

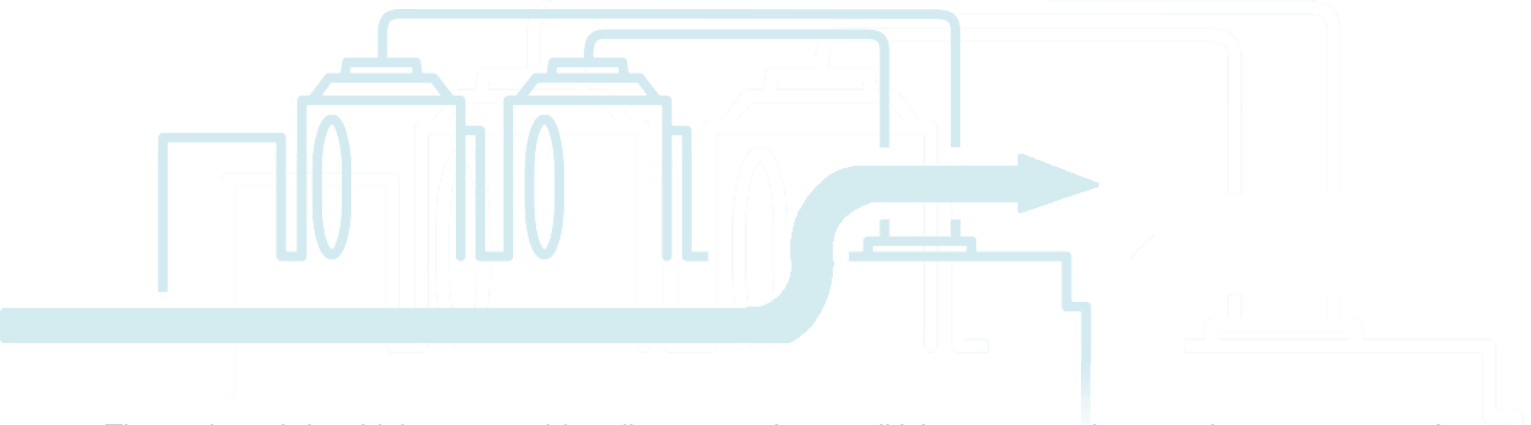


White Paper

Digital Maturity of Production Processes

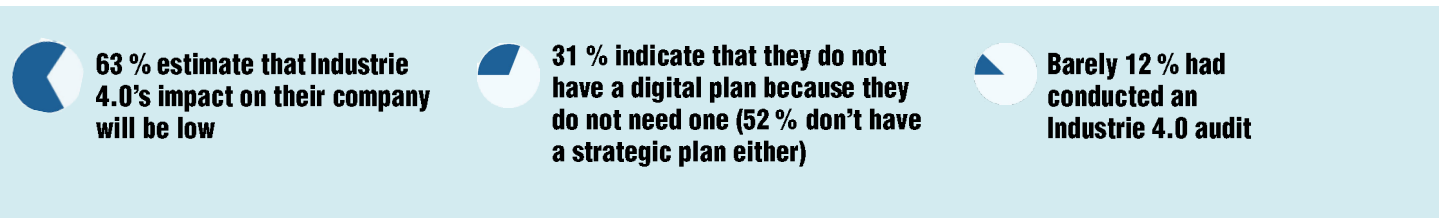
Industrie 4.0 — www.efficientplant.com/services
Bernard Boire, M.Sc.A., FIC





These days, it is widely accepted by all — executives, politicians, researchers — that our economy’s long-term competitiveness depends on its flexibility, agility and ability to quickly adapt to a constantly-changing world. Similarly, we all recognize the enormous opportunities made possible through the digitization of production processes, their interconnectivity and cutting-edge technologies. These various elements combine to create new business models, the sustainable and efficient use of limited resources, and the low-cost production of highly customized products. This combination of elements is known as “Industrie 4.0”.

