# Operational Excellence fostering Innovation in R&D processes
# A case study in semi-conductor industry

## Study context

Performance and efficiency in R&D processes is a critical point for industry. Operational excellence in design and development is required to overcome the business challenges that companies face. It is the case in the semiconductor industry where products have to be developed quicker whilst maintaining a high level of quality.

Lean product development is viewed as a global approach that offers a framework to address design performance [1]–[3]. This approach was chosen by a large semiconductor company to achieve its full agile transformation, modifying both practices and mindset of global R&D teams.

The challenge for the company is substantial since it concerns more than 2000 Engineers spanning 6 countries. It concerns a large strategic program to increase client centric R&D focus and improve R&D efficiency. The objective is to transform practices and introduce lean development approach as a new standard of working. A similar transformation had previously been carried out in the company in the deployment of Lean Manufacturing supported by a large training program. On the strength of this successful experience, the managers of R&D and HR decided to launch a similar program in R&D.

The PhD thesis proposes to analyze and support the implementation of lean product development practices in the semiconductor company R&D organization. Measurement and quantification of operational excellence, prototyping of improved organizations and identification of hindering factors and supporting factors are proposed to be set up and promoted.

## Expected results and research questions

### Measurement of operational excellence to develop innovation capacity

The first expected results are related to measurement of operational excellence in R&D processes. Some Key Performance Indicators (KPI) and Key Behavioral Indicators (KBI) will be identified in order to measure effective improvements in both term of activities and results:

- KBI's linked to activities or operational changes
- KPI's linked to operational results (for instance share of added value in the designer presence time)
- KPI's and KBI's linked to innovation capacity and organizational innovativeness

These KPI's and KBI's should be well chosen in term of relevance and efficiency. A lean approach will be followed and it will not be an objective to multiply the number of indicators.

Among the potential relevant KPI's or KBI's, one can propose:

- New product development project numbers (work-in-progress)
- Time to Market
- Level of innovation in new developed product
- Knowledge sharing activities

### Fast prototyping of efficient organization and practices monitoring

In order to improve R&D efficiency, some new type of organizations and practices will be proposed following recommendations of the literature. For instance, among possible actions, multi skilled designers, short feedback, limited project portfolio, limited level of multitasking are recommended by literature [2]–[4]. Regarding innovation, practices such as Set Based Concurrent Engineering (SBCE) could be implemented and monitored.

On the same order of ideas, best practices regarding knowledge sharing, organizational learning and expertise management will be implemented and monitored.

It will be proposed to prototype on small structures such expected efficient organizations or actions in order to measure impact on innovation capacity and operational excellence.

### Identification of hindering factors and supporting factors

During the implementation of new practices, updated organizations and potentially new roles, some hindering factors and supporting factors will be identified.

The objective will be to set up counter measures in order to limit hindering factors and to promote conditions bringing supporting factors.

## Research Methodology: empirical, grounded and iterative

The transformation project offers a great opportunity to analyze both existing practices and transformation dynamics.

The research will be conducted as an empirical research closely linked to the practices. It will be a qualitative research using when possible quantitative data from the field.

A systematic literature review will be used in order to target a state of the art publication for major topics of the PhD.

PhD students will act as an observer and participant in a constructivist approach of research aiming at developing grounded theories. Pilot project will be analyzed as case study and teams will be followed along the period. These case study will allow to collect data in a systematic way and test new approach and hypothesis.

Data collection will be made by project data analysis like project deliverables and exchange within teams. Semi structured interview of experts and practitioners would be made. Workshop of expert and practitioners could be realized in case

The data from online community of practice would be also analyzed with agreement of participants.

Survey within the company can complete the data collection to validate or test some conceptual models.

Pilot projects and teams followed will be decided in accordance with people engaged in the transformation, the management and the relevance concerning research questions.

The research will be organized using four loop of experimentations in order to propose operational results to the company and to test propositions in the context of the study.

Two experimentations concern the measurement set of indicators that will be proposed after state of the art of company practices and literature review

Two major case study will be the heart of the research. The PhD Student will support and participate to the implementation of the new practices targeted by a research team of R&D. Analysis Interview monitoring will be organized to collect data during change and monitor effects.

Beyond these four experimentations, Operational commitment of the PhD Student within the transformation program allow to collect complementary data through meeting participation, trainings, interviews or surveys.

