



WHITEPAPER

PROCESS MANAGEMENT 4.0 ENGINEERING SUCCESS

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Developing products for an increasingly complex world certainly challenges or even exceeds engineering capabilities. There are many factors impacting complexity such as connectivity, security, safety, product variants, development velocity, reliability and quality. It can be argued that a major driver to better manage this complexity is the engineering paradigm of Industry 4.0. To succeed in this new age, engineers must look for solutions to adapt engineering to a more dynamic world. This whitepaper introduces a solution to address the engineering challenges of the modern-day industrial revolution.

THE INDUSTRY 4.0 PARADIGM

Industry 4.0 facilitates the vision and execution of a “Smart Factory” (See figure 1). Within the modular structured Smart Factories of **Industry 4.0**, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real time, and via the Internet of Services, both internal and cross-organizational services are offered and utilized by participants of the value chain.

Characteristics of Industry 4.0 include:

- ▶ serves more complex (production) processes
- ▶ flexible and responsive
- ▶ decentralized and adjustable

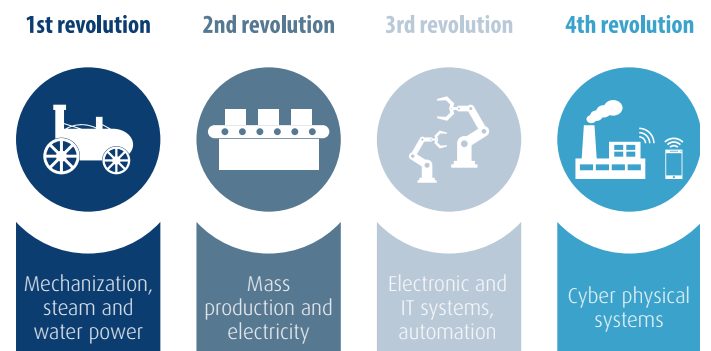


Figure 1: The evolution to industry 4.0

How should an organization prepare for **Industry 4.0**? What should be changed to prepare for this paradigm will vary significantly by company or product. How change is managed is much more critical, to guide the organization, this new paradigm calls for flexibility and agility and has little tolerance for waste.



ENGINEERING CHANGE

Engineers typically embrace the opportunity to learn and adapt. However, engineers and teams alone face diminishing returns, organizations must learn to change, to be responsive, faster and more agile.

Agile principles such as those originally outlined in the agile manifesto have long been popular. In recent years, frameworks such as Disciplined Agile and Scaled Agile have emerged to help expand the benefits of agility beyond a single team.

Such frameworks can be valuable tools to create the cohesive structures for organizational change. However, the basis for change must be the business needs or the business goals, the organization then needs the ability to set direction, steer and deploy resources effectively and efficiently.

Product development can only succeed in the **Industry 4.0** paradigm by building a learning organization. In many organizations, this means addressing fundamental factors required to enable the organization to change and learn. Building a learning organization requires engineering management foresight to reset inefficient practices and deploy resources more systematically.

Indicators of organizations with a low ability to learn include excessive rework and low engineering efficiency leading to overruns and recalls as engineers maybe stuck firefighting. This may also result in low employee satisfaction and retention leading to knowledge drain.

The notion of learning organizations is not new; the concept was coined through the work and research of Peter Senge 1990:

A learning organization is the business term given to a company that facilitates the learning of its members and continuously transforms itself. Learning organizations develop as a result of the pressures facing modern organizations and enables them to remain competitive in the business environment.

According to Senge the typical benefits of a learning organization might include:

- ▶ Maintaining levels of innovation and remaining competitive
- ▶ Being better placed to respond to external pressures
- ▶ Having the knowledge to better link resources to customer needs
- ▶ Improving quality of outputs at all levels
- ▶ Improving corporate image by becoming more people oriented
- ▶ Increasing the pace of change within the organization

Extending this concept into engineering will help us to better manage the challenges of Industry 4.0.

EFFECTIVE PROCESS MANAGEMENT

Good process management is the foundation of establishing a learning organization in a complex engineering environment. Without it organizations maybe chaotic, dependent on heroes, and caught reinventing the wheel on each project; this introduces waste, redundancy and risk.