And yet, Quebec’s manufacturing SMEs are still ill-equipped to profit from this full potential:



According to a [survey](#) of 401 heads of Quebec manufacturing SMEs, conducted in 2019 by Léger for the Ministère de l’Economie et de l’Innovation.

An astounding situation, especially considering the province’s poor performance in terms of [productivity growth](#):

En conséquence d’une croissance particulièrement faible de sa productivité pendant près de 40 ans, le Québec affichait en 2019 l’un des plus faibles niveaux de productivité du travail parmi les 30 économies analysées (Graphique 9). Avec une productivité du travail de 64,67 \$CA/h, le Québec ne devançait que la Corée du Sud, la Nouvelle-Zélande, le Japon, le Manitoba et les trois provinces maritimes. Et en comparaison, la productivité du travail moyenne au sein du groupe OCDE20 était 30 % plus élevée qu’ici. C’est donc dire que ces pays dégageaient en moyenne tout près de 20,00 \$CA de plus que le Québec pour chaque heure travaillée. Face à un tel écart, on ne peut se surprendre que la province peine à suivre la cadence des autres pays.

GRAPHIQUE 9
PRODUCTIVITÉ DU TRAVAIL EN 2019
PIB par heure travaillée en dollars canadiens à parité des pouvoirs d’achat



« Productivité et prospérité au Québec— Bilan 2020 », Centre sur la productivité et la prospérité

Translation: “As a result of particularly low productivity growth for nearly 40 years, Quebec had one of the lowest levels of labour productivity among the 30 economies analyzed in 2019 (Chart 9). With a labour productivity of C\$64.67/hr, Quebec was ahead of only South Korea, New Zealand, Japan, Manitoba and the three Maritime provinces. And, in comparison, the average labour productivity in the OECD20 group was 30% higher than here. This means that these countries were earning on average almost C\$20.00 more than Quebec for each hour worked. Given this gap, it is not surprising that the province is struggling to keep pace with other countries.” **LABOUR PRODUCTIVITY IN 2019 : GDP per hour worked in Canadian dollars at purchasing power parity.**

It goes without saying that our SMEs must greatly speed up their ‘digital transformation’. The purpose of this document is to present our approach to diagnosing the digital maturity of production processes, and how to derive a comprehensive digital plan leading to a high level of 4.0 maturity.

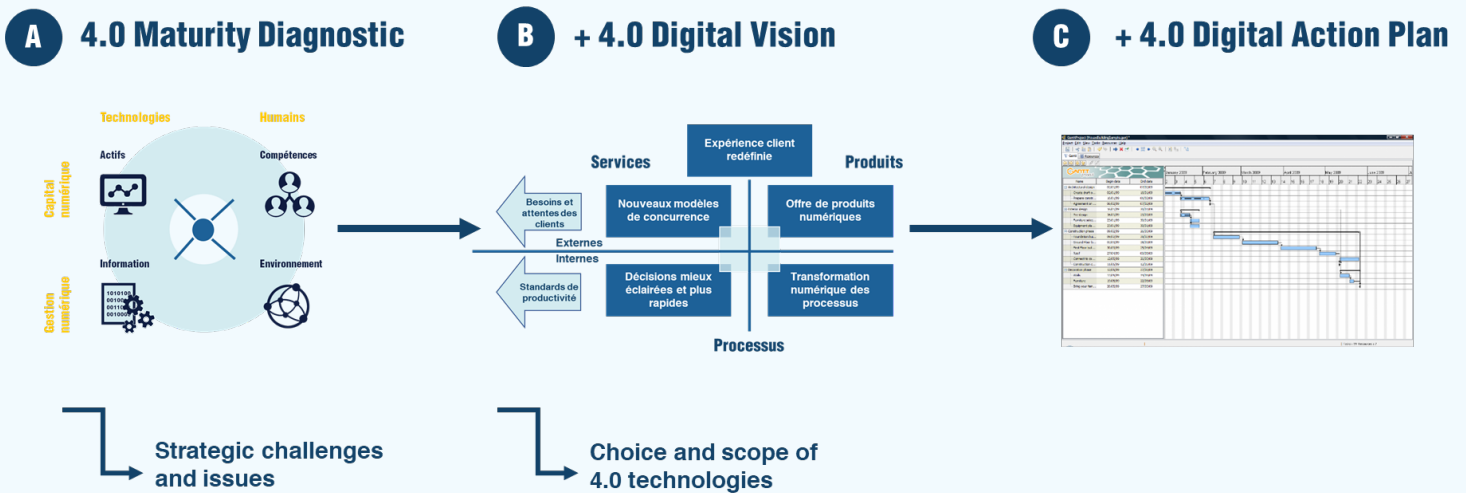
Undertaking your 4.0 Digital Transformation

