list of connection categories;
  OPE is a finite list of operations (algorithmic transformations above sets of objects);
  RUL is a finite list of rules (set of consistency statements about categories and their attributes)
- If OPE is an empty set, we speak about structural model, otherwise we speak about model of behaviour.

Two kinds of models

- Models interesting by themselves
  - they are not liven up by game with instances from CAT and CNN, or OPE and RUL
  - we use them to ***MENTION*** properties of the model, properties of its elements, of its behaviour
  - so-called static models
- Models, which we want to ***USE***
  - to simulate reality by game with instances from CAT and CNN
  - by executing the operations from OPE in compliance with rules from RUL
  - so-called dynamic models

Examples

- Static models
  - Data model
  - Organisational diagram
  - Business process model
- Dynamic models
  - Work-flow system
  - arbitrary IS

Modeling tool (1)

- Let MT=(CAT, CNN, OPE, RUL) be a dynamic model such that
  - every category from CAT $\cup$ CNN could be filled by instances,
  - every operation from OPE could be executed
- Then we say that MT is modeling tool.

Modeling tool (2)

- Let M=(B, F, O, R) be a model and let
  - $\forall p \in B$ be an instance of some $c \in CAT$
  - $\forall p \in F$ be an instance of some $c \in CAT \cup CNN$
  - $\forall p \in O$ be an algorithmic computable function defined above $OPE_1 \subseteq OPE$
  - $\forall p \in R$ be such consistency statement, that for its verification is enough to execute an algorithm containing (besides of logic and mathematic operations) only rules from RUL and/or operations from OPE
  - Model M fulfil the set of rules RUL
- Then M is called to be a model constructed by modeling tool MT

Notes

- By modeling using MT we can create a dynamic model M, which we can use again as modeling tool.
- The creation of model M by modeling tool MT means, that we simulate M by game with instances of dynamic model MT.
- Definition of MT is fundamental. It corresponds with intuitive approach of model creation in modeling tool and also with common praxis in available SW, which are considered as modeling tools.

IS as modeling tool

- IS is a dynamic model.
- Every modeling tool MT could be seen as dynamic model created in any (other) modeling tool MT_1.
- And vice versa. Dynamic model could be used as modeling tool.
- This way could be created the whole sequence of MT:
  $MT_1 \copyright\Rightarrow MT_2 \copyright\Rightarrow MT_3 \copyright\Rightarrow \ldots \copyright\Rightarrow MT_n$
- IS is a „leaf MT“. Model created in it is not a dynamic model. This, what we have in IS, we can only ***MENTION***. Not ***USE*** !!!

Modeling Capability (definition)

- Let MT_1 and MT_2 be modeling tools. Let $\Leftarrow\!\copyright$ denotes "can be created by".
- If $\forall M\ ((M \Leftarrow\!\copyright\ MT_1) \Rightarrow (M \Leftarrow\!\copyright\ MT_2))$ then $MT_1 \angle_{mc} MT_2$, i.e. modeling capability of MT_1 is lesser or equal to (or "at least the same as") modeling capability of MT_2.
- If $MT_1 \angle_{mc} MT_2$ and $MT_2 \angle_{mc} MT_1$, then $MT_1 \approx_{mc} MT_2$, i.e. MT_1 and MT_2 have the same modeling capability.

Modeling Capability properties

- Relation $\angle_{mc}$ on set MMT of all modeling tools is partial quasi-ordering.
- Reflexivity and transitivity leads from definition, antisymetry does not work.
- Relation $\approx_{mc}$ on set MMT is equivalence.
- Reflexivity, transitivity and symetry comes directly from definition.
- It is known from algebra, that $\angle_{mc}$ induce partial ordering $\leq_{mc}$ on the set of clasess of equivalence MMT/$\approx_{mc}$.

