Comparing Global (Multi-site) SPI Program Activities to SPI Program Models

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Abstract. Software Process Improvement (SPI) methods have been used for years as means to try to solve the problems in software development. Number of SPI life cycle models exists, and some of them take a wider look to the problems. However, little information exists about how the SPI models apply to global level SPI programs in a multi-site environment. This article takes a historical look into one such case and compares how well IDEAL and ISO 15504-7 models match the actual activities. The results are naturally only indicative, but suggest that the literature models do not readily scale up and that a separate model may be needed to support setting up and guiding the execution of a multi-site SPI program.

1   Introduction

In the past 10 to 15 years Software Process Improvement (SPI) efforts have become rather commonplace means to try to solve, at least partially, the problems in software development. These efforts range from small, local, and focused projects to larger and more sustained programs that tackle bigger goals, some of which may attain a truly global nature spanning over several sites. In many cases global SPI initiatives can be considered to be simply a heightened management focus for process improvement, without actual program structure. The SPI activities are indeed local and the main 'global" activity is setting a high-level goal (such as "attain maturity level 2") and monitoring of progress. Sometimes, however, in multi-site and global companies there may be a need to create a more cohesive SPI effort across the entire company.

How bad the need for coordinated effort is depends on great many things, but one observable factor, based on authors' experience, is the structure of the company's R&D organization. In cases where each site is self-sufficient R&D –wise, the need for a global SPI program may be less than in cases where the R&D is distributed and there is a strong inter-dependence between sites for product development. In latter cases an uneven progress in SPI is undesirable, as the product development becomes a chain where the weakest link (or site) has a significant impact on the net maturity (i.e. reliability, quality), effectively negating the gain from SPI on the sites where progress is faster. As improvement costs money, not only to do but to maintain as well [3], it is

quite understandable that from management viewpoint then, the SPI efforts on all the other sites are effectively a waste of money. A more harmonized approach is desirable, and a proper SPI program, at the global level, is a natural attempt to tackle this need.

The literature offers a number of SPI life cycle models, most of which are well suited for local SPI efforts (e.g. Plan-Do-Check-Act [21], Effective change process [10], AMI [20], Pr^{2}imer [13], Iteration cycle [4], CPI-7 [15]), and a couple that try to provide insight for larger, sustained long-term programs that encompass multiple SPI activities, mainly IDEAL [17], ISO 15504-7 [12], and Quality Improvement Paradigm [2], [3]. In addition, industry experience reports are available (e.g. [1], [11], [6], [7], [8], [9], [5], [16]) to describe how these models have been applied. However, these reports also have a focus at local, rather than at the global activities.

Reports describing the SPI programs that span multiple sites are not readily available, nor do the models discuss how, if in any manner, the life cycle models can be applied for global level SPI programs. At best they offer only rudimentary responsibilities such as 'providing resources', 'monitoring progress', 'directing the program' [17], or 'fostering communication and teamwork', 'providing reward and recognition' [12] etc. For the operational manager, charged with the task of setting up and maintaining the global program, these are clearly not sufficient – more tangible guidelines are needed; what is the organization like, what kind of processes run at global level, how they are related to local level activities, how to balance the global need for uniformity vs. local desire for diversity, and so forth. A natural thought is that the SPI cycle models could be used as such – a global SPI program is, after all, an SPI program (although different in scope and scale). But do the models easily scale up, or is the global cycle somehow different?

This article studies one global SPI program that was clearly cyclic in nature and compares its activities against the IDEAL [17] and ISO 15504-7 [12] SPI cycle models, both of which are intended for large and more sustained programs. A third candidate with elements to support a larger program, the QIP [2], [3] was left out for two reasons – the lack of space in this article and due to lesser familiarity to the authors. The purpose is to see if the global level program followed these cycle models or if it was very different from what the models propose.

Since the viewpoint in this study is a global level SPI program, the comparison requires some definition of what actually is a *global level* SPI program and how it differs from a *local level* SPI program. The following definition has been used here:

> A global level SPI program is a program that is working to improve SW process of an organization in a situation where the organization consists of a number of independent and geographically distributed SW development units.