Making a success of your 4.0 digital transformation involves more than just installing two or three software programs, and one or two automated machines. We're talking about a complete transformation of your company, its ways of doing things, of managing. This requires an extensive willingness to change. Fundamentally, 4.0 technologies provide access to a vast array of data (more and better-quality data, in real time), as well as giving providing the ability to take advantage of these data to learn and take better decisions, support the continuous improvement of your processes and help you to quickly and nimbly adapt to changing conditions.

To achieve this it is crucial to go about it the right way, carefully planning how to proceed. And given its wide scope, a "4.0 Digital Plan" is essentially a strategic process.

Moreover, one of its first steps would be to align with a strategic plan, in itself a challenge considering that half of SMEs don't have such a plan. There needs to at least be consideration given to your broad strategic guidelines, the sought-after positioning and the value proposition.

As for any strategic management process, there are three broad steps to devising a **digital plan**: a diagnosis, a vision, and an action plan.



The **diagnosis** consists of gaining an overview of the current level of maturity of the processes in place.

The **vision** consists in choosing the digital value levers which will support the company's strategy, then target the priority technologies.

Finally, the **action plan** will program the activation of the vision.



The purpose of a digital plan is to allow a company to improve its 4.0 maturity.

In accordance with many authors and researchers, we have selected 6 levels of maturity, which we describe in detail here:

	Level	Viewpoint	Focus	Data
N1	Artisanal/ Differed	What is happening	Some tasks supported by digital processing; repetitive tasks automated	Manual, partial, ad hoc, raw
N2	Descriptive/ Static	What has happened	Architecture Structured systems and integration	Historical, structured
N3	Diagnostic/ Reactive	Why it happened	Advanced analysis and data-based decisions	Correlated, contextualized
N4	Predictive/ Anticipatory	What could happen	Partial digital modelling; anticipated future based on understanding of processes	Simulated
N5	Prescriptive/ Decisional	What should happen	Optimized decisions based on simulations; Complete digital twin	Optimized
N6	Adaptive/ Proactive	What is happening adaptively	Independent reactions to self-monitored conditions and systems	Autonomously retroactive

4.0 Digital Maturity

		1.	2. Descriptive/Static	3. Diagnostic/Reactive	4. Predictive/Anticipatory	5. Prescriptive/Decision-making	6. Adaptive/Proactive
4.0 EVOLUTION	Transaction 3.0		A. Visibility Surveillance / Control	B. Comprehension Transparency / Analysis	C. Anticipation Predictability	D. Prescription Optimization	E. Feedback Self-control
			Real-time data	Information	Knowledge	Optimal decisions	Autonomous actions
4.0 EVOLUTION			Dashboards Observe what is going on Measurements, signals, alerts	Mega data/Analytics Understand why it happens Interactive, explanatory graphics; real-time display; reports	Data sciences (ML+DL) Predict what will happen Predictive model, pattern recognition, simulations, sensitivity analysis	Algorithms/AI Decide how to act on what will happen AI-assisted decisions, algorithms, dynamic adjustments (pricing, schedules, etc.) for optimization purposes	Act and react continuously on what is happening Integrated intelligent system (humans and machines) in closed loop; implemented decisions
			Retrospective (Digital silos)		Prospective (Digital connectivity)		Proactive (Digital adaptability)
			4.0 Beginner	4.0 Intermediate	4.0 Experienced	Expert 4.0	4.0 Top performer
			Monitors and captures to transmit and store data	Uses data to understand and control	Interconnects data to model it	Leverages data to optimize	Self-implements decisions from data