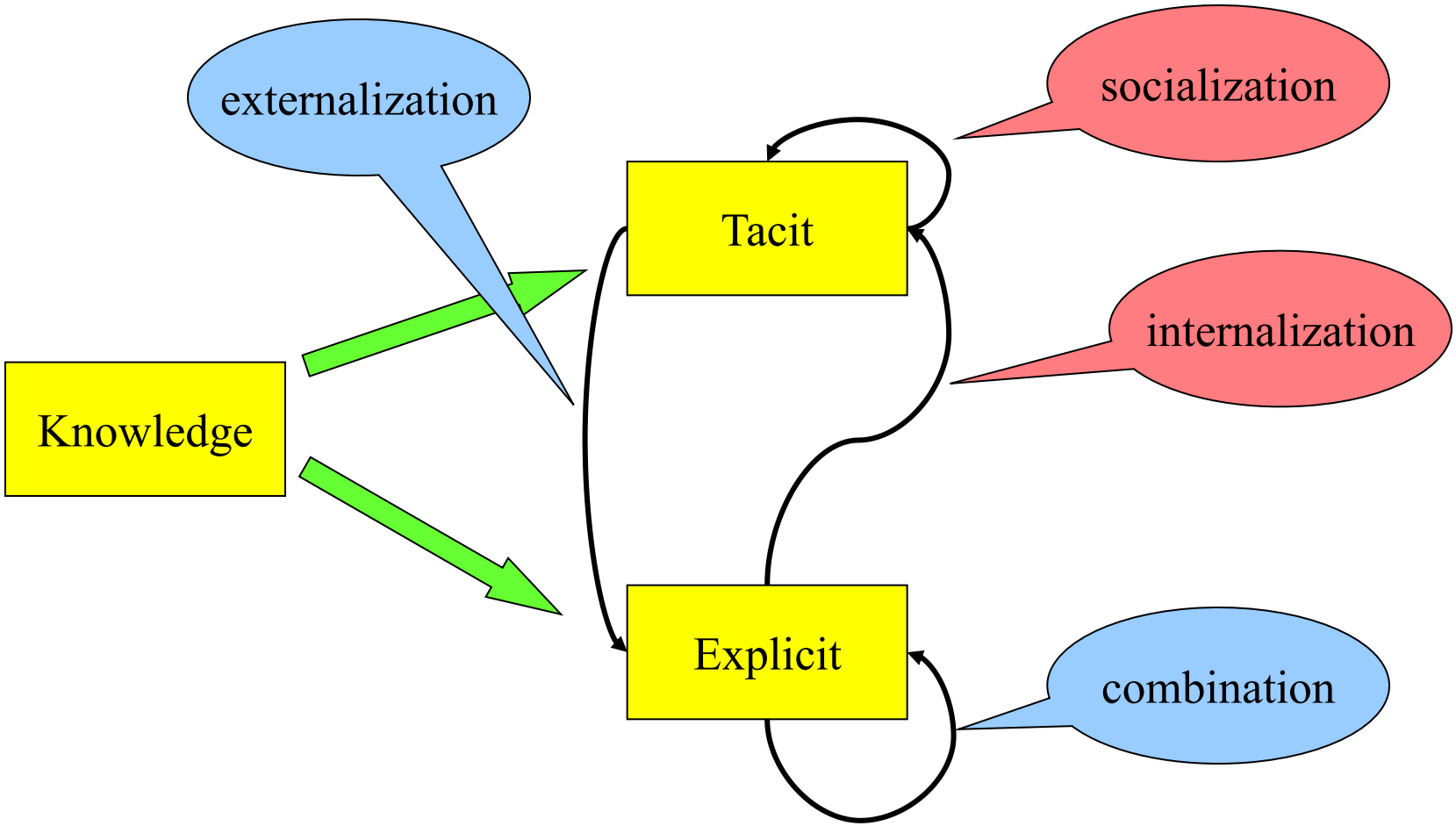
Ordering by modeling capability

- DEFINITION: Partial ordering $\leq_{mc}$ on set MMT/$\approx_{mc}$ is called ordering by modeling capability.
- Every class of decomposition MMT/$\approx_{mc}$ defines one specific modeling capability, which is shared by every modeling tool belonging into that class.
- If MT is modeling tool, then [MT] denotes class of all equivalent modeling tools, it means class of decompositon MMT/$\approx_{mc}$ generated by this MT.
- Concept of modeling capability allows to compare strength of modeling tools in an intuitive manner, and the way corresponds with comparison of information capabilities of database schemes.

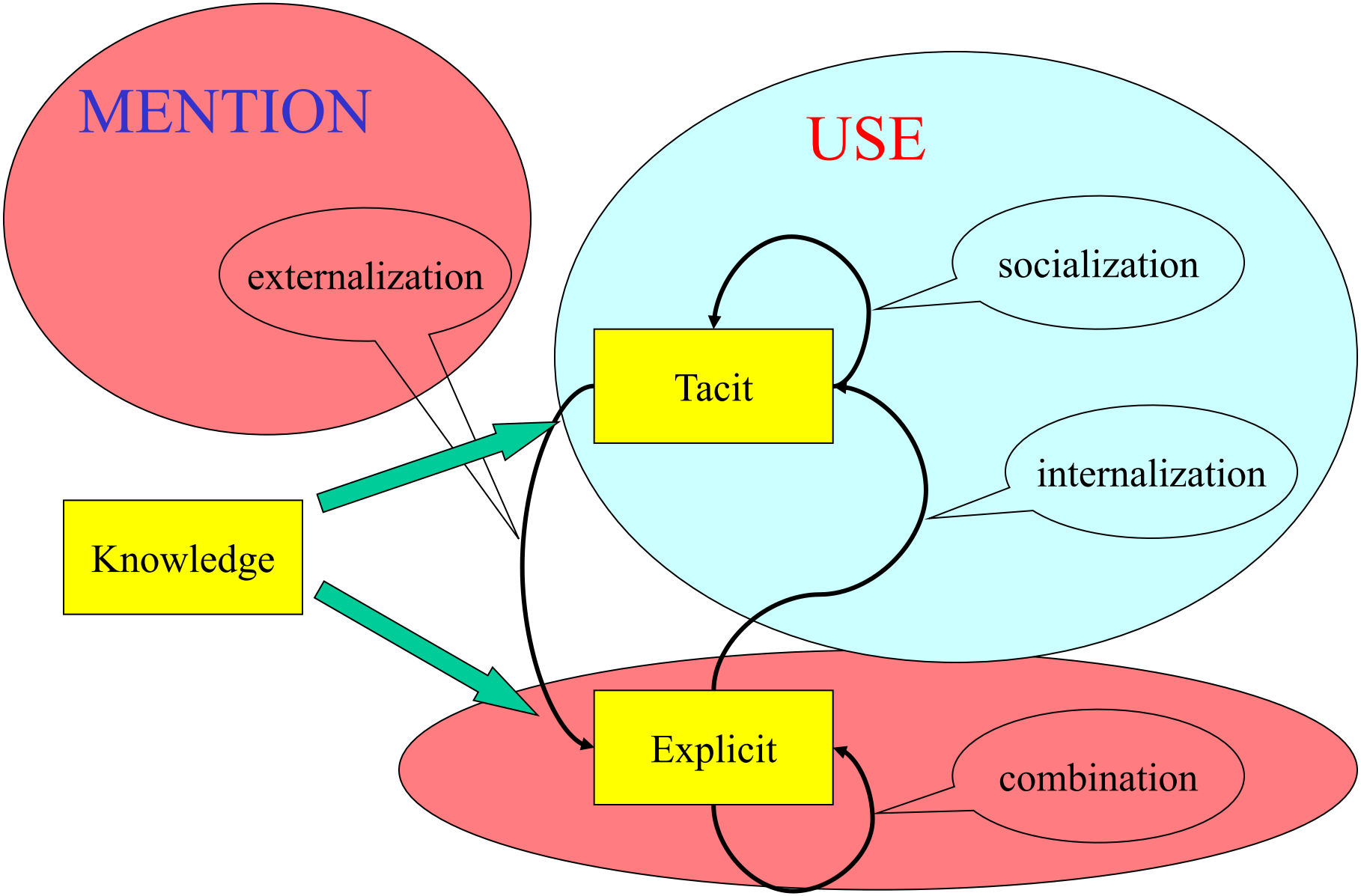
Knowledge Management and Models/Modeling Tools

