The Computational Process Model

By analysing inventions in the history of humanity, prototypical operations can be identified that re-surface in creative processes. The *Computational Process Model* takes such an approach. It has been adapted for design thinking modeling purposes based on the closely related *Lucky Leap Model* [1].

The *Computational Process Model* highlights seven kinds of operations in creativity and innovation (Fig. 1).

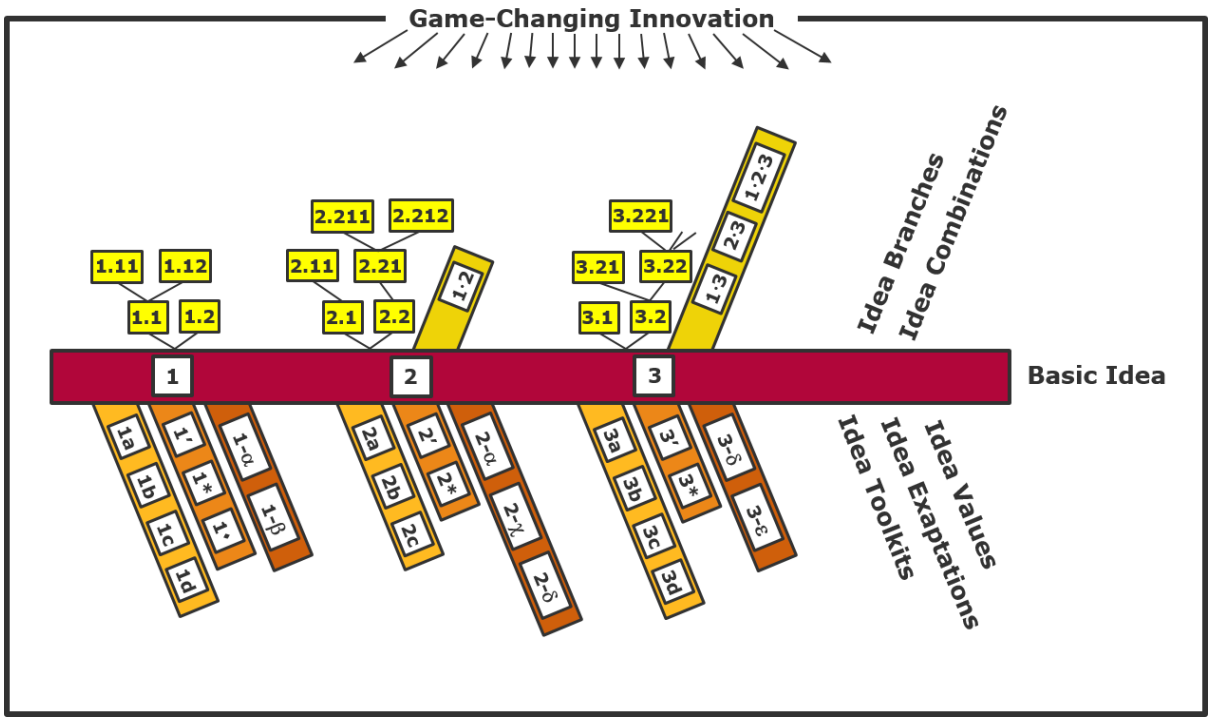

Fig. 1 The ***Computational Process Model*** distinguishes seven mechanisms that humans use to create novel solutions.

As a basic entity, the model introduces "ideas" – a notion that is used very coarsely in this context. Clearly, ideas need to be manifested in some way. Newly emerging ideas are often expressed verbally, or they are sketched out visually. Ideas that have been around for a long time are often available in manifold form, for instance as tangible goods.

Seven kinds of operations have been identified, which re-surface in human creative processes:

i. Basic new ideas emerge (e.g., boxes 1, 2, and 3 in Figure 1). For instance, in the history of humanity, the basic new ideas of "agriculture" and "wheels" were set forth. These novel ideas were embraced by larger groups of people and thus became radical innovations. In more recent times, the "motor" can be considered another basic invention.[1]

[1] In the modelling process, basic ideas can be identified based on how an idea is used in the community. Each idea that gives rise to an idea branch, novel combination, toolkit and/or exaptation is to be treated as a basic idea in the model. Thus, some ideas re-appear at different locations over time. E.g., a combination idea like the motor, which integrates several previously existing components, can be used as a basic idea by the community later on, i.e., as a building block for further developments.

ii. Basic ideas give rise to idea branches (e.g., boxes 1.1, 1.11, 1.12, and 1.2 in the model). Idea branches exhibit two major characteristics: diversification and refinement. An example of diversification is the development of different lineages of motors, such as diesel vs. petrol vs. electro technology. Refinement means that solutions become ever more effective over time in light of a continuous value or development goal. For instance, present-day automobile engines have more horsepower than motors available a hundred years ago.

iii. Basic ideas get combined (e.g., boxes 1·2, 1·3, 2·3 1·2·3). For example, combining the two ideas of agriculture and wheels yields vehicles for agricultural purposes, such as a hay cart. Including also the idea of a motor, one gets motor-powered vehicles for agriculture, such as a tractor.

iv. Toolkits get developed. These are novel solutions designed to render the application of a basic idea more convenient and/or effective. For instance, to render "agriculture" effective, tools such as plows and water management were invented.

v. Existing solutions obtain novel functionalities – idea exaptation occurs (e.g., boxes 1', 1*, 1♦). Here, basic principles are identified in an existing solution and re-used in a different context. For instance, one basic principle of the wheel is that there is something spinning around an axis. This principle can be re-used to invent a windmill. Another basic principle of the wheel is that there is a circular element turning around. This principle can be re-used to invent a pulley.

vi. Existing solutions convey values and elicit value reflections (e.g., boxes 1-α, 1-β in Figure 1). The term "value ideas" (or "values" in short) is used in a broad sense here and can be interpreted in terms of creativity goals, effectiveness standards, human needs and need hierarchies, ideals, social norms, legislation, and related constructs. Values are important for basic ideas to be maintained and to evolve further over multiple generations. Without the enduring goal of maximizing horsepower, automobile engines would not have evolved continuously in this direction. Without value changes in favor of eco-friendly solutions, there would not have been a shift of efforts away from diesel and petrol technology to electric car engines, as observable in recent years alongside the diesel scandal and environmental movements. One value can be associated with multiple ideas, e.g., the value of eco-friendly solutions can inform creative developments in various domains, such as the automobile sector and the field of agriculture.

vii. Finally, there are game-changing innovations, which facilitate upcoming creative developments. For instance, when writing and the printing press were invented, these were game-changing ideas [3]. Printed records improve the documentation of creative achievements. The communication of ideas across individuals improves drastically. There is less knowledge loss over time, and more individuals get access to available knowledge. Therefore, new generations of creators benefit more from ideas that had been developed and probed in the past.

The *Computational Process Model* has been published in [3] and [4], where you can find more information.
The model has been applied in a case study [5], to quantify the impact of political regulations on the development of innovation in society.
People can train the use of the seven mechanisms described in the model by playing the *Game of Invention*: **https://hpi.de/neurodesign/projects/game-of-invention.html**

References

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