The digital plan thus enables you to map out the progress from a transactional world, poorly integrated and slow to react, to a world of adaptive and proactive systems where problem-solving cycles are contained in continuous and independent feedback loops.

Various 4.0 Digital Diagnosis Models

Measuring and understanding a company's digital maturity is the first step and a major issue of interest. Many companies, research centres and consultants have developed their own methodology for evaluating 4.0 maturity. Each methodology approaches the issue from a different angle and can be classified into one of three approaches:

The technological approach

comes into two versions:

- The simplest approach is limited to taking a list of certain cutting-edge technologies and verifying whether or not they are present.
- A more advanced approach assesses the relevance for the company of each of these cutting-edge technologies, in terms of complexity, cost and impact on their strategic and operational KPIs.

The process approach*

largely ignores technologies and focuses on the nature of the processes in place, more specifically the extent to which they reflect the adoption of some of the key principles of 4.0:

- The digitization of processes and automation of operations, in order to ensure the virtualization and transparency of information
- Interoperability and interconnectivity;
- Real-time operation (for control and dynamic analysis purposes;
- The decentralization of decisions.

The holistic approach deems that technological advances and the nature of the processes are not the only things to be taken into consideration. The growth of a company's digital maturity depends on two interrelated dimensions: its **digital resources** (technologies and processes) and its **digital environment** (structure and culture). This approach also does not endeavour to make specific technological choices.

**Typically, in these approaches many dozens of processes and sub-processes are looked at in detail, but little attention is given to the organization's environment nor, essentially, to which technological to select*

If you want to harness the potential of a vast quantity of data in real time, you need to transform not only your organization's **technological factors**, but also the **human factors** of organizational management and culture. Ultimately, your company must become a learning and nimble entity, able to take advantage of cutting-edge technologies so as to continually, quickly and flexibly adapt to a constantly-changing environment.

While examining the technological aspects will help you assess your ability to use cutting-edge digital tools (to interact with clients, partners or suppliers), automated data collection tools (to speed up decision making) and business process digitization and integration tools (for interoperability), evaluating the human aspects will assess whether "winning conditions" are in place, that is, a shared digital vision, support from management, an environment that is open to change and which values experimentation and collaboration, the professional planning of projects and an ongoing development of digital and collaborative skills.