- Nonaka-Takeushi cycle of knowledge transformation
- What is a role of ***model*** from the knowledge management point of view?
- Sequence of creation and usage of models / modeling tools
- Does the sequence end? Actually, does it start?

Review: Nonaka&Takeushi Knowledge Life-Cycle



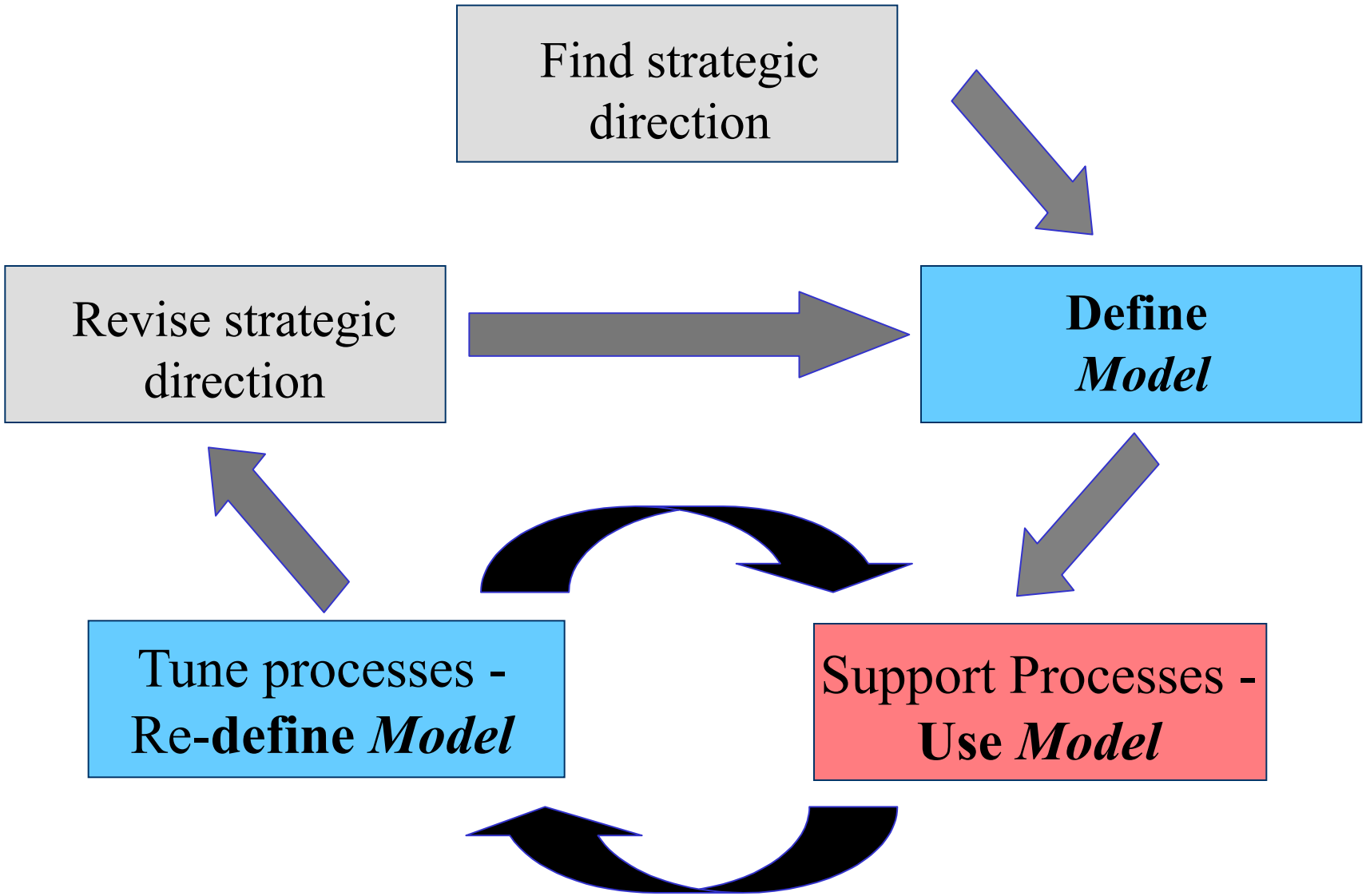
Nonaka&Takeushi Life-Cycle and MENTION-USE switching



