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Generation Y – Modularity Enabling Radical Innovation

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Abstract. SMEs, in particular, have challenges working purposefully with innovation and development, as this is in a continuous conflict with day-to-day operations. The innovation work is therefore often random and characterized by further development of existing product / production, or with technology suppliers setting the agenda. Traditionally, a distinction is made between stepwise / incremental and radical innovations. The latter involves creating new products, services, processes or mindsets (Generation Y) that can outdate existing ones (Generation X). Radical innovations require conceptual and long-term thinking, and often require large amounts of resources that make it challenging to succeed. Incremental innovations, often via further development / improvement of existing products and pro-duction systems, occur far more frequently, and the overall effect of gradual innovations can be significant. But the step-by-step innovations can be unstructured and do not necessarily contribute in a direction that ensures long-term competitiveness in relation to Generation Y. Through three different (but connected) pro-jects, we have approached different aspects of aiming to enable a more modular, but radical innovation process. This involves the development of solutions to concretize the future concepts for product / production through reference models, define the various innovation steps (modules), and solutions to follow up the path towards radical innovation (Generation Y).

Keywords: Innovation, Modularization, Concepts.

1 Introduction

1.1 Drivers for innovation

We live in the era of constant transformations where e.g. technological, product and process innovations have altered manufacturing for decades. The ability to be flexible and agile have been key qualities for success. It goes without saying that the future will witness even more breathtaking technological disruptions, as research around nanotechnology and big-data analytics start to impact numerous manufacturing applications. The report "Remaking of Industries" [1], identifies six drivers for industrial changes; the always-on, hyperconnected consumer's search for personalized products and experiences; growing imperative for higher productivity and to do more with less; the challenge of digital disruption, which is blurring industry boundaries and upending markets at a rapid pace; the drumbeat to "go green", long a mantra but now in-

creasingly a reality; evolution of business ecosystems, where established companies must work with, not against, start-ups, competitors and customers; the politics of economics, in which long-held views on trade and internationalism are strongly challenged resulting in new regulations.

These forces do not exist in a vacuum but collide in ways that increase their power and keep companies scrambling to keep up. How do you build for tomorrow without risking all that you do today? How do you keep pace in what may be an older but still-strong core business, alongside a new core that has lots of running room left and new businesses that are taking shape but face great uncertainty? Only strong players will get a chance to fulfil established goals, provide goods and services for untapped markets, and, finally, to stay ahead of the competition.

According to the BCG's Global Innovation Survey 2020 [2], the most innovative companies are those that view the need to constantly innovate as a top-priority and support this approach with a coherent strategy and sufficient investment. This group accounts for 45% of the more than 1.000 companies taking part in the Innovation Survey, which results in the top 50 innovator list. At the other end of the scale, 30% of companies in the survey were categorized as "skeptical innovators," placing little importance on defining a clear innovation strategy or committing investment. 25% of companies sit in the middle ground, exhibiting an inconsistent or indifferent approach to innovation and its importance to their business. This clearly states that companies need some kind of vision of the future superior products and processes.

Norwegian and international surveys show that 80-90% of managers see the ability to innovate as crucial for value creation and competitiveness. However, more than half of the managers are also unsure whether the company has enough innovation capacity and resources to succeed in innovations.

1.2 Scope

The paper is conceptual as it aims to describe how in particular SMEs could increase their innovation pace through a stepwise, modular approach, at the same time as they head for radical innovation. The paper presents different elements of modularization and prerequisites for such an approach to innovation, including enablers and methodologies for modular innovation. Section 2 describes the theoretical aspects, while section 3 presents the use-cases/projects the paper is based upon. Section 4 goes into the different elements of our approach for modular innovation.

1.3 Research Approach

This paper is based on the research in four R&D projects in medium sized manufacturing companies in Europe. A common denominator for the projects is the objective on improving product development. The 3- to 4-years projects have several of the same partners, hence the R&D-work has been fertilized between the projects. One is funded by EUs H2020, while three are co-funded by the Norwegian Research Council (NRC). The action-oriented approach means that the researchers have actively worked out solutions the companies can use and possibly implement – in line with traditional action research methodology.