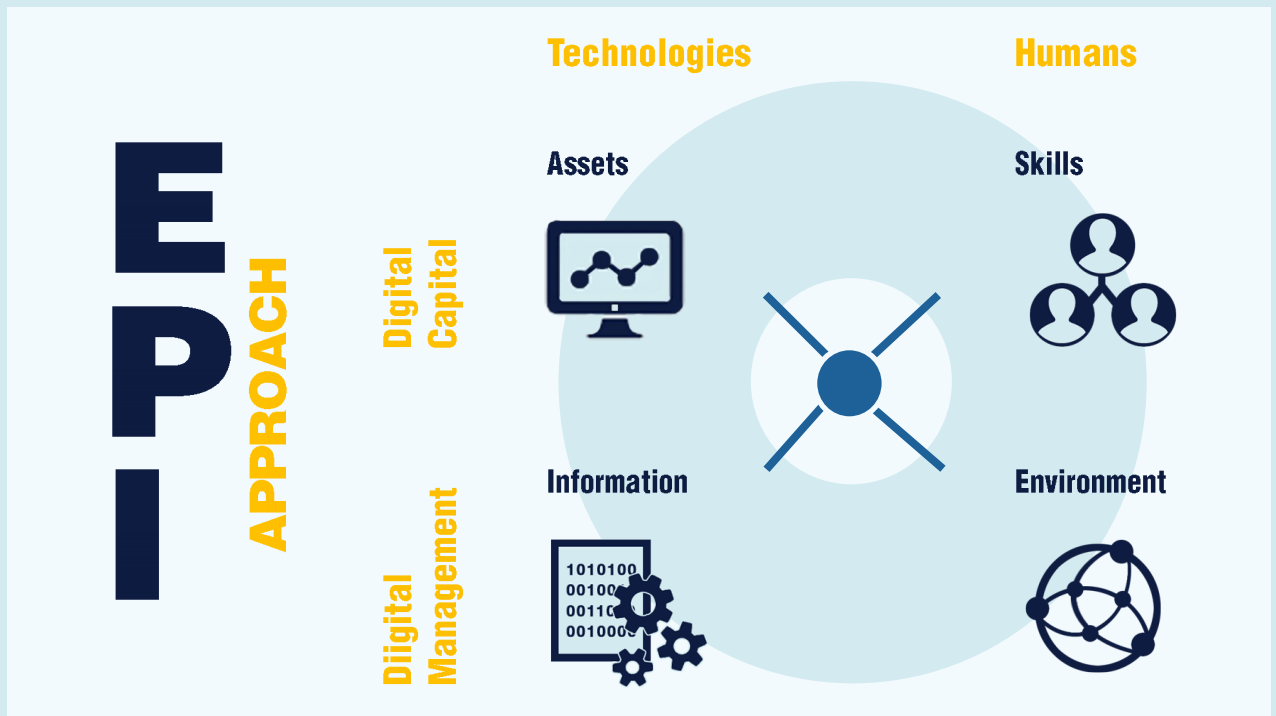


The EPI Approach

Over the last ten years, we have carried out numerous Industries/audits by using one or more of the aforementioned approaches. They each have their own strengths and weaknesses, but none of them fully satisfy either us or our clients. This is what has led us to develop our own methodology, which combines the best aspects of the existing approaches.

Firstly, we should specify that we have developed our approach specifically for **manufacturing** production processes. We are fully aware that 4.0 technologies are also relevant to other processes, for instance logistics, engineering, sales and marketing or even for all administrative support processes. That being said, our mission, our expertise and our key skills centre on the management and control of production activities. We do however have a network of partners who conduct audits of these other processes if needed, for clients looking for a more all-encompassing approach

Our Industrie 4.0 approach focuses on two complementary aspects: **technologies** and **humans**. Each one is examined from two angles: the presence of **digital capital** and its **digital management**.



The purpose of the diagnostic is to assess the presence of key success conditions for each aspect:

Digital assets

- Digital capture equipment in place (modernity, connectivity)
- High-performance data communication (structured, validated, contextualized)

Digital skills

- Technical skills (proficiency and continuous learning)
- Cognitive skills (digital literacy)
- Collaborative skills (sharing, confidence in systems and data-based decisions)

Digital information management

- Disciplined integration (interconnectivity, governance, cybersecurity)
- Data enhancement (contextualization, analytics)

Digital environment management

- Organic structure (decentralization, agility, communication, participation)
- Culture of digital transformation (vision, openness to change)
- Dynamic external collaboration (client focus, cooperation with the value chain)