Performing process audits and assessments around the globe in over 700 engineering organizations Method Park has witnessed many examples of best and less effective practice. Organizations which invest in process management to support their business have a higher chance of success.

Industry 4.0 processes differ from regular business processes with context and depth of understanding required. When deployed processes for **Industry 4.0** are usually unique, due to factors which impact their use such as compliance, safety or risk levels, product lines, departments or customers. Many tools for business process management are insufficient to capture, manage and communicate these engineering processes due to differing requirements; business processes are often repeatable, require less context and depth of understanding. This means that organizations resort to using applications like Microsoft PowerPoint, Word, Excel and Visio. These tools have significant limitations for process capture;



creating clear, consistent and understandable processes is extremely challenging (See figure 2). Dependencies which exist within and between documents are impossible to manage, in addition thousands of man hours are invested to draw and communicate processes.



Figure 2: disconnected process assets

The process consumer is then challenged with processes which are disconnected, incomplete and inconsistent. Significant time and effort is required to sort through the mountains of documents and understand what needs to be performed in the context of the business unit, program, project, product line or customer. As a result, Method Park has often seen processes which are theoretical, vary in granularity, outdated and do not allow tailoring. These factors increase the chances that processes are not accepted, followed or improved.

However, there is a way out: digitalization of the quality management system by putting processes into a database provides engineering organizations with a platform to manage the flexible and decentralized complex processes required to succeed in **Industry 4.0**. Method Park developed the web-based process management software **Stages**[®] (see figure 3) to meet these challenges. In a modular and extendable way Stages provides the right context for the end user, generating different perspectives to support and enhance understanding. Capturing the process landscape in a database ensures interfaces are managed and processes are consistent. Only in this way we can make processes usable, focus on process content and learning instead of management and capture.

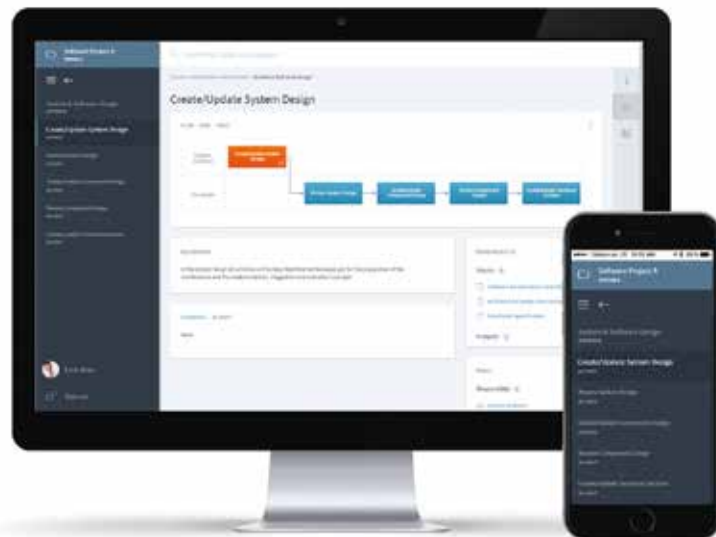


Figure 3: The Stages process management software by Method Park

Effective process management supports the learning organization to:

- ▶ Enable organizational development according to changing business objectives
- ▶ Meet business objectives in a managed and repeatable way
- ▶ Manage repeatable experience by definition of processes
- ▶ Establish measurable process improvement following the changing business objectives

THE METHODOLOGY

All too often process investments and improvement projects in large engineering organizations are made without a clear methodology, the result is compounded waste and failure. Method Park has witnessed many examples of documentation of processes which do not support understanding or use, excludes tools and how to use them. Typical statements often heard which indicate ineffective process management and a weak learning organization:



“Without a running product, we can’t care about the processes.”
Project Manager

“We do not need processes, we have tools.”
Engineering Manager

“We have to harmonize processes before we can release them.”
Process Responsible

“We just care about the processes, we do not deal with the project work.” EPG Lead

These experiences over 15 years led Method Park to develop a methodology to support engineering organizational change and learning. Rather than following a hit and miss approach, our goal has been to capture the lessons of effective process management and help engineering organizations to compete in the **Industry 4.0** age.