A preliminary work plan is proposed below as a Gantt chart, including publication plan. International Conferences of design society and IEEE community are targeted. Journals like IEEE Transactions on Engineering Management, Journal of Operations Management, Journal of engineering design or journal of innovation and product management can be target for publication

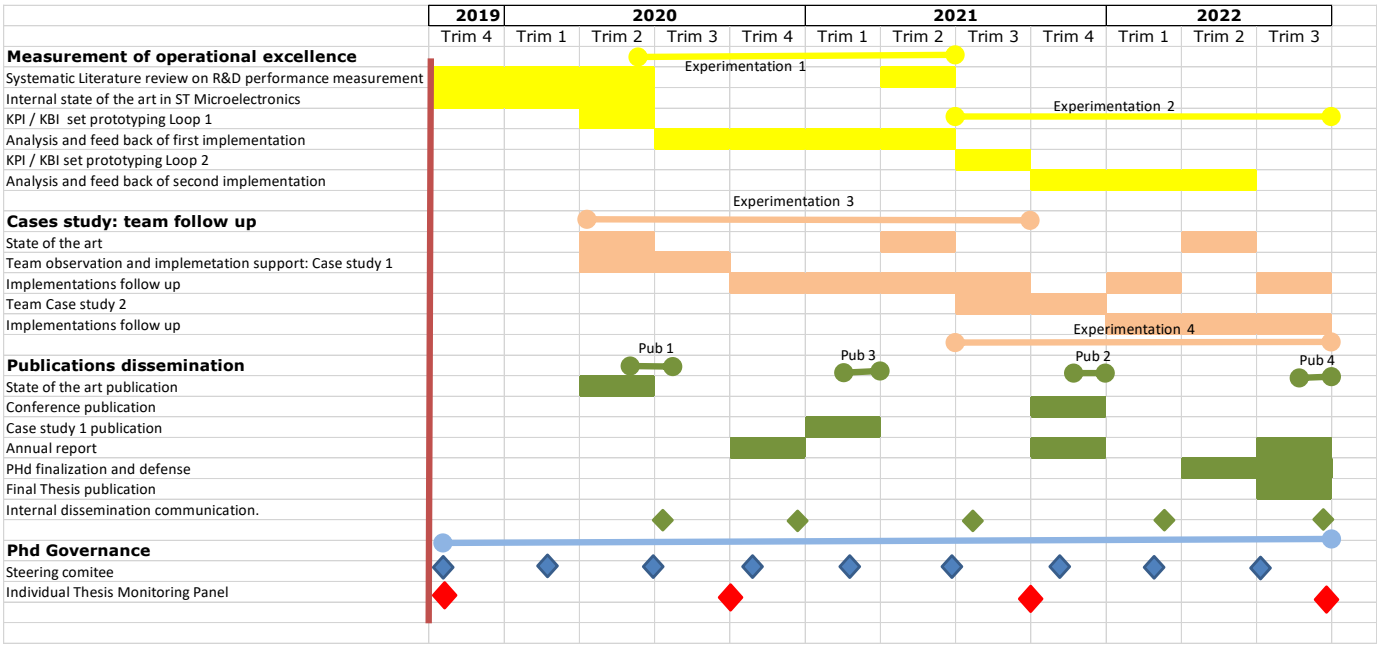


*Figure 1: Preliminary PhD work plan*

## PhD thesis organization and governance

### Governance

A steering Committee will be nominated. Three project reviews per year involving the steering committee will be scheduled. Main decisions about thesis organization and PhD student activities will be decided during these project reviews.

Members of Steering Committee:

- Company supervisors
- University laboratory supervisors

The steering committee will be chaired by ST Microelectronic R&D Director.

### PhD supervision

The PhD thesis will be supervised on both company side and university research laboratory side. Identified supervisors are:

- Company side, ST Microelectronics: Cécilia Barontini, Cyril Colin-Madan
- University side, G-SCOP Laboratory: Eric Blanco (PhD Thesis Director), Pierre Chévrier

As required by Doctoral school regulation, a PhD Monitoring panel will be defined and will meet the student every year to audit work and allow PhD Student registration.

## Planning and organization

The PhD student will split his working time between the company and the university research laboratory. Over the 3 PhD's years, 60% of the time will be spent in the company. According to PhD phase, detailed activity planning will be managed and agreed during steering committees.

Some international collaborations, for instance with India or Italy, will be considered. Synergies with local R&D department of the company will be supported.

The scientific results of the PhD thesis will be published regularly. The objective will be to publish at least once a year in international conference and in international journal.