A local level program would then be an SPI program that is working to improve SW process of one (single) SW development unit.

A global SPI program is also considered to include all the SPI activities that take place in an organization. The activities are considered from global viewpoint, i.e. how the task or results reflect across the entire company and how well the activity covers the units within the scope of the program. For this reason e.g. a single process

assessment activity in a single site does not constitute a process baseline activity for a global SPI program, any more than an in-depth process analysis of a single process done by an SPI action constitutes a comprehensive assessment activity for a local SPI program.

The rest of this paper contains the case description including a detailed look at the cycles from global perspective (chapter 2), a comparison of global activities to IDEAL and ISO 15504-7 cycle phases (chapter 3), a comparison of global activities to IDEAL and ISO 15504-7 continuous activities (chapter 4), discussion (chapter 5) and conclusions (chapter 6).

2   Case Description

Nokia Corporation is the world number one manufacturer of mobile terminals, owning close to 40% of the world mobile terminal markets. It is structured into business groups, one of which is Nokia Mobile Phones (NMP). This particular business group is further divided into R&D centers (sites) around the world, responsible for product development, all of which had SW activities ongoing. The product development is done in a distributed fashion, i.e. software from one site is delivered to other sites and to multiple products. In this article we will look at the SPI effort at the NMP level, which can clearly be considered to be a global entity. The material of the case has been gathered over the years from the start of the NMP SPI Program, to its closure. Furthermore, one of the authors of this article was the manager of the said NMP SPI Program for two years, and kept following the progress of the program out of personal interest afterwards. The same author also studied the NMP SPI Program from infrastructure point of view. Those interested can read more of this study and of the case itself from [14].

2.1   The First SPI Cycle

A corporate-level SPI initiative was launched at Nokia in early 1996, with an aim to get more focus on SPI and drive it into sustained activity across the corporation. The business groups of the Nokia Corporation were expected to establish their respective SPI efforts to meet the corporate level targets. [18] Although NMP had had SPI activities and goals already prior to this, they were not in par with the corporate expectations and NMP had to re-evaluate its SPI approach thoroughly.

The operative SPI manager for NMP was committed to the corporate level goals and obtained also support to a new SPI initiative from the top management of NMP. A task force was set off to evaluate if the goals could be achieved with the current SPI set-up or should something be done. The task force studied the current problems and lessons learned from past SPI efforts and, as a result, recommended a new global SPI program for NMP, to facilitate the achievement of the goals. It was also evident that the entire SPI infrastructure in NMP had to be revised in order to meet the corporate level demands. The new NMP SPI Program was initiated in late 1996.

The first task of the new NMP SPI Program was to define a set of global and local level objectives. These were based on both demands from corporate level and needs of NMP. However, it should be noted that the objectives were defined without actual measurement data; as such data covering the entire NMP was not available. Furthermore the global objectives only indicated areas for improvement, based on the Capability Maturity Model for Software (CMM) [19], and did not define any particular processes or action plans, as the improvement needs varied from site to site.

A staged approach to reach the corporate level goals was adopted. In accordance with the task force findings, the first set of objectives were mostly about revising the SPI infrastructure, rather than focusing on the actual software process improvements, and as such fell short of the corporate level initiative targets. This was, however, deemed to be necessary in order to sustain the SPI activity on a long run. In addition, some of the objectives and requirements dealt with the actions to collect and report status data, including process maturity reports from self-assessments, which could be used to evaluate the problems and maturity of the SW Process both at the local and at the global level. A calendar-based checkpoint for closing the first cycle and revising the objectives was agreed. The assumption was that for the second cycle the set of objectives would be in par with the Nokia-level SPI goals.