2 Theoretical Perspectives

2.1 Towards Radical Innovation

Radical innovation can change our everyday lives and improve sustainability through, e.g. new technology that gives us new products, radical improvement in performance, quality and / or price. Incremental innovation builds on and optimizes existing products / services, technologies, processes. As shown in figure 1, one can group innovation in relation to the extent to which the product and / or production concept itself is changed, and whether the innovation involves a change in whether the various components are connected in a new way. This gives us two more models for innovation, "architectural innovation" and "modular innovation".
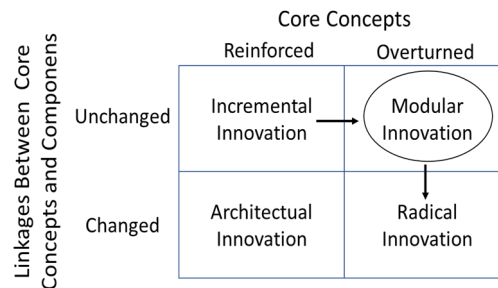

Fig. 1. Radical innovation through modularity [3]

Lack of resources, focus and / or knowledge can lead to a lack of innovation. By combining radical and incremental innovation in a systematic way, it will be possible to accumulate knowledge and product / process properties which means that, even in the improvement of an existing portfolio, the company's resources are purposefully utilized. However, there are few wide-spread, or rather no, good SME-adapted approaches, methodologies or practical solutions to achieve this. Therefore, there is a significant research need that is the starting point for Generation Y.

Recent innovation theory emphasizes interactive processes in which companies in most innovation activities interact and are dependent on actors in the organization's environment [4]. A key challenge, however, is to set these processes in a future, radical perspective, where known and traditional incremental techniques in e.g. Total Quality Management (TQM), Lean Product Development (LPD), Business Model Canvas [5], and others, must be set in a future perspective so that, for example, a re-design of a component and the accompanying process change (incremental Generation X innovation) takes into account that this can be used as an element (module) for the future Generation Y product/service/process. To succeed, one must work from a modular approach, but this is challenging if this is not the basis for Generation X and must be solved so that this work contributes. There are also great challenges in draw-

ing a clear picture of the future product and production concepts that, among other things, manage to capture e.g. technological change and sustainability issues.

2.2 Modularization – Enabler for Innovation

With a holistic approach, module-based development / innovation will relate to module-based products with associated module-based production. This is the basis for various forms of module-based knowledge. Modularization usually yields gains in connection with. time, cost, quality, but the flexibility in modularization can also lead to development races that take us away from where we want to be in terms of strategy and radical innovation [**Error! Reference source not found.**].

The concept descriptions for Generation Y must make it possible to think modularization and different time cycles for incremental innovation steps. Important premises for the module structure are service life, potential / risk of change in special technology, and user/market needs. This requires a form of innovation agenda and solutions that dynamically connect the opportunity space to Generation Y. In practice, this means having good processes and support systems to be able to develop the various elements (modules) of smart products and smart factories. A state-of-the-art study [7] from 2019 shows little link between modularization as a concept in the innovation literature and the more industry-oriented approaches, hence the focus is needed.

3 The Research Projects

This paper is based on the research in three Norwegian R&D 4-years projects co-funded by the Norwegian Research Council (NRC) in medium sized manufacturing companies, and one EU-funded H2020-project. A common denominator for the projects is the objective on improving product development and innovation capabilities. The projects emphasize how digitalization could enable process improvements and more fact-based decisions also at a strategic level.

RIT (NRC): 2018-2022, 3 industrial- and 3 R&D partners. The main objective is to develop a Design Dashboard where large data volumes are analyzed/presented together with other types of data according to product requirements in the leisure boat industry.

RADDIS (NRC): 2018-2022, 4 industrial- and 2 R&D partners. The main objective is the reduction of physical work using enabling technologies within visualization, product digital twins and simulation. The project also aims to find more proactive ways to deal with regulations within the leisure boat industry.

WRAPID (NRC): 2018-2022, 2 industrial- and 2 R&D partners. The main objective is to develop solutions for fact-based modularized product design for heavy machinery for agricultural and industrial applications.

LINCOLN (H2020): 2016-2019. 3 industrials and 13 R&D partners. The main objective was to develop three radical new boat/ship-concepts for aquaculture, coastal surveillance and search- and rescue operations.

4 Modular Innovation – The Conceptual Model

4.1 Challenges Experienced

For the projects' case-companies, the picture drawn in section 1 (introduction) describes the situation they experience. The companies feel pressures for change and innovations, but have challenges in prioritizing among projects, finding resources (financial, but also people, equipment etc.) for the bigger innovation projects.

