How the Liberation of Human Talents can Leverage the Innovation Potential of Industrial Enterprises

A Human Centered Learning and Innovation Strategy for the Post-Modern Industry

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***Abstract*—Methodic Innovation is a methodology, consisting of a suite of methods based on open standards, that supports employees of an industrial enterprise individually or in teams to improve and innovate their work. They are given the freedom to redefine their job-role such that their work fits better with their talents. Employees are also encouraged to develop their own skills and knowledge further, in order to maximize their talents. This approach results in an organization that improves itself continuously. The methodic learning process is done in collaboration with schools and/or universities so that students receive 'on-the-job' training and teachers can provide courses for personnel. Models of existing and new (innovative) working practices or technological advances, which are made as part of the innovation processes, are generalized and made available to other innovation projects, as well as for education. The latter contributes to a dynamic school curriculum which is automatically updated with the latest scientific and industrial insights. Methodic Innovation is successfully applied in a pilot project involving 15 companies and 3 schools for higher education.**

Keywords: Continuous Improvement, Creative Learning, Explorative Learning, Continuous Innovation, Methodic Innovation, Sustainable Entrepreneurship, Cognition, Knowledge Management, Life long learning, Postmodern Organization.

I. INTRODUCTION

Whatever it is that makes an industrial enterprise competitive and successful, one thing is certain: as success will be copied by competitors, it is essential for market leaders to keep on moving.

In the 1970-ies, automation, robotization and information processing became important drivers for the improvement of industrial productivity. Not much later, western industrial enterprises learned about lean manufacturing, originally developed in Japan. These influential factors merged into the concept of Business Reengineering [1], with a focus on business processes aiming at increased productivity of the work force.

Although most industrial enterprises apply lean concepts today, BPR appeared to be insufficient. Faced with the competition from low wage countries, western companies were forced to focus on the unique qualities of their products, and thus on client value [2]. Only by offering the best value for money, these enterprises could survive.

This notion led to concepts such as 'mass- customization': the development and application of flexible and programmable production methods that combine the advantages of an 'economy of scale' with the added value of customized solutions. The offering of client-specific products requires contact between client and producer, so that the focus on value rather than costs helped several western enterprises to beat the competition from low wage countries. However, emerging economies such as China, India, Brazil, Russia and South-Africa have also fast growing internal markets. These markets will increasingly demand customized solutions.

Attention is shifting further towards the performance of products throughout their useful life. This asks for combinations of products and services, aiming at the reduction of total lifecycle costs and the increase of customer value through reliability, availability, flexibility and safety. They may actually lead to entirely new business propositions [3, 4].

While the time-to-market of new products must be as short as possible, the complexity of modern products is becoming an endangering factor for many enterprises. Systems Engineering (SE) is a methodical approach to master complexity, while Concurrent and Collaborative Engineering (CE, CCE) are possible organizational solutions.

Information Technology is a major enabler for business process improvement and business innovation. During the 1990-ies, focus shifted from information to knowledge along two different, and until now separate evolutionary lines. The first is the creation and management of externalized (human) knowledge, of which Nonaka's theory has received the most attention [5, 6]. The second is the expression of knowledge in terms of formal, computer interpretable form, such as knowledge engineering, artificial intelligence and, more recently, semantic technology, such as for the development of a semantic web [7].

None of the aforementioned developments replaces another. Today's enterprises require most – if not all – of them to stay ahead of competition. The biggest challenge is however the implementation of new practices, tools, methods, processes and organizational structures without disrupting regular business too much. Knowledge about new approaches is usually limited to experts that are hired as external business consultants. As changes are usually considered as incidents, the knowledge about change and change management is not part of the regular business structure.

Employees tend to resist change if they are forced to do so via a top-down approach. But, provided that they are given the support, the tools and the time, employees may actually be the best people to develop and implement new practices, processes and organizational structures. At the end, they are also the ones who have to execute these plans once these are ready.

People's talents tend to be under valuated in many industrial enterprises. For a part this may be attributed to the history of mass production, which emerged in a time when there was a shortage of well educated technicians. That problem was solved by separating 'white collar' work (i.e. the brains in the office) from 'blue collar' work (i.e. the hands on the production line). Although there is generally no shortage of skilled personnel today, this division is still prominent in most organizations. But people at the production line have brains too, and their practical insights may be of great value for the enterprise. Reversely, white collar workers may learn a lot from 'hands on' experience that cannot be learned from theory.