Process Management 4.0 is the methodology which allows organizations to specify and manage processes for building and using Internet of Things for development and production purposes. It supports on the fly created value chain approaches and business models.

Benefits of Process Management 4.0

- ▶ serves more complex processes (in development and production)
- ▶ is flexible and responsive (in design and execution)
- ▶ is decentralized and adjustable (in definition and responsibility)


The methodology can be broken down into five practical steps. At each step, there are choices to understand and integrate the right approach or techniques based on the business context.

1) Define Goals

 Change should be guided by the business goals. When goals are identified and traced to projects and activities they can steer the organization. In this way, we can help ensure the efficient and effective use of resources. Traceability of objectives and goals to actions helps to focus the organization and can resolve difficult discussions and reduce waste. We recommend the use of approaches such as Goal-Question-Metric approach such as those from Basili Rombach as effective tools.

Many organizations define their process improvement goals from what they are forced to do by their customers, OEMs, or the regulators. This leads to goals like “We have to meet Automotive SPICE level 3 until the end of the year” which almost never has any sustained value for the organization, because all the efforts are targeted towards reaching the level and all process efforts are abandoned after the appraisal. The real business goals are determined by asking “Why?” until you find the real goal. In most organizations we worked with, that were targeting a certain level, asking the “Why?” question lead us to goals like “We would like to win at least 10 new clients because we want to grow by 25% in revenue”. This can then be broken down into sub-goals to make the organization more efficient, e.g. by automation, to be able to scale up their business, and to define and document lean processes to allow the organization to grow 20% in engineering personnel. This brought real value to the organization, the improvements were sustained and institutionalized, and meeting the required Automotive SPICE level was a mere side-effect.


2) Analyze Process Capability

 Understanding capability might be established through assessment or audit based on capability frameworks such as SPICE or CMMI. We may also pull together contextual information such as the tools in use, history and structure of the organization. With a transparent and realistic assessment of the current state of engineering we can start to build a road map. This way we ensure the right fires are extinguished in the right order.



Examples for such capability determinations are either a semi-formal gap-analysis against a subset of Automotive SPICE (e.g. SWE.1 Software Requirements Analysis, MAN.3 Project Management, and SUP.8: Configuration Management), or a lightweight SCAMPI C appraisal against the CMMI-DEV level 2 process areas. Both methods only take a few hours of effort, if they are conducted by experienced assessors or appraisers.

3) Define Business Process Management (BPM) Organization

 Now we have a clear understanding of our business we can identify the process architectures that will be required in our organization to support the business. Understanding the different types of architectures is critical, as in our experience there is not a best but the right architecture for your organization. Defining clear architectures at this point we can reduce the risk of rework in the future.

Ensuring the right stakeholders are involved is a critical factor, change will only happen when engineers see value, own and accept the process. This requires that the process management organization is setup correctly with a mixture of support roles and practitioners. Many organizations do not build clear roles and responsibilities in the process management organization, examples of a BPM structure is outlined in Figure 4. Things to consider in building effective process governance include:

- ▶ Process Architecture
- ▶ Process Management Team
- ▶ Process Management Program
- ▶ Process Management Toolset
- ▶ Modelling Guideline