It often looks like a kind of "muddling through" where projects are brought to the decision table often based on outside initiatives (equipment companies, or consultants) and not based on strategic processes/considerations. Another well-known challenge that the SMEs face is the problems of keeping continuity in their projects as the day-to-day activities and operations often must be prioritized, capturing key personnel and resources from the development and innovation activities.

In all four projects different approaches to improve the development and innovation processes have been introduced. Some of them includes different tools for a more fact- based processes, while we in other cases have put more focus on project models and checklists. However, a common imperative has been to find ways that enable a dynamic and adaptive approach to innovation linked to a long-term strategy or vision. In all the projects modularization in products, production and product development has been tested and to some extent implemented. The research activities have enlightened modularization as a key for a new approach to innovation.

4.2 Generation Y

As the companies improved their efforts towards modularization, the perspectives towards innovation became clearer and a more innovation-oriented modularization process was discussed and conceptualized as illustrated in Figure 2.

What we are heading for through the Generation Y-concept is to put innovation in a concrete industrial context and develop the practical approaches and solutions that increase the success rate. This involves moving from the theoretical models as described in Figure 1 into an innovation context where one is able to create the robust images of what it is desirable to realistically move towards, and which one is at the same time able to relate to on an ongoing basis. Findings from the projects has shown that this must be enabled without a rigid control system. Moving in this way from the theoretical innovation models to practical fact-based solutions that are also feasible is very demanding and we have only made initial attempts at this in our cases, but with great promising results.
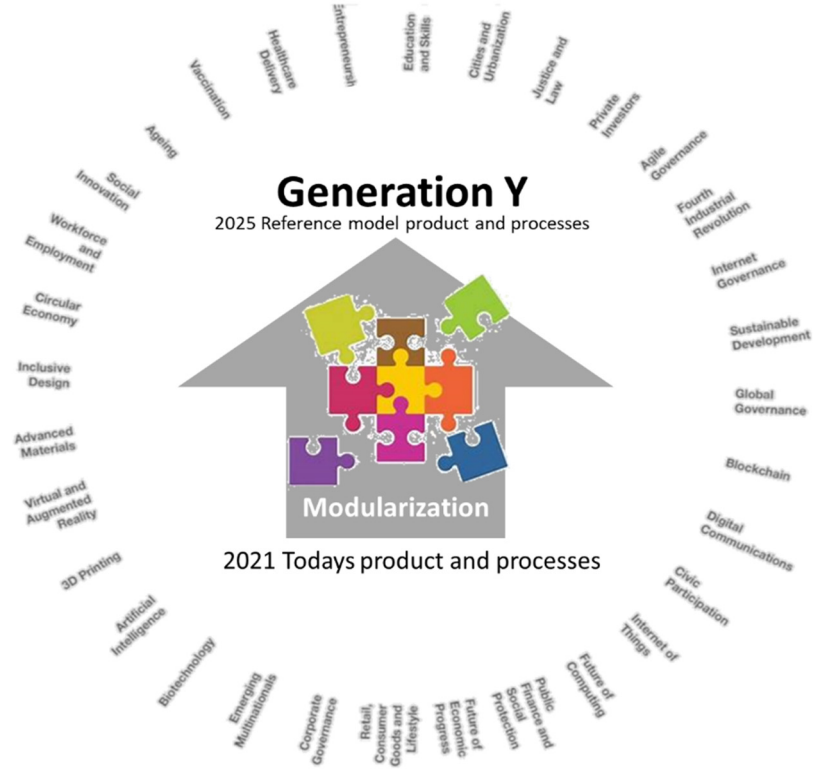
Fig. 2. Generation Y – A concept for modular innovation

Radical innovation is usually about new products, services, processes and systems based on a completely new technology that gives us a dramatic improvement. Drivers for radical innovations can also be from the needs and user side where there is experience and competence the manufacturer does not have – i.e. user-driven innovation [8]. Establishing concepts that are radical and robust in relation to the future is both demanding and risky as the future is largely unpredictable, (ref. Corona crisis 2020/2021). At the same time, the description/conceptualization of Generation Y, must be so specific that it is possible to manage the ongoing development activities accordingly. Consequently, there are challenges associated with processes and methods for establishing the radical product and production concepts. In the WRAPID project we emphasized the gathering of facts from the market department and sales forces especially on trends and customer expectations on what the future products could be like. This was then merged with the technology window defined through technology workshops.

After defining the reference Generation Y, an innovation agenda of which areas to be develop/focused in order to achieve Generation Y must be defined. In practice, this means having good processes and support systems to be able to develop a platform for sustainability, and the various elements (modules) of smart products and/or smart

factories. In the LINCOLN, RIT and RADDIS projects different systems for simulation and onboard data-gathering and transfer were used for different kinds of analytics in the product design to get a picture of to which extent our innovations were coming together towards Generation Y. A further focus on modularization in all cases did substantiate this process.

Generation Y must be sufficiently concrete and measurable so that we can follow development work in relation to them at all times. Innovation barometers [9] can be used, but these are of a general nature and as snapshots, for example in an industry. Good monitoring solutions for ongoing follow-up of innovation work in SMEs over time are to a small extent available, but some are available e.g. Balanced Scorecard (BSC), with a sharper focus on strategy and learning [10]. All four research projects focus on fact-based product design to make our decisions in product design as robust as possible. Especially, the RADDIS project aims to visualize and show a dynamic picture of our products and production through avatar solutions. In the roadmap towards Generation Y we also need to keep a close eye on critical measures for the products/concepts. These measures need to be as concrete and realistic as possible. The BEEM- methodology (Business Effects Evaluation Methodology) [11] is a such method defining objectives and measures, which was used in all use cases in our four projects. BEEM sets targets and enables measuring several dimensions: 1) product-/service – quality, 2) cost and profitability, 3) growth, 4) sustainability, 5) company specific. This makes it easier not only to establish a roadmap towards Generation Y, but also to see if we are following the right path.

5　　Conclusions

Modular Innovation as a theoretical approach makes sense as a way for companies to head for radical innovations, as incremental innovation in e.g. today's product portfolio can dramatically contribute towards the radical if done in a context. Modularity on product and processes has gained a lot of popularity, which we also have experienced through our research projects. Bringing modularity into the innovation-fields as in our Generation Y concept requires a lot more research to be holistic and provide complete tools for companies. In our research projects, we will continue to explore and exploit different elements of it. However, we already see that modular innovation works in practice. In this way, especially SMEs, could gain a lot through a more efficient use of resources, capabilities and knowledge. This gain could be both in economical terms, but also in speed and the actual innovations and competitive-ness coming out of these processes.

References

1. Accenture Hompepage, https://www.accenture.com/us-en/insights/industry-x-0/reinvention-of-industries, last accessed 2021/07/18.
2. The World Economic Forum Homepage, https://www.weforum.org/agenda/2020/07/most-innovative-companies-bcg-survey-apple-amazon-alphabet/, last accessed 2021/07/18.
3. Henderson, R.M. and Clark, K.B.: Architectural Innovation. In Tushman. M.L and Anderson, P. Managing Strategic Innovation and Change. Oxford University Press (2004).
4. Jensen, M.B., Johnson, B., Lorenz, E., Lundvall B.Å.: Forms of knowledge and modes of innovation. Research Policy, vol. 36, Issue 5, pp. 680-693. Elsevier (2007).
5. Osterwalder, A. and Pigneur, Y.: Business Model Generation. John Wiley and Sons Inc., Hoboken, New Jersey (2016).
6. Henriksen B., Røstad C.C.: Paths for Modularization. In: Grabot B., Vallespir B., Gomes S., Bouras A., Kiritsis D. (eds.) Advances in Production Management Systems. Innovative and Knowledge-Based Production Management in a Global-Local World. APMS 2014. IFIP Advances in Information and Communication Technology, vol 440, pp. 272-279. Springer, Berlin, Heidelberg. (2014).
7. Micheli, G.J.L., Trucco P., Sabri, Y., Mancini, M.: Modularization as a system life cycle management strategy: Drivers, barriers, mechanisms and impacts. International Journal of Engineering Business Management, vol. 11, pp. 1–23. (2019).
8. Hoholm, T. and Huse, M.: Brukerdrevet innovasjon i Norge. Magma no 5, (2008).
9. Cramo Homepage, https://www.innovasjonsbarometeret.no/. last accessed 2021/07/18.
10. Madsen, D.Ø. and Stenheim, T.: Balansert målstyring. Magma no 4, pp. 22-33. (2014).
11. Henriksen, B. and Røstad, C.C.: Evaluating and Prioritizing Projects – Setting Targets. The Business Effect Evaluation Methodology BEEM. International Journal of Managing Projects in Business, vol. 3, issue 2, pp. 275–291. Emerald Group Publishing Limited (2010).