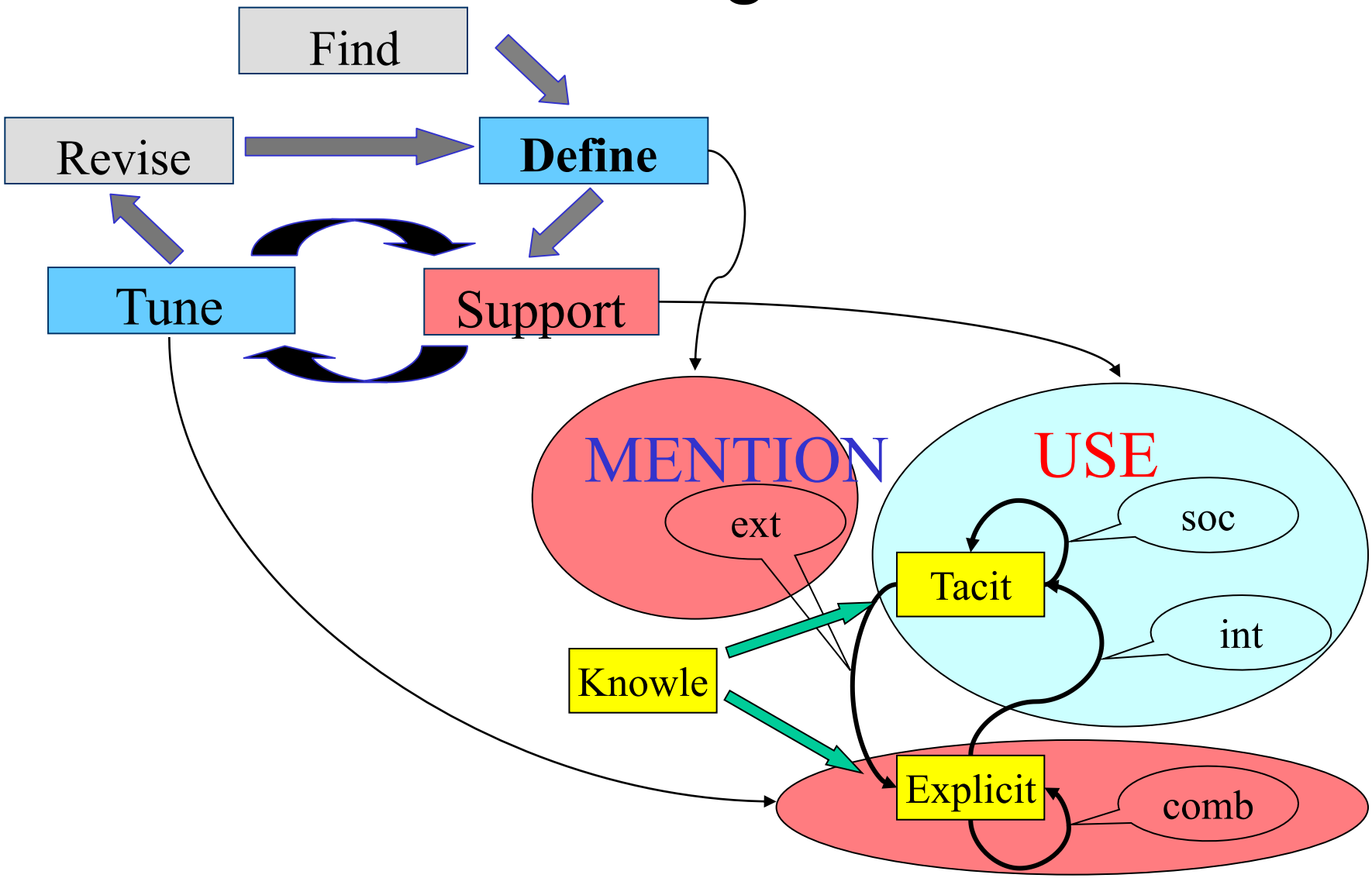
Role of ***Model*** / ***Modeling Tool***

- Process of ***externalization***: this is about creating a ***model***.
- The best way to perform a ***combination*** is to do it by means of an appropriate ***modeling tool***.
- ***Internalization*** and ***socialization*** can be more effective when supported by an appropriate ***dynamic model*** or ***modeling tool***.

Cyclical Paradigm

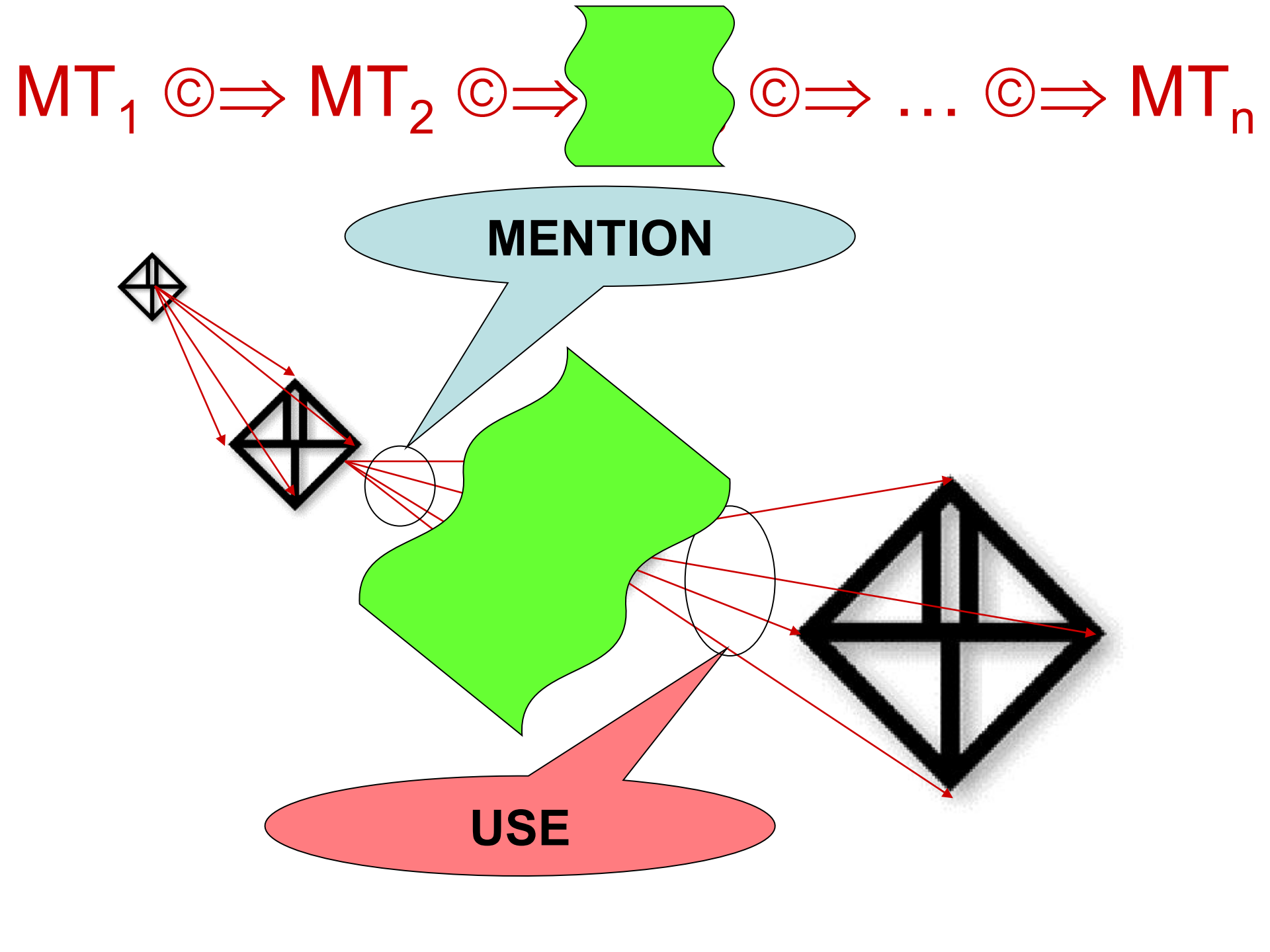


Nonaka&Takeushi vs. Cyclical Paradigm



How to support the Knowledge Life-Cycle effectively ?