A second factor is education. Education takes the form of teaching, not learning. Teaching means that students have to accept what is being told to them; learning is based on exploration and experience. Students are trained for a profession, which they are supposed to do for the rest of their life. But modern society changes so rapidly that much of what they learn becomes rapidly obsolete. Professions die out while others emerge. Children have a natural talent for self-education through exploration. This is how they learn before they go to school. If this talent can be developed further, children may become more agile once they start working.

Hence, business innovation should not be limited to process change or organizational change from a top-down perspective; employees should have the opportunity to change too. They must be supported to explore their own capabilities and to exploit their talents. In stead of trying to fit people in predetermined functional boxes, employees should be encouraged to develop themselves as individuals when they move from role to role. This creates the perspective of a dynamic enterprise, lifted by a dynamic workforce.

A human (employee) centered approach may therefore be a serious alternative for current top-down oriented change strategies. The empowerment of employees to design and implement changes for improvement and innovation may also be a prerequisite for an enterprise to stay ahead of the fierce competition on global markets.

In Organization Theory, a distinction is made between Modern, Symbolic and Postmodern perspectives [9]. A modern perspective is object centered, i.e. the product plays a central role in the process. This is the predominant type of organization in industry today. In the symbolic perspective, the human being plays a central role. It can be found in, for example, management and sales training, where use is made of the principles of cognitive psychology. Postmodernism supposes the integration of both perspectives [10].

This paper describes the development of a Postmodern innovation strategy, called *Methodic Innovation*. It is the result of about 30 years of study and practical implementation of business reengineering, business reorganization, automation and education projects in several advanced enterprises in the Netherlands. The foundation AcadeMi-IO is initiated to guard the methodology.

In its current form, Methodic Innovation was first applied in three industrial sectors in the Netherlands: the food machine sector, the installation sector and the shipbuilding sector. Many enterprises that work in these sectors are global market leaders. For example: machine manufacturers for potato, cheese and poultry processing in the Netherlands have a global market share between 50 and 80% [11]. This strong position can be attributed to the high-tech nature of these machines, which is based on advanced mechanical, mechatronical, sensotronical and software technologies.

II. CREATION OF AN ENTREPRENEURIAL BUSINESS CULTURE

Success starts with people. An enterprise can only perform on world class level if all the talents of its human workforce are fully exploited.

A. Self-management

This means, first of all, that people get the freedom to think and act outside the functional box in which they were placed at the moment when they were hired. People must be enabled to develop their personal talents when they move from role to role in the organization. And, most importantly, they must be able to do this themselves. Self-management is therefore an essential skill. People can develop individually but also jointly with others in teams.

B. Learning

In order to increase individual and team performance, people must learn. A distinction is made between three levels of learning:

- First order learning is the classic way of learning at school, where students learn from books and from teachers, but not from practice. It based on instructions, guidelines and rules.
- Second order learning, or Creative Learning, is learning from hands-on experience. Students or employees in an enterprise are given the freedom to experiment with alternative solutions. The subject of study is the value chain in the enterprise (i.e. marketing, sales, design, development, production, support, etc.).
- Third order learning requires that people step out of their daily business. They take a helicopter view and/or

an introspective view. The subject of study is not the primary value chain but ones own functioning within the enterprise. This may be a form of self-reflection of the individual or of the team. Third order learning, also called Explorative Learning, aims at the redirection of ambition and goals, and the development of new skills or knowledge.

Second and especially third order learning are usually best accomplished by the most talented people. But every employee deserves the chance to explore new horizons. As first order learning is the most commonly applied approach in schools, it may happen that students that under perform there become out performers through second and third order learning.

C. *Empowerment*

Employees should get the time and means for second and third order learning. An enterprise could, for example, reserve one day per week, or one day per two weeks, in which employees are dispended from regular work so that they can rethink their work, develop new solutions, or take a course. This can be done individually as well as in teams. Teams may not be restricted to immediate colleagues, but may also be cross-disciplinary.

D. *From knowledge push to knowledge pull*

Methodic Innovation reverses the knowledge acquisition process. In current education, teachers tell students what they have to know. With Methodic Innovation the process reverses: students, employees and managers ask questions and search for answers. They may do this autonomously, with the help of modern information and knowledge technology, or supported by coaches or advisors.