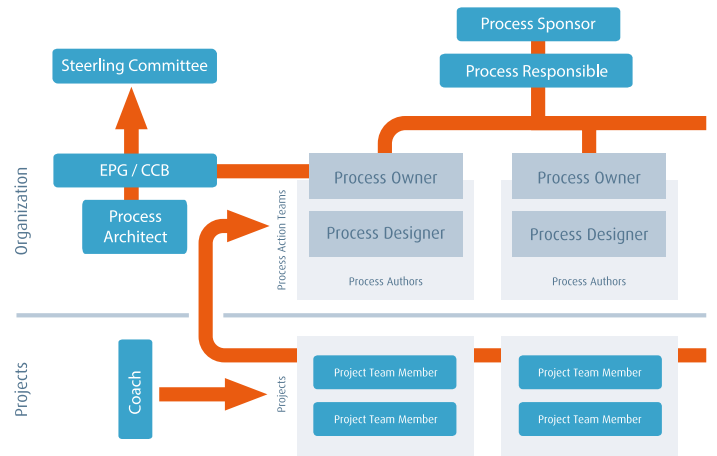



Figure 4: Example BPM organization

4) Model Processes

 Process definition must be managed to ensure consistency; we need clear process governance. This includes defining terminology, guidelines and the landscape based on the outlined architecture. Guidelines will help to address variations in granularity and approaches used in the definition. An example of a guideline taken from the Process Management 4.0 methodology:

“ER 3.4 Granularity of Roles Define as few roles as possible. Splitting or merging of roles shall be done considering the skill sets.”


The methodology provides an extensive library of best practices guidelines. These approaches will have a large impact on the outcomes, they will shape the landscape for learning. For example; should work products or activities be captured first or should reviews be explicitly defined? The process modelling will be an iterative process repeated per process area. It should be noted processes must not be 100% complete, shorter release cycles are recommended where feedback is integrated quickly. This type of approach versus a big bang approach will help to overcome resistance to change, forge a culture of learning.

From our experience, a good approach is to focus on modeling the value chain processes first and leave management and supporting processes on the side for the first few iterations. The value chain can best be determined by looking at the organiza-



tion's product lifecycle, or following the technical system engineering processes from chapter 6.4 of ISO 15288 ("Systems and software engineering -- System life cycle processes").

5) Establish Learning Organization

 In order to learn it is necessary to build measurements into the organization which are traced back to business goals. Principles should be established such as no process should exist without feedback, no process without the evacuation of measurements, allow changes & improvement all the time.

One of the most successful organizations applying our methodology processed and incorporated over 1.000 feedback items from its engineers within a single year. This way, the process participants felt empowered to influence the way they work, which resulted in a very high process acceptance and institutionalization.

Establishing a learning organization is a process but also a cultural change. Processes capture the knowledge and experience of an organization. Therefore, processes will always change, because our knowledge and experience grows every day.

Usually you start to do intuitive engineering of new products in order to be creative. Whenever you have been successful in engineering you try to repeat that approach for future development, i.e. you gained experience based on the knowledge you used. In order to repeat your success, you write down what you have done. This written down experience is called a process.




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SUMMARY

In a dynamic engineering environment organizations need the ability to respond to change. Change is a process and a culture of learning which steers the organization. This process enables people to function together, to develop and grow. Building a learning organization is about creating the structures to enable people to change together.

 People don't resist change. They resist being changed! **Peter Senge**

The foundation of transformation is effective process management coupled with a systematic approach to change focused on the business goals. In this way engineering organizations can learn to adapt to the needs of **Industry 4.0** to be flexible and responsive, decentralized and adjustable.



About Method Park

For many years Method Park has successfully offered consulting in questions of software for safety-critical systems in the automotive industry and in the medical technology area, for which the company develops its own software solutions. Method Park brings extensive know-how to fields with high and extremely high safety requirements. With this knowledge Method Park offers its customers a variety of solutions from a single source that contribute to the success of each company. Method Park is the competent partner for consulting, coaching, training, engineering services and products for all questions of software development processes. The “Stages” web-based process management tool developed by Method Park supports users with the practical implementation of development processes. Stages ensures the realization of predefined quality standards and process models and can be integrated in all common development environments. Furthermore, Stages enables the global distribution of development tasks beyond corporate boundaries. Founded in Erlangen in 2001, Method Park employs around 170 persons at sites in Erlangen, Munich, Stuttgart, Hannover and Frankfurt/Main, as well as in Detroit, Miami and Pittsburgh in the USA.

Take a training and learn more about the methodology described in this whitepaper:

Process Management 4.0 – Best Practices

Courses are available at our training center methodpark.com/training



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