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## Annex: Literature review

### Added value share in global engineering working time

Study of design practices in aerospace have illustrated that only about 10% of design activity is spent on creating value [4]. If this number appears alarming, many engineers participating in design activity agree that practices could be improved to address issues in efficiency and performance.

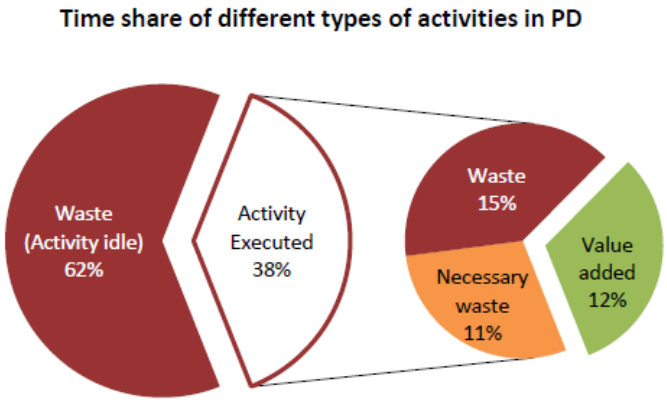


*Figure 2: Time share of different types of activities in Product Development* [4]

### Multitasking, queues and infinite resources

Flow based new product development and lean approach are based on attacking the biggest cause of lost productivity identified to be organizational multitasking [2].

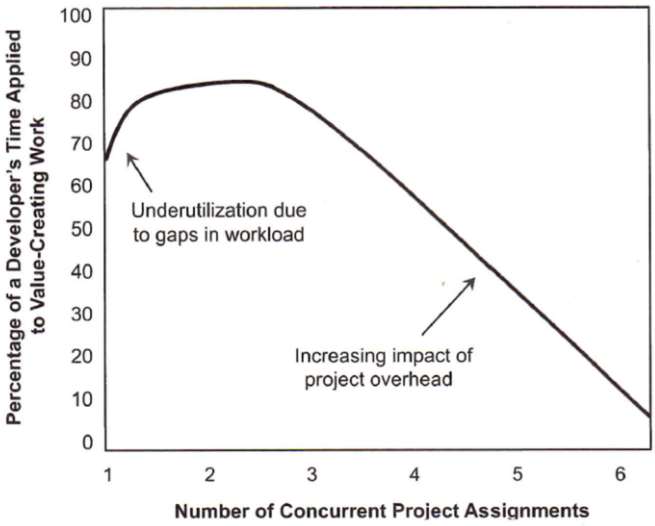


*Figure 3: Impact of Multitasking on Operational Excellence* [2]

In design project management impact of multitasking and interruptions [5] , or Parkinson law [6] had been proven to be of importance.

Within academic literature, constraint theory had been used in project management to improve project performance [6] [7]. Localization and visualization of queues [1], very often linked to scheduling projects assuming infinite resources [3], could be a solution to identify improvements. Queues are directly increasing the time-to-market which is the most significant driver in R&D activities.

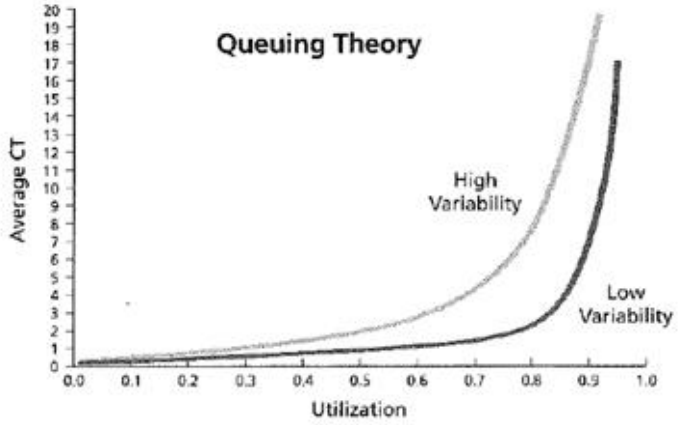


*Figure 4: High Capacity Utilization and Variability are creating queues* [8]

Such change is impacting both individual behavior and collective practices. On individual side, time and priorities management could significantly decrease micro-interruptions and minor tasks multitasking. On collective side, it has been proposed [2] to define slot of 2 hours working time focused on added value for development project. Such kind of organizational change must be supported by management in order to align practices and mindsets.

## Managing complexity

Another characteristic of new product development project is its complexity and the uncertainty linked to complex environment, challenging technology and potential innovation.

It has been shown that fast feedback is supporting complexity and uncertainty management [1]. In order to support lean development approach, such practices should be encouraged.

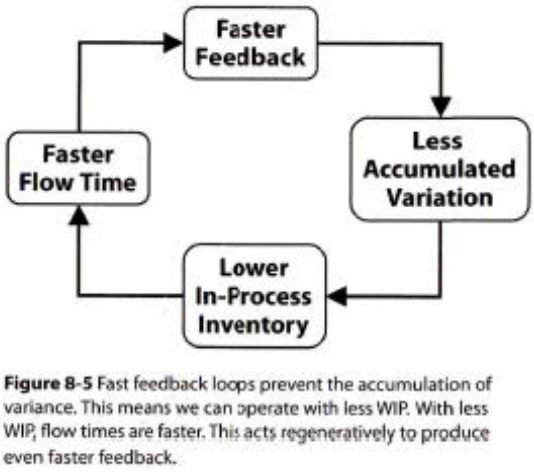


**Figure 8-5** Fast feedback loops prevent the accumulation of variance. This means we can operate with less WIP. With less WIP, flow times are faster. This acts regeneratively to produce even faster feedback.

*Figure 5: Managing complexity through fast feedback* [1]

During New Product Development (NPD), complexity and uncertainty management is also strongly influenced by project manager skills[9].

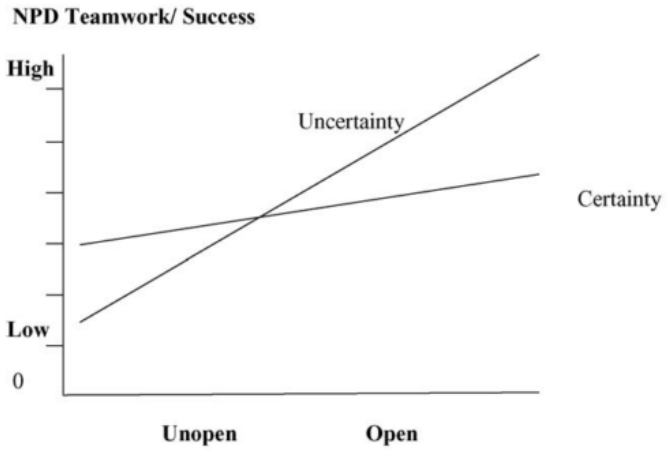


*Figure 6: Theoretical effect of uncertainty on the relationship between NPD leader personality and success* [9]

Impact of mindsets such as 'Give the right to fail', 'Develop continuously people skills' and 'Work in team' are also known to support efficiency during New Product development [8]. In a similar way of thinking, the leadership behavior and its impact on management system will be evaluated in order to confirm its major and proportional impact [8]:

Leadership behavior x Operating System = Management System

## Measuring R&D performance and innovation capacity

Operational excellence aims at reducing cost and speeding new product development but also at developing innovation capacity or organization innovativeness [10].

However Operational excellence is often focused on development and knowledge exploitation phases. Research and innovation as Exploration activities remain out of operational excellence scope. Th concept of ambidexterity [11] has focused on this tightness between the two dimensions of R&D activity.

Nevertheless Performance of R&D is the core of an extensive body of literature but few relate to effective practices and linked the effectiveness of best practices [12]. Multiple methods to evaluate R&D had been proposed [13].

Classical performance measurement are linked to efficiency and effectiveness. Authors like Reinerstern claim that performance of development activity indicators should be closely linked to economic performance of the firm to be relevant. To evaluate Innovation capacity both technological and human factors has to be included in the analysis [10]. If product Innovation is viewed as exploitation of new ideas, performance implies two dimension novelty and use. Multiple innovation indicators had been proposed, a recent review of literature identify 82 indicators which are mostly process indicators [14]. But following Drongelen and al [15] this go beyond to decide about a set indicators, to get an efficient management control system decision have to be made to combine feedback and feed forward management control and also to distinguish between R&D function and R&D organization since R&D processes go beyond R&D department. We can adopt their definition of performance measurement: "*the acquisition and analysis of information about the actual attainment of company objectives and plans, and about factors that may influence this attainment*" (p36)

The research will require a deep literature review crossing literature from management and operations management to clarify the state of the art and to evaluate the choices made by the company within its management system and further relate them to operational excellence practices and transformation running within the company.