The main advantage of knowledge pull is that the knowledge which is acquired is fit-for-purpose: it comes at the time when it is needed and in the form that is needed. In traditional education this is not the case: much of what is learned may never be used or be forgotten once it is needed. Knowledge pull does require, however, a global form of knowledge and the availability of 'knowledge navigation' tools.

III. A METHODICAL APPROACH USING OPEN STANDARDS

A. *Knowledge navigation tools*

For knowledge navigation, three basic tools have been developed: (a) a map, (b) a compass, and (c) a measuring device.

The map

The map is a generic model of an industrial enterprise. It identifies the main processes and job functions, such as: marketing, sales, design, engineering, planning, purchasing, work preparation, production, assembly, testing, servicing, and organizational support processes such as finance and control.

The compass

The compass gives eight directions for improvement; see figure 1c. These are logically derived from two orthogonal dimensions. The first one (figure 1a) makes a distinction between work (i.e. the primary business process which normally results in products), improvement of work performance, and innovation. These three levels correspond more or less with 1st, 2nd and 3rd order learning.

The second dimension (figure 1b) makes a distinction between acting, learning and thinking.

Figure 1c shows the result, where the human individual is placed in the middle. On the right hand side a distinction is made between product, information and knowledge. Product is that what a company sells; this may include services. Information and knowledge may be about the product but also on other topics identified by the compass. On the left hand side a distinction is made between the primary process, such as design and production, process control, and finally the transition from one state of the organization or human individual to another state. The central vertical column is about learning and memorizing; this can be team learning and team memorizing respectively, but also individual learning and individual memorizing. Memory (i.e. the recording and retrieval of experiences or findings) plays an important role in learning.

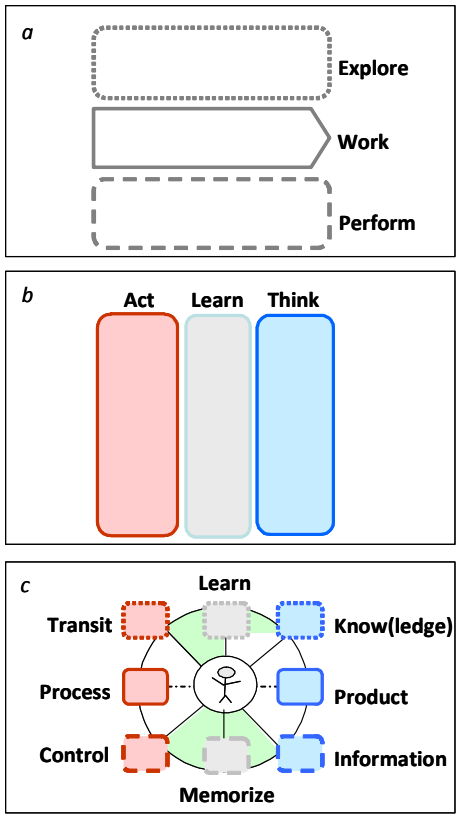

Figure 1. The two dimensions that form the compass.

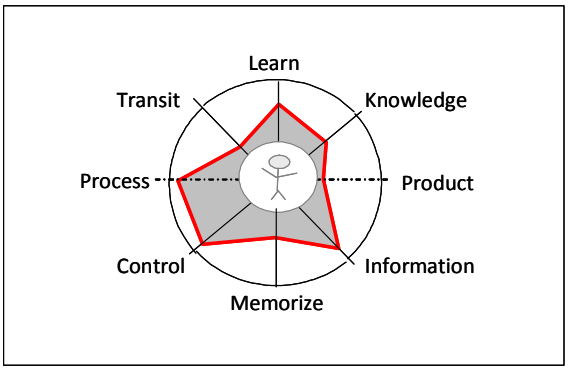

Figure 2. The measuring device values strengths and weaknesses in each direction of the compass.

The measuring device

The measuring device makes it possible to value an individual employee, a team, an enterprise or a value chain (such as a supply chain) on any of the eight directions of the compass. This is done through a list of questions. The answers provide a reasonably objective indication of the performance of the subject being questioned.

Once the questionnaire is filled in, the measuring device provides a 'radar diagram' showing the strengths and weaknesses of an organization; see figure 2.

The approach followed is derived from the CMMI standard (CMMI: Capability Maturity Model Integration) which is developed for the management of process improvement [12]. This concept is extended by AcadeMi-IO for other directions in the compass.

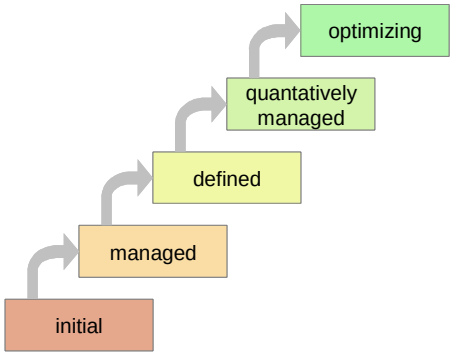

Figure 3. The CMMI model distinguishes five capability maturity levels.

B. *Methods*

For each of the directions in the compass, methods are used that enable employees to describe the current state and a desired future state in the form of models. Hence, there are methods that support the modeling of knowledge, products, information, memory, controls, processes, transitions and learning. The models facilitate people in the organization to discuss the current situation and the desired future situation.

Figure 3 gives a simple example of a product configuration structure, for which the 'hamburger-technique' is being used [13].

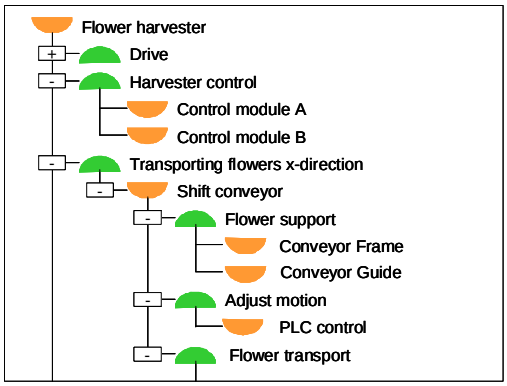

Figure 4. A portion of the product configuration structure of a flower harvester.

For the direction 'Learn' in the compass, use is made of Nonaka's SECI method (SECI = Socialize, Externalize, Combine, Internalize) [6]. A more advanced method, which makes use of knowledge acquisition using computer technologies, such as Computer Aided Design, is Cognitive Product Development [14].

C. *Dictionaries and ontologies*

A problem that frequently occurs in organizations is the inconsistent and different use of terminology. Different disciplines within the organization may use different terms for the same concept, and the same term may have different meanings. One of the tasks that has to be done is the development of a common dictionary or thesaurus. In order to make life easier, AcadeMi-IO developed a generic template, i.e. a standard dictionary that can be adopted as a basis by enterprises.

Concepts that are part of the formal domain of the methodology, such as the terms used for the eight dimensions in the compass, become part of an ontology, which is currently in development.

D. *Open standards*

The entire methodology is, as far as possible, based on widely accepted and generally official standards. A prerequisite is that these standards are open so that they can be extended if necessary.

E. *Simulation and gaming*

Where the user of the methodology is provided first of all with simple to learn and easy to use methods, more advanced techniques may also become in reach, such as formal and semi-formal methods. The big advantage of using these for the description of various aspects of an enterprise is that the gap between the language on the work floor and the languages used for Information Technology will gradually disappear. A formal description of a business process, such as using BPMN (Business Process Modeling Notation) may provide a basis for a model in BPEL (Business Process Execution Language). This makes it possible to simulate and execute new working practices in a virtual environment, or to develop new work flow management applications. In general, for many practices,

simulation and gaming may be options for the training of personnel in new working environments.

F. *Accessibility for small and medium sized enterprises.*

On a short term, Methodic Innovation is implemented by appointing in each firm a person who is 'Innovation Director'. This can be a full-time job for large companies, or a part-time activity for small ones. As the navigation material, including the map, the compass and the measuring device, forms the core of the methodology, a reasonably short training can be sufficient. If more information is needed, the Innovation Director can access this via a web application. If necessary, additional courses can be followed.

This approach shows how the navigation method of Methodic Innovation reverses the learning process from knowledge push to knowledge pull.

IV. CLOSED LOOP COOPERATION WITH EDUCATION

The methodology is applied through a collaboration of industry with educational organizations. Educational institutes and schools provide the courses and trainings to industrial personnel. Reversely, industrial enterprises offer students the possibility to learn 'on the job'. In innovation projects, which may be organized as joint efforts of industry with education, students, such as apprentices, do much of the analysis and modeling work. The MI methods provide an excellent medium for students to understand how enterprises work today. The models are shown to personnel and form a basis for discussions about improvement. In addition, the web site of AcadeMi-IO contains many examples of business best practices for specific tasks such as sales, engineering, purchasing, logistics, manufacturing and servicing. These example models plus results from scientific research may be inspiring for further discussions and, finally, the development of a 'to be' model of a preferred new working practice or the improvement of a machine. The methodology provides also suggestions for the required transition process between current and future practice.

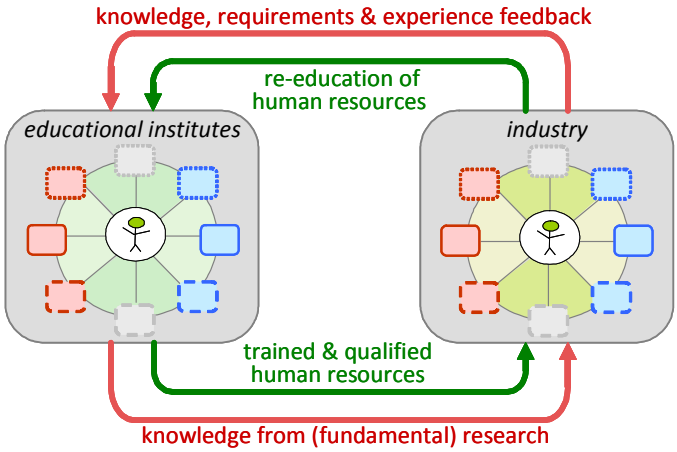

Figure 5. Closed loop interaction between industry and educational organizations (schools, universities).

The 'to be' models of new practices or new technologies are generalized and made anonymous, after which they can be added to the library of best practices. They become then available for innovation projects in other companies. The library becomes thus a 'living system' of advanced business practices in industry. By sharing this knowledge, an industrial sector as a whole can accelerate its innovation potential.

The 'as is' and 'to be' models are of course also available for the educational bodies, such as schools. They become then base material of the curriculum of these schools. Likewise, the methodology contributes to a 'living curriculum' that is continuously updated with the latest insights in industry and science.

Through this collaboration, Methodic Innovation will turn into a standard part of a school curriculum. It enables schools to work with up-to-date, state-of-the-art models of industrial practices. Equipped with this knowledge and the experiences gained through on-the-job training, the value of students for industry will increase considerably.

Figure 5 depicts the resulting closed loop interaction between industry and education. One loop concerns human resources (green), the second knowledge sharing and exchange (red).

V. CASE STUDIES

Methodic Innovation is the result of many years of applied research, done in the context of business or education reorganization projects. The methodology in its current form is applied and tested in three recent projects.

A. *Inquiry amongst 29 manufacturers.*

In 2008, 29 manufacturers of machines for the production, processing, packaging and distribution of food, were invited to do the capability maturity check using the map, the compass and the measuring device. In reaction to the questionnaire they were asked which areas require urgent improvement. The result, which is shown in figure 6, is quite remarkable. Of the topics that were given 1st and 2nd priority, just 17% fall in the left hand side of the compass (Act). The entrepreneurs think that their operational processes and control functions are satisfactory. Only the long term ambitions and the ability to change (transit) are important.

No less than 73% of the scores fall in the right hand side of the compass (the blue column), and deal with knowledge explicitation and reuse, knowledge of the client, product complexity (such as modularity, flexibility of design, standardization, fitness for production and servicing), information sharing and information accessibility.

The low score of learning may be attributed to the association with 1st order learning at school. It is not yet clear to most entrepreneurs that learning may also be creative and explorative, and be an enabler for business innovation.

		1st priority	2nd priority	Total	
Act	Transit	6	0	**6**	
	Process	1	2	**3**	**17%**
	Control	1	0	**1**	
Learn	Learn	1	1	**2**	
	Memorize	1	3	**4**	**10%**
Think	(Know)ledge	11	6	**17**	
	Product / Result	6	7	**13**	**73%**
	Information	2	10	**12**	

Figure 6. Inquiry about the priorities for improvement amd innovation amongst 29 manufacturres of machines for the food sector.

B. Methodic Innovation programme for the food chain

After this inquiry, a major programme for Methodic Innovation started with 15 manufacturers and 3 schools for higher professional education, called 'Creating better food, sustainable innovation in the food chain'. As a project it ran between 2008 and 2011, but it will be continued by the participants on individual basis.

The results can be split into those on company level and those on chain level [16].

The main results on company level are:

- Innovation talents of employees have increased through team learning, through explicit and reusable knowledge, and through the new skills of self-management and self-learning (explorative and creative learning).
- Functional thinking improves client- and environment-oriented design. Companies report higher success rates of scoring orders of up to 30%.
- Modular design and standardization of modules make a design and consecutive processes such as procurement, manufacturing and servicing, simple and more economical. Companies report total cost savings of up to 40% and a substantial reduction of errors.
- Less resistance to change, higher motivation of employees.
- The quality of work and organization increases as the work becomes debatable through the models, and employees have room for self-regulation. This reduces stress and stimulates a climate for co-operation.
- Business management discovers that not the school but the enterprise is responsible for life-long learning of employees.

The main results on chain level are:

- The use and sector-wide development of a single innovation language encourages knowledge sharing.
- A universal learning strategy stimulates co-creation.
- The combination of theory and practice increases the utilitarian value of knowledge.
- Teachers get motivated to coach industrial employees. Reversely, they also learn from them.
- Schools discover that knowledge reuse and client-orientation are also valuable concepts for education.
- The common memory of innovative knowledge (in the form of shared models) for industry and education increases. The sharing of knowledge between schools for the regular updating of curricula reduces costs, which is estimated at 20%.
- Knowledge and skills of students fit better with the needs of industry.

C. Revival Technical Education

An earlier project for schools at lower and medium levels (RTO – Revival Technical Education), in which no industrial companies were involved, showed that Methodic Innovation is highly appreciated by students. It makes learning fun. The number of drop-outs decreased to almost zero, and the number of students that chose for a follow-up course at higher education level increased significantly [17, 19].

VI. CONCLUSIONS

Methodic Innovation is the final result of 30 years of business experience and applied research. During the early years, the authors discovered that the efficiency and effectiveness of enterprises could be improved significantly by using new methods for systems engineering, product and process modeling, knowledge management, and several more. However, the uptake by industry was slow and cumbersome. It became gradually clear that this was largely caused by the top-down approach used for business reorganizations, which causes resistance at the work floor. The awareness grew that knowledge about these methods, and the responsibility to improve and innovate a business, should be given to employees. In the context of business transition, employees should also be given the opportunity to develop new job roles for themselves, so that they can explore and exploit their own talents. Companies can grow only if their employees grow too. For employees, this requires a new mindset and new skills. The necessary transition is therefore only possible through a close collaboration between industry and education. Three recent projects have demonstrated that this human-centered approach really works. It increases the innovation potential of enterprises, even of small and medium sized enterprises, and accelerates the speed of innovation.

More specific conclusions are:

- The instruments developed for Methodic Innovation enable people to rethink and redefine their own job role in a team context, so that their knowledge and skills are fully exploited. This is a fundamental change compared with old thinking, where people are supposed to fulfill a predetermined job role. The latter may lead to mismatches between job role and people's talent, and thus to under-utilization.

- The empowerment of people and teams leads to new work divisions.
- Human thinking shifts from what (i.e. to do what a boss tells you to do) to why (i.e. to keep an eye on client needs and the societal/environmental consequences of ones work). The latter concept is also known as mindfulness.
- Human competences to act are extended with competences to learn from experience (i.e. the development of cognitive competences)
- Consequently, enterprises become places where people learn. They provide learning-on-the-job facilities for schools, but they facilitate also life-long-learning.
- Business reorganizations and cultural changes will only be successful if they provide new opportunities for employees.
- People were educated in the past to fulfill a mono-disciplinary role in society. Their new freedom to learn continuously and to redefine their own role results in trans-disciplinary experts: people who combine the knowledge and skills of several disciplines and are able to bridge gaps between these disciplines.
- Open standards are necessary to facilitate communication. They enable knowledge reuse and make enterprises more flexible, efficient and effective.
- Methodic Innovation can be applied in companies of any size. It is therefore also suited for small and medium sized companies.

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