From incremental to radical: organizational knowledge-related barriers and enablers of paradigm-shifting innovation

A distinction is traditionally drawn in the innovation literature between *incremental* and *radical* types of innovation, the latter being defined as the significant (Ettlie, Bridges et al., 1984), clear (Duchesneau, 1979) or even risky (Dewar and Dutton, 1986) departure in technology or process currently adopted by an organization.

However, despite the long-established dichotomy, there are still some important gaps in relation to our understanding of radical innovation's *origins*. Indeed, there is a fair amount of literature dedicated to the implementation stage of radical innovation (RI), i.e., the later stages of the innovation cycle, adopting predominantly a business development perspective – i.e. how a radically new product can be introduced into a market – e.g., O'Connor, 2008, and Slater, Mohr et al., 2014, among many others.

Only a few studies have attempted to tackle the question of how RI can be *created.* Peschl and Fundneider, 2014 pointed out that innovation cannot be brought about by mechanistic means, and instead, an 'attitude of enablement' is required. Lin and Luh, 2009, have suggested a design approach combining the 'traditional' methodologies such as TRIZ with others in order to create a balance between rational/logical and intuitive/creative thinking. It has also been recognised that the creativity in design is stifled by the existing design theories and formal NPD processes (Le Masson, Hatchuel et al., 2011; Griffin, Price et al., 2014) which obstructs RI. In an empirical study Griffin, Price et al., 2014 analysed cases of companies with a track record of serial radical innovations. The findings showed that successful radical innovation companies focus heavily on its so-called 'fuzzy front end', and that their innovation processes tend to be non-linear. This finding is also be supported by a study by Yang, Chou et al., 2014, who found that *organisational unlearning* is positively linked with radical innovation. It is also stressed that existing experiences and traditional ways of operation can be restrictive (Atuahene-Gima, 2005; Chang, Chang et al., 2012; Nicholas, Ledwith et al., 2015). Examples above show that there is some understanding in the literature that RI is related to organizational learning and organizational knowledge, and especially new knowledge creation, however, Nonaka and Takeuchi's (Nonaka and Takeuchi, 1995) SECI model is most often assumed as *the* knowledge creation framework (Popadiuk and Choo, 2006; Liao, Fei et al., 2008; Donate and de Pablo, 2015), and to date, no detailed accounts could be found investigating the knowledge-related processes underlying RI in detail.

Some authors tackle the origins of RI – creating a significantly novel idea – from a somewhat different angle, i.e., that of *creativity*. For example, Amabile, 1997, points it out as the first step in innovation, and this view has since taken the dominant position in innovation literature. At the same time, this particular stance is not without gaps, either. For example, Çokpekin and Knudsen, 2012, highlight that the relationship between creativity and innovation is still not fully understood; Driver, 2008, points out that the organizational creativity research is focussed much more on maximizing its output rather than on intricacies of the process itself, and Litchfield, Ford et al., 2014, state that creativity and innovation, despite the link outlined in Amabile's seminal works twenty years ago, are still treated independently in the literature.

Furthermore, another level of complexity is added to the issue when we talk about *collective* creativity, which is inevitable if the innovative product in question is a result of a team effort. Multiple authors point out that this is a distinct gap in the literature (Driver, 2008). Bissola and Imperatori, 2011, argue that innovation related to complex problem requires creativity at a group, rather than individual, level, yet currently there are no models explaining its development, and the organizational context is related in the literature to individual creativity only. Similarly, Chiang and Hung, 2014, state that collective creativity still needs further research, and there is little understanding of how a group of creative individuals can work together in order to create an innovative product.

Overall, this work-in-progress paper is attempting to answer this hitherto under-explored area and to answer two research questions: what are the knowledge-related processes underpinning radical innovation; and what are the RI's barriers and/or enablers?

The case it examines is related to the design and manufacture of a high-end sailing catamaran racing at the World championship level. Dating back to the 1960s, boats in this class have been gradually developing through incremental innovation, becoming lighter, more reliable and somewhat faster through the introduction of new materials and improvement of the hydro- and aerodynamics. However, their evolution has reached the stage of diminishing returns, and none of the teams have been able to create a Class-legal design delivering a step change in performance.

One of the teams competing in the Cup is the UK-based Team Invictus. Founded in 2002 by a group of Airbus engineers, Invictus raced in 2004 and 2010, and took the third place. Ever since, striving for the Champion's title, the team's designers have been trying to find ways of breaking from the established pattern. However, it was becoming increasingly clear that the path-dependency brought by the traditional aerospace design and engineering methodology was restricting the team's creativity. The team has decided to try a new approach: instead of the 'traditional', mechanistic and taylorist project management, all procedures were relaxed and they went through the new design cycle in a way that they described as *"high entropy"* and *"organised chaos"*. The results were astounding: a boat was created that, although still compliant with the Class's requirements, challenges the very fundamental principles of sailing boats' design, and is capable of delivering performance by far surpassing any of the traditional sailing catamarans.

Our results to date, based on a number of grounded theory-based interviews, highlight several important barriers and enablers that may have prevented the radical design shift at the earlier stages of the boat's development. They can be broadly identified as *unwillingness* and *inability* to make a risky departure from the 'safe haven' of the traditional design.

The *unwillingness* refers to reluctance to make any major departure from what is already known. It transpired that this reluctance is a complex matter, expressing itself, primarily, in risk aversion brought about by the cost of failure (both monetary – the cost of a boat in this class is several hundred thousand pounds - and reputational, i.e., an unwillingness *"to be seen as fools again"*), and also, and more importantly, by the lack of the knowledge's breadth. The latter means that the design space – the multidimensional combination of dozens of variables involved in defining the new design - has too many blank spots, or 'unknown unknowns'. As a result, the designer team do not feel confident enough to explore its 'outlandish' areas too far off the traditional paradigm; although these are where the radically new design resides, they also contain the unknown and unclear 'no-go'

zones, i.e., combinations of variables that do not produce a workable solution. Thus, since it can't be told whether a design concept is a clear non-starter or not, and given the cost of failure, design teams resort to safer, incremental tweaks that are clearly within the workable part of the design space.

The *inability* dimension is closely linked to the matter of collective creativity. Although there is no evidence to say that any of the design team members lack *individual* creativity as far as developing new parts of the boat is concerned, the result is still incremental, rather than radical; this is due to two factors. One is the path-dependency characteristic of the traditional, step-by-step approach, whereby new solutions are created as a development of the old ones, and as a consequence, bear the inheritance of the previous ideas, concepts, and mental models. Therefore, making changes to any of the parts, creative although those changes might be in their own right, still means creating new versions of the old design. The other factor is the complexity of the desired product and the potential knock-on effect of any drastic changes to any of the constituents' design on the overall boat's functionality; if one makes a radically new assembly that performs well in isolation, when taken in the context of the overall system, it may result in undesired side effects, and may put the system as a whole into one of the 'no-go' areas of the design space. Therefore, what turns out to be essential, is a shift from a 'bottom-up' approach, whereby individual pieces of new knowledge are created and put together in a hope for generating a radically new whole product, to a 'top-down', holistic one, starting from looking at the systems as a whole, and taking into account multiple interactions and interdependencies between constituent parts. This, in turn, requires a different approach towards *organizing* the design process, letting go of the (multi)sequential approach typical of the aerospace and other hi-tech engineering, and opting for a *systems-thinking*, holistic one, described by one of the respondents as *"organized chaos"* instead. This enables the design team to develop a radically new solution whereby all new elements are interlinked in their functionality, and work together well, thus producing an end product that is radically new both in parts and as a whole.

The findings above are based on the analysis of the 'old' approach that the team used successfully over the years to create incremental innovation, but not the radical one. Our further steps are to gather and analyse more data related to the 'new' approach, and to get a more in-depth understanding of the knowledge-related processes underpinning the successful RI carried out by the team. The findings would be of interest to both academics working in areas related to new knowledge creation, innovation and creativity, and practitioners dealing with the matters related to radical innovation.

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