**C-K Theory**

B={T,F,U}

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| **Concept C** |  |
| C ={ x | x : K } | Space C contains ‘‘concepts’’ which are undecidable propositions in K (**neither true nor false in K**) about partially unknown objects x. Note: Cannot contain known proposition or else it won’t be a concept.  Concepts define unusual sets of objects called C-sets, i.e. sets of partially unknown objects whose existence is not guaranteed in K. |
|  | Let us start a design process with a  concept C: ‘‘there exists an x with a set of attributes A0’’.  At step i, the designer has changed the initial set of attributes  A0 into Ai by adding or subtracting new attributes and  has introduced some partial design parameters Di.  **At this stage, a new proposition Ci has been formed: ‘‘There exists x with a set of attributes Ai, which can be made with a set of design parameters Di’’.**   1. Ci is false in K and the design process has to change some of the Ais or the Dis; 2. Ci is true in K and (Di, Ai) is one candidate as a ‘‘solution’’ for X; we call it a ‘‘conjunction for x’’; 3. Ci is neither true nor false in K: hence it is a new concept and we have to continue the design process. |
|  | In space C, we define concept-set as follows: a set defined by a proposition which is a concept relative to K. For example, if C is the concept ‘‘there exists an x with A(x)’’, the C-set is the set of all objects x that verify A. They are neither empty nor non-empty.  Note: Talking about group here |
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| **Knowledge K** |  |
| K ={ P | (P : B->T) U } | Space K contains all established (true) propositions (the available knowledge). We assume an expandable Knowledge space K, which contains true propositions characterizing partly known objects as well as partly known relations between these objects. In K, all propositions are true or false.  We consider propositions of the following type P: ‘‘There exists some  entity x (or a group of entities) for which series of attributes A1, A2, Ak are all true in K’’. We define P as a concept relative to K if P is neither true nor false in K. |
|  | Obviously, it was not possible to prove that C0 was true with existing K, but was C0 false in K? In fact, it needed only one proposition in K to ‘‘kill the concept’’. |
|  | Let us start a design process with a concept C: ‘‘there exists an x with a set of attributes A0’’.  At step i, the designer has changed the initial set of attributes A0 into Ai by adding or subtracting new attributes and has introduced some partial **design parameters Di.**  At this stage, a new proposition Ci has been formed: ‘‘There exists x with a set of attributes Ai, which can be made with a set of design parameters Di’’.   1. Ci is false in K and the design process has to change some of the Ais or the Dis; 2. Ci is true in K and (Di, Ai) is one candidate as a‘‘solution’’ for X; we call it a ‘‘conjunction for x’’; 3. Ci is neither true nor false in K: hence it is a new concept and we have to continue the design process. |
|  | Let us assume, in space K, propositions about a collection of objects O which all possess an attribute A0 (example: ‘‘all known car tyres are made of rubber’’).  O. Let usput forward the proposition Q: ‘‘There exists O without A0’’ (‘‘there exist car tyres without rubber’’)’’.  If K contains a universal proposition which says that all O, whatever the time or place, have the attribute A0, then Q is false.  But if K only contains the proposition: ‘‘All known Os have the attribute A0’’3 then Q is a potential concept that may lead to a revision of the identity of O.  Let usput forward the proposition Q: ‘‘There exists O without A0’’ (‘‘there exist car tyres without rubber’’)’’.  If K contains a universal proposition which says that all O, whatever the time or place, have the attribute A0, then Q is false.  But if K only contains the proposition: ‘‘All known Os have the attribute A0’’3 then Q is a potential concept that may lead to a revision of the identity of O. |

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| **Object** |  |
|  | Identity of an object in K Let us assume, in space K,  propositions about a collection of objects O which all  possess an attribute A0 (example: ‘‘all known car tyres are  made of rubber’’). Thus, A0 (‘‘made of rubber’’) can be  considered as a partial element of the identity of O. |

**End Goal:**

Design proceeds by a step by step partitioning of C-sets until a partitioned ‘‘C-set’’ becomes a ‘‘K-set’’ i.e. a set of

objects, well defined by a true proposition in K.

C= K

E= designer’s environment

The name ‘‘C-K theory’’ reflects the assumption that Design can be modelled as the interplay

between two interdependent spaces with different structures and logics: the space of concepts (C) and the space of

knowledge (K).

Theoretical problems only arise when design itself becomes the object of academic inquiry (Evbwuoman et al. 1996; Blessing 2003; Simon 1979).

Design is a mapping process between functions and design parameters or structures (Suh 1990; Yoshikawa 1981); this may be achieved in a small number of fixed steps (classic systematic design) or may follow a more evolutionary

process (Gero 1996).

In their approach, Design is modelled as a dynamic mapping process between a function space F (set of functions) and a structural space D (set of design options or parameters).

We could say that he designs a decision function to find it; and Decision theory can be seen as a minimal form of design.

Mathematically, the driver problem can be approached by programming heuristics, problem-solving theory and multicriteria decision-making (Simon 1969). These models fully capture the dynamic mapping between solutions and criteria, but not the ‘‘generation’’ of new things, i.e. in example A, the definition of a new engine whose principles are not necessarily known today, as well as the identification of conditions guaranteeing the existence of such an engine.

The starting point of a design project is described in pragmatic terms as a ‘‘brief’’, an ‘‘idea’’ or ‘‘abstract specifications’’. These expressions attempt to describe an object that is not completely defined and whose conditions of existence are not completely known. Therefore, the only way to start the design process is to formulate an incomplete, even ambiguous group of desired properties for this object. To capture the reasons and rationale for such odd formulations we need to model both what is known and what is partly unknown. The two spaces of C-K theory fulfil this need.

For the same reasons, concepts are not propositions that can be tested like scientific hypotheses. As the latter have to be assumed as true this would mean that the design work has already been done.

**Definition Design is a reasoning activity which starts with a concept (an undecidable proposition regarding**

**existing knowledge) about a partially unknown object xand attempts to expand it into other concepts and/or new knowledge. Among the knowledge generated by this expansion, certain new propositions can be selected as newdefinitions (designs) of x and/or of new objects.**

However, this power of expansion depends on particular conditions in K Whenever possible, universal propositions should be avoided in K as they are logical obstacles to the revision of object identities.

**In space C, we define concept-set as follows: a set defined by a proposition which is a concept relative to K. For example, if C is the concept ‘‘there exists an x with A(x)’’, the C-set is the set of all objects x that verify A.**

**They are neither empty nor non-empty.**

In classic programming theory or problem-solving theory (Simon 1969; Simon 1979;Simon 1995), the task is to explore a problem space containing a list of potential or approximate solutions. All solutions may not be accessible; it is however assumed that solutions are built by the combination of well defined objects like, for example, in the game of chess. In contrast, Design faces situations where it is not possible to define even an infinite list of known design candidates or even to define what such candidates are. C-sets capture this situation by modelling collections of partially unknown objects which verify a proposition which is undecidable in K.