After the objectives for the first cycle were defined, commitment to them was obtained from the local level. While most of the sites were committed, some sites were unable to resource the activity at this stage and it was agreed that they would work on the resource issue and join the program later on. Those sites that did join the program were given the responsibility to create a local level SPI infrastructure, and form local SPI actions that would work towards the objectives. The NMP SPI Program established the global level infrastructure and defined interfaces and rules for running the entire program. The role of the global level was defined to be that of monitoring, coordination, fostering communication, improving SPI competences, acting as a mediator between external SPI consulting sources and local SPI activities, and providing support for the local level.

It was also agreed that the local level had the responsibility and power to define their specific goals according to local situation – thus the global part of the NMP SPI Program had only loose control over the local SPI programs. While the sites were committed to the global objectives, they also had local needs and these two sometimes had a priority conflict. Such conflicts were handled on a case-by-case basis, and in some cases the local level SPI program delayed its progress towards global objectives in order to answer to the local needs first.

After having committed to the globally agreed objectives, the local level sites initiated their own SPI strategy and action planning phases and continued from there to do measurement and improvement activities, supported by the global SPI entity. They were also required to report their status on a regular basis. In most sites the local level was able to establish an entire SPI program to run the local SPI activities, but some sites used the global level objectives in a quite straightforward fashion and simply executed those as separate SPI projects, without taking first the assessment steps and without an overlying local SPI program.

Throughout the first cycle the activities to strengthen and improve the infrastructure were ongoing in parallel with other SPI activities both at the global and local level.

2.2   At the Checkpoint

At the agreed checkpoint time NMP SPI Program performed a status review, where achievements were evaluated against the objectives and requirements. This was carried out in two areas – first the status of the SPI infrastructure (and hence the SPI program itself) across NMP was evaluated and lessons from trying out the new approach were collected. The activity was about gathering and communicating the lessons learned in order to see if the program was going into a right direction, and how it could be further improved. The second review was that of evaluating the status of the SW Process in NMP from the status and assessment reports delivered from the sites. These reviews allowed the global level to monitor the use of the new processes and formed the global level baseline findings and recommendations report, which was then communicated across the organization, and to the Nokia level initiative.

After the evaluation, the goals for the next cycle were defined based on the review and evaluation of the objectives, and commitment from the local level to the goals was obtained. As some of the SW process related objectives for the first cycle had not been achieved across NMP, it was realized that the two-step approach was not realistic, and the goals for the second cycle had to be re-thought. With the insight obtained from the global baseline, the next set of goals was based on more realistic understanding of the current status and SPI capability. Nevertheless the progress was good enough to make the new objectives focused on improving the actual SW process, rather than establishing the improvement infrastructure. The measurement objectives for the second cycle were also reviewed but no changes were made.

2.3   The Second SPI Cycle

The second cycle was very similar to the first, with three major differences. First, some of the local SPI projects were not finished during the first cycle and were carried over to the next, so the local and global cycles were not synchronized. Second, the NMP SPI Program initiated certain global SPI projects, managed directly by the global organization. These were based on the needs apparent from the local reports and observations that had been made during the first cycle. These projects were given a thorough planning at the global level, very much like a local level SPI project would be planned. The third difference was the inclusion of several R&D sites that had not been able to resource the SPI activities during the first cycle but were now ready to join the program. For these sites the set of objectives for the second cycle was considered to be too demanding, and a reduced set of objectives, achievable within a year, was defined. In addition some of the sites that had been active from the beginning had had problems with establishing the local infrastructure, and were also given a 'reduced' set of goals. Thus it was acknowledged that sites advance at different pace and in the progress is not "synchronized". This had to be taken into account in planning and managing the global objectives and the NMP SPI Program itself.

At the end of the second cycle the NMP SPI Program went again through the status check and established the objectives for the third cycle. In addition the lessons learned were used to improve the SPI program infrastructure.

2.4   The Third SPI Cycle

The third cycle was initiated but never quite completed, as the changes in NMP organization made it too difficult to maintain a NMP-wide SPI program. Furthermore the Nokia-level initiative was closed in 2001, as it was concluded that SPI had become business as usual, and the corporate level task force was no longer needed.