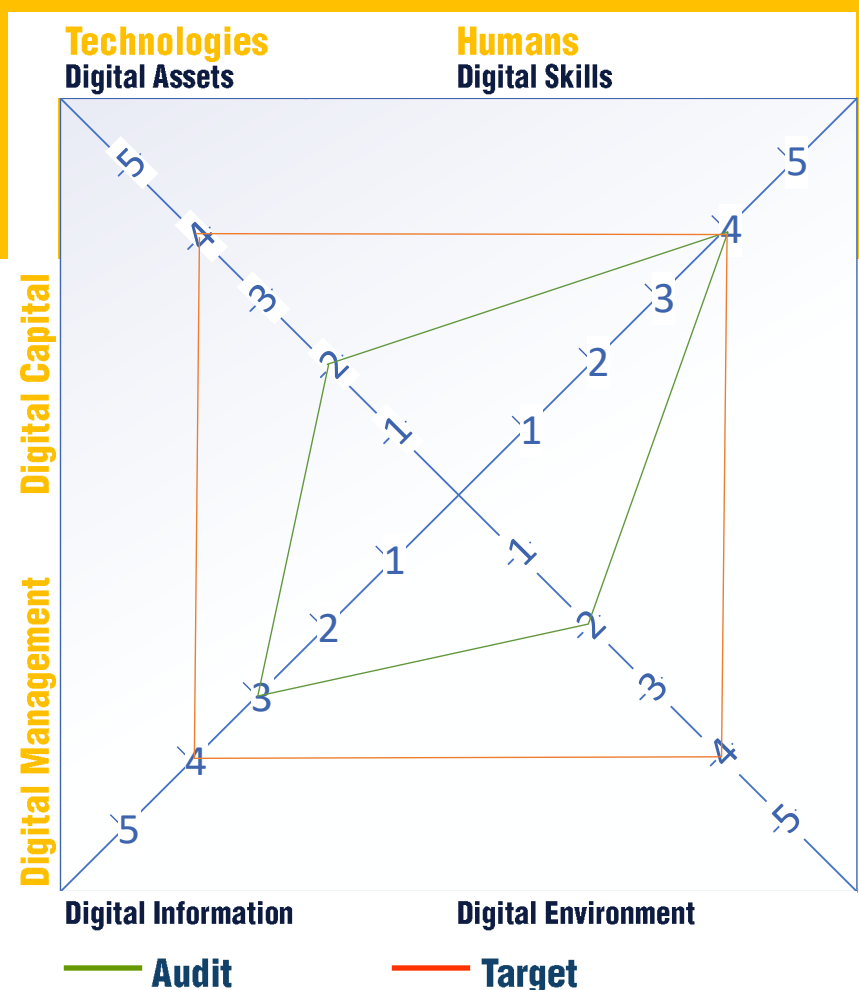
To judge the digital maturity (by assigning it a maturity index of between 1-6 as presented earlier), given the current state of these conditions, we assess, for each, the degree of presence of two to five necessary aptitudes. For example, the three following aptitudes will be assessed, for each process, for the "Collaborative Skills" key condition, under the "Digital Skills" aspect:

- Ability to take data-based decisions
- Sharing of expertise and information

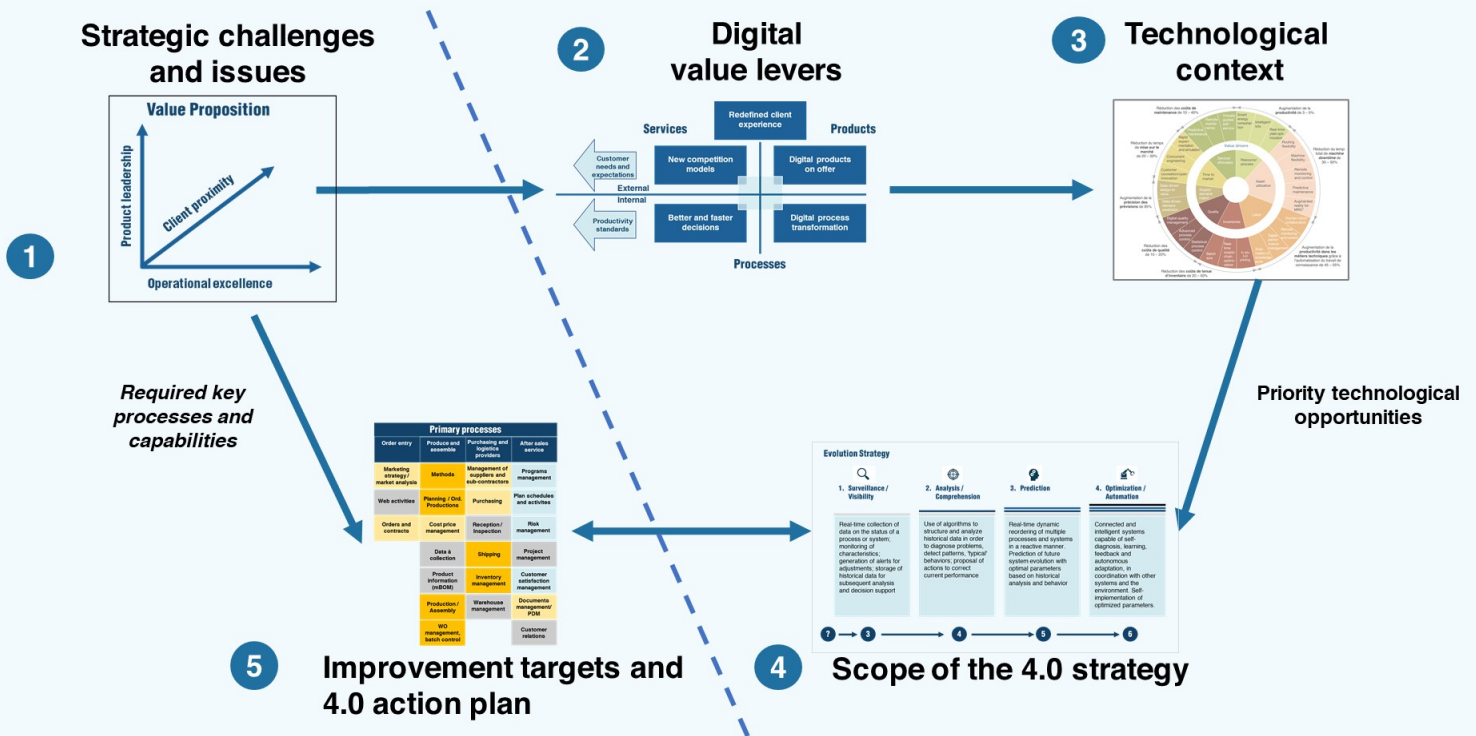
The different indices are then aggregated in order to calculate an overall maturity index for the process. Afterwards, if you wish, we can aggregate the indices at higher levels (e.g., department, factory, company).

A clear overview of the current situation is a good starting point, but it doesn't stop there (often the weak point of many other approaches). Decisions must then be made regarding what improvements must be prioritized.

This is what we call the **digital alignment** process.



4.0 Digital Alignment



Firstly, as previously highlighted, it is vital that the digital plan provide a solid **alignment** to the company's true business challenges and strategic issues. Ideally, these challenges and issues will have been previously defined; alternatively, we can supervise the examination of these points by the management committee.

The goal here is to target the **key processes and skills** (see table) which need to be improved in order to achieve your company's strategic and operational goals.

Possible key processes:

- Management of BOMs and routings
- Planning and scheduling
- Production monitoring
- Stock management
- Maintenance
- Quality
- Continuous improvement
- Project management
- Cost price
- Performance management
- Automation
- 3G
- Robots
- Network
- Skills management

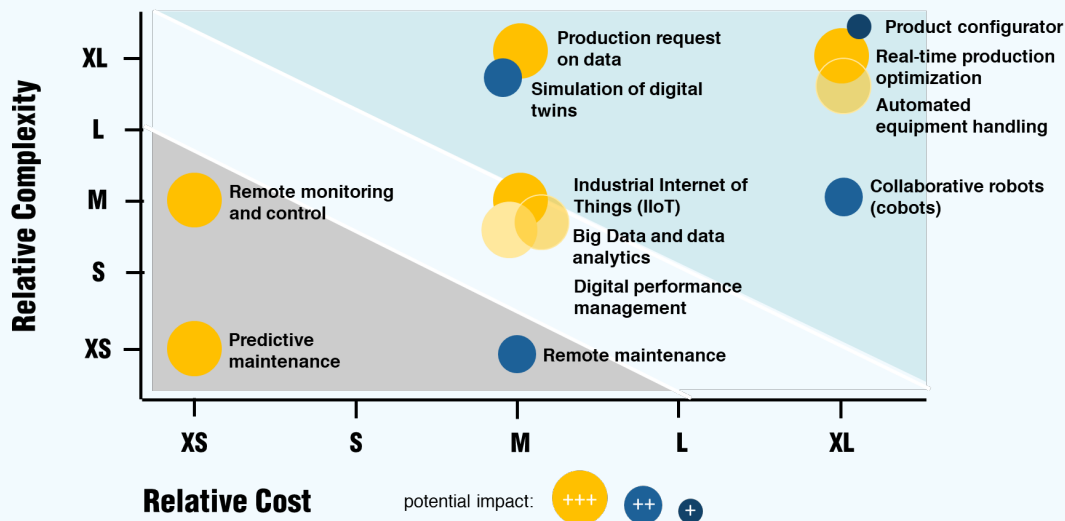


Once this base has been established we can move on to the **technologies selection** step, which includes three elements:

The first consists in clearly identifying which digital value levers will be needed in order to meet the challenges and address the identified issues. Do you want to digitize certain manual tasks, improve and speed up decision-making processes, add digital functions to products, transform the client relationship and/or roll out a new business model? This will already highlight some more interesting and relevant technologies.

The second includes getting to know what 4.0 technologies are available. This can take the form of a seminar where management will familiarize itself with new promising technological avenues that could solve their issues, or even could allow them to exploit new opportunities.

The last includes a structured process of defining the main scope of the 4.0 technologies to be selected – e.g., are we looking to collect, analyze, simulate or optimize data? Finally, a structured process for classifying the various 4.0 technological opportunities will help you choose which ones to implement on a priority basis.



All that remains then is to articulate these choices in a **4.0 action plan**. This is where all the steps and sub-projects encompassing the human aspects of your equation (development of digital skills and adoption of digital environment management best practices) need to be included. Insufficient, or even largely absent, project management is one of the main reasons for the failure of major transformation projects. That is why we also include at this step the configuration of **project management best practices** which will be required to ensure the good governance of the action plan, that is, the management of the scope of work, schedules, costs, human resources (management of change), purchases, quality, risks, communications and the integration (in short, PMI 101).

Conclusion

We live in a world of constant change, increasingly competitive, especially within the manufacturing sector. Beset on all sides by megatrends (globalization, personalization, sustainable development, digitization, etc.), companies must find effective ways of dealing with major challenges: reducing costs and timescales, agility in dealing with change, management of complexity, increased regulatory constraints, etc.

A wise use of cutting-edge technologies and a constant, but well-planned, evolution towards the ultimate goals of the Industrie 4.0 model, is the way forward.

EPI is here to help you make a success of your digital transformation.



Digital transformation requires talent. Assembling the right team of people in four domains — technology, data, process people, and organizational change capacity — may be the single most important step that a company contemplating digital transformation can take .”

– Davenport & Redman, 2020, Harvard Business Review

Authors:

Bernard Boire, M.Sc.A., FIC
Director, Industrie 4.0
Efficient Plant Inc.

André Michel, ing.
President
Efficient Plant Inc.

Copyright © 2021 Efficient Plant Inc.

Efficient Plant Inc. (EPI) is a consulting engineering firm specialized in the development, integration and operation of complex automated systems. EPI provides services in Industrie 4.0, MES, process improvement, performance management, project management, technical support and training.

Efficient Plant Inc

710-6600 Trans Canada Hwy,
Pointe-Claire (QC), H9R 4S2
(514) 674-1271 |
info@efficientplant.com
www.efficientplant.com