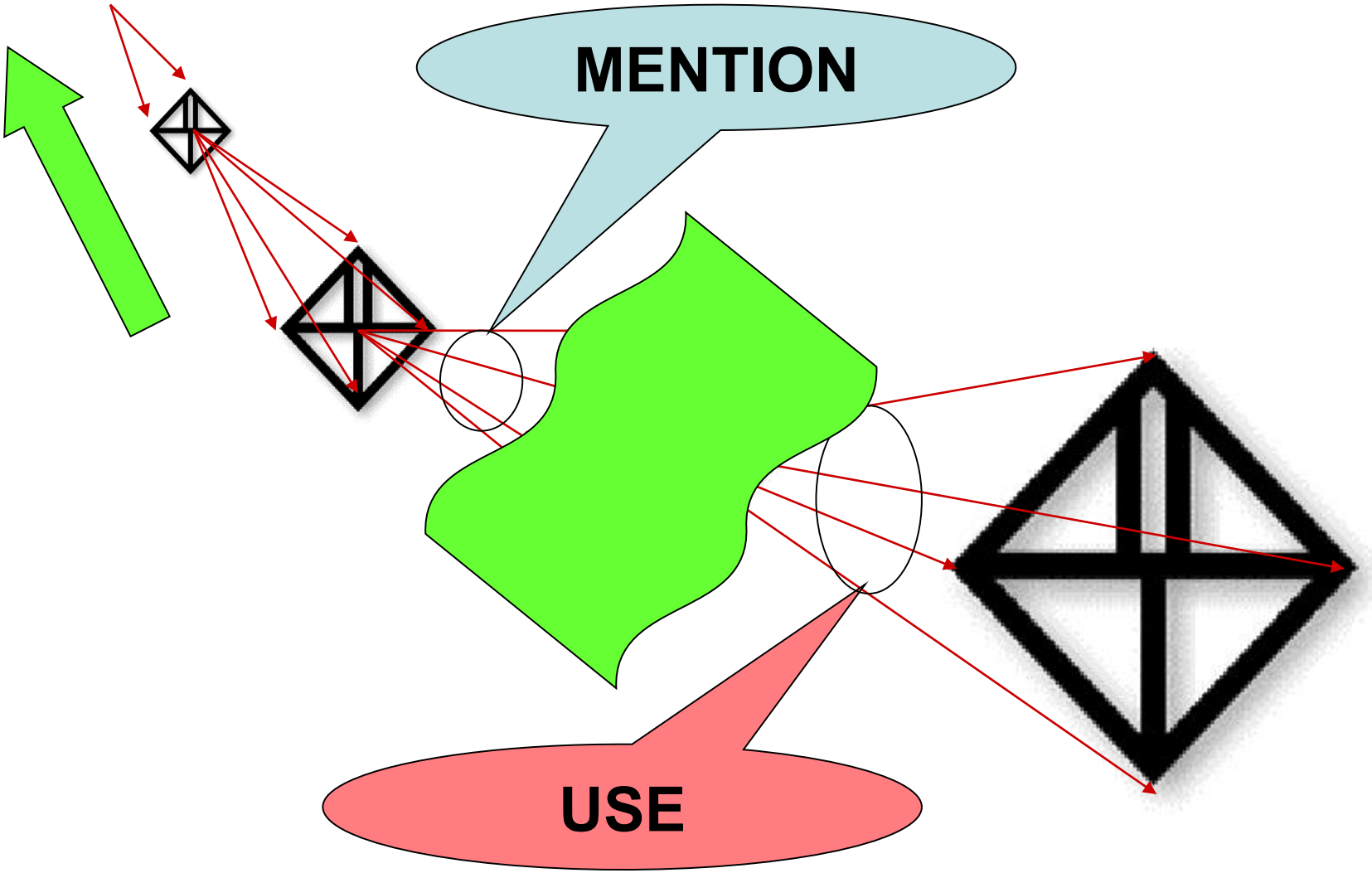
- We need to model, thus, we need a modeling tool
- We need to use created model, thus, created model has to be dynamic one
- According to observations on this dynamic model we need to re-model it. For this purpose maybe the modeling tool must be improved.
- A modeling tool for adapting of our modeling tool is needed.
- ….


MT_1 ©⇒ MT_2 ©⇒ ©⇒ … ©⇒ MT_n
MENTION
USE

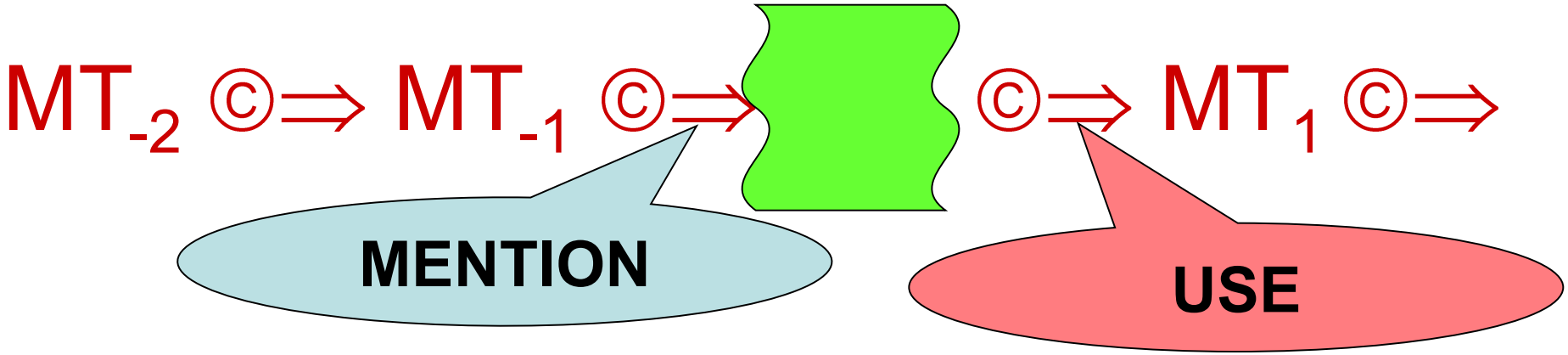
What is model from the knowledge point of view?

- We externalize tacit knowledge and combine the result into created (mentioned) model
- We internalize and socialize explicit knowledge by using model
- **Model is a form of a record of knowledge!!!**

Where does it end / begin ???

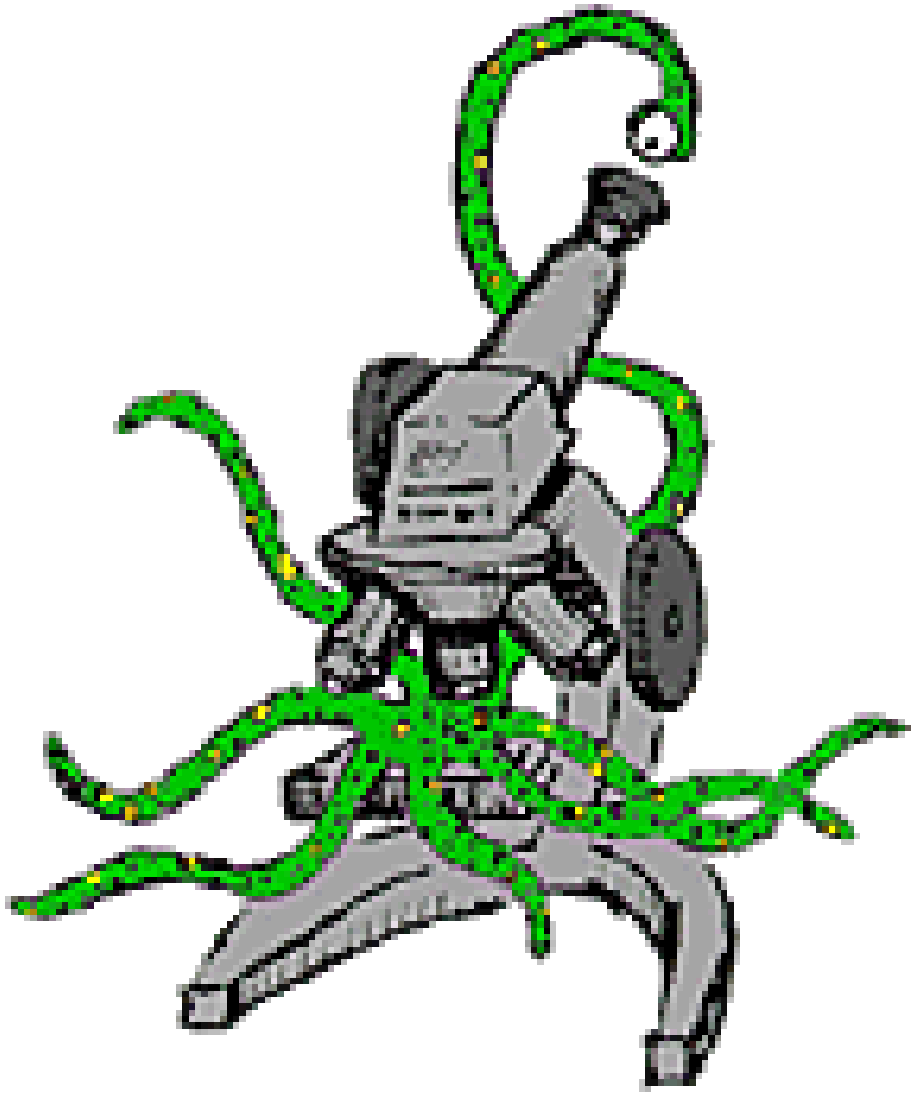


Requirement of universality



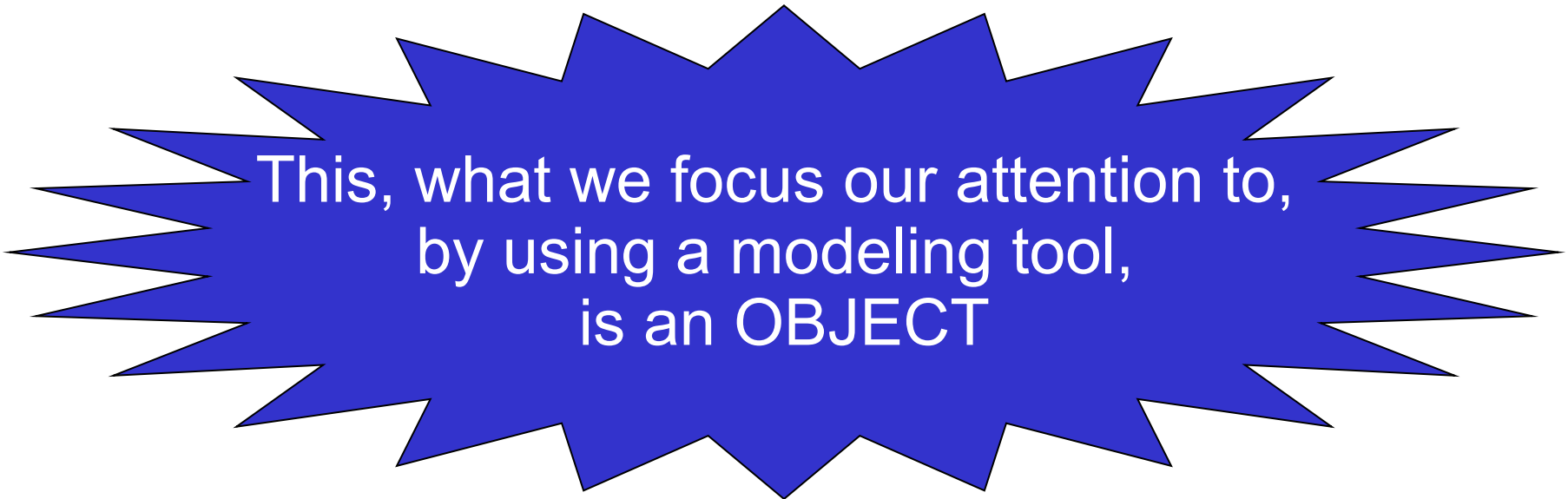
- Process of management of knowledge in business is continually switching between MENTION and USE
- To achieve continual switching MENTION → USE → MENTION → USE → …, modeling tool has to allow to model itself as a model.

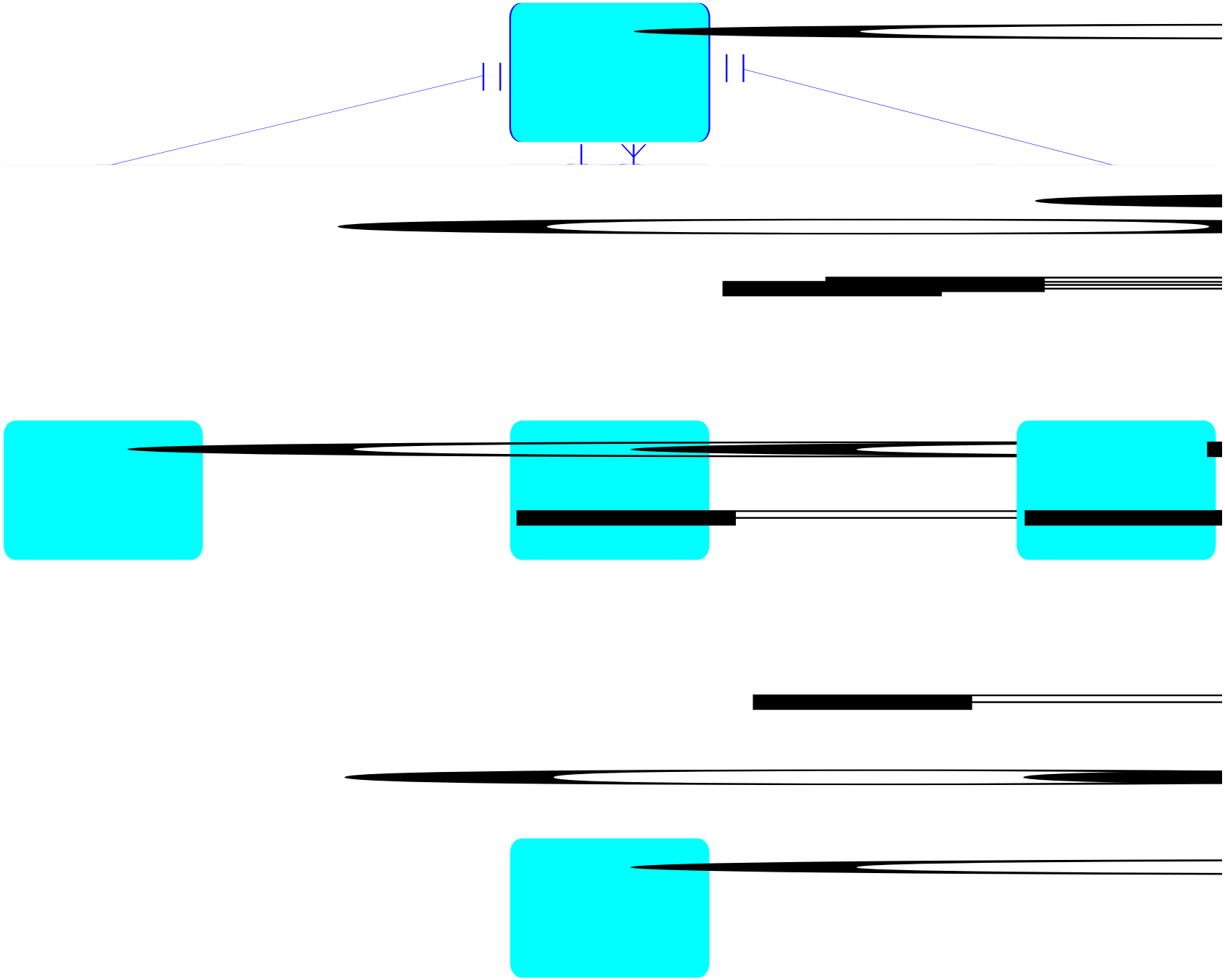
Self-reference



Modeling tool once again

- Let MT=(CAT, CNN, OPE, RUL) be a dynamic model such that
  - every category from CAT ∪ CNN could be filled by instances,
  - every operation from OPE could be executed
- Then we say that MT is modeling tool.





Top-down approach to MT construction

1) A mapping of existing or possible MT into a common representation, which allows a formal manipulation and the application of algebra, is found.
2) A theory of comparison and measuring of modeling abilities is designed. A pragmatic restriction for ordering of modeling abilities is chosen.

Top-down approach to MT construction (continuance)

3) The member of the set of existing and possible MTs which is the supremom of the given restriction of ordering is chosen. The member is exactly defined and possibly implemented.
(see principles of OOP – deferred and effective classes)
4) Every MT which is comparable with the supremom MT^{sup} within the given restriction of ordering is constructed or defined by MT^{sup}.

What does Top-down approach bring?

- Possibility of assembling the image of the world as a mosaic with knowledge that says where to place each piece of puzzle so that the whole makes sense (is consistent) i.e. to classify knowledge of given topic into a context of already accepted and "experienced" knowledge!
- That what we used to call 'understanding'
- Ability to be well informed about the unknown and the new
- Possibility of simulation of cognitive processes in a software system

… and what is human attitude to new knowledge?

- Anything new for us, as human beings, is compared with already known (knowledge) or already had (information).
- It reflects in behaviour, perception, and thinking.
- No new knowledge or information is “alone” in our minds. Each is classified into some ordering – i.e. memory organization, thinking organization
- This is what help us to work with **complex events** of **any order**.

Consequences for Intelligent Service Systems

- If we want to construct an intelligent Service System, there is nothing we can do but follow the integration of “the new” into already constructed organization !!!
- Without ability to classify new knowledge into an organization of learnt knowledge it is not possible to talk about ***understanding***.