With the closure of Nokia level initiative also the NMP SPI Program was closed and responsibility for SPI was transferred to the new business units that had been formed between the global level and the site level.

2.5   The Global Cycle

Based on the case data, it is possible to draw a rough SPI process cycle from the global perspective.
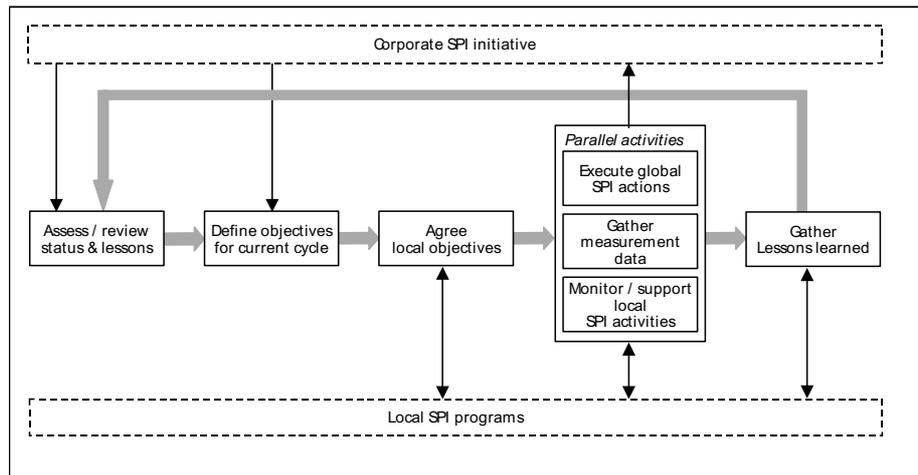

Fig. 1. A global SPI process cycle

The first phase is where the accumulated knowledge of the process maturity and lessons are evaluated, to establish an understanding where the company as such seems to be in respect to overall goals. There was no 'initiation phase' in the case studied, as NMP already had an SPI program in place. The program was thoroughly revised, but this does not constitute initiating a completely new program. In the second phase the accumulated knowledge is turned into concrete plans, influenced (during the first pass) by the corporate initiative. The third phase is where the different sites are consulted and a set of objectives is agreed for the current cycle and incorporated to the local SPI programs. It is important to note that although the picture does not point it out, there were eventually three sets of goals – one for those sites who were not yet part of the program as such (no SPI resources), one for those who had just started, or had not had decent progress during the previous cycle, and one for those who had had

good progress. The fourth phase is the 'main' work during the cycle, mainly with the local level but also at global level and included status reports to the corporate initiative. The last phase was to get ideas for improving the SPI processes and was done as a workshop at the end of the cycle, together with local and global representatives.

3 Comparison to Cycle Phases

Both IDEAL and ISO 15504-7 cycle models take an approach that an SPI program, once initiated, works towards its improvement goals. When the goals have been achieved the 'old' SPI program is concluded and a 'new' program is initiated, with new objectives. Both models contain two different types of activities: the actual cycle activities and the continuous activities. In this chapter the NMP SPI program activities are compared to the cycle activities of both models.

3.1 IDEAL Cycle vs. NMP SPI Program

The IDEAL model states up front that the guide is "primarily focused on organization-specific activities" [17, p.8]. Organization in this model is equivalent to a single unit, as opposed to corporation, which the IDEAL model defines to be "made of a number of separate organizations" [17, p.8]. Looking at the Nokia case, at the business group level the 'organization' would be a single software development unit (R&D site) and the business group (e.g. NMP) is equivalent to IDEAL model's 'corporation'.

The IDEAL phases can be summarized as [17, p.6]:

I (Initiating) – Learn about process improvement, commit initial resources, and build process infrastructure. This is carried out only once, and the subsequent SPI programs go from Leveraging phase to Diagnosing phase, providing that the continuous cycle is kept up.

D (Diagnosing) – Establish current levels of process maturity, process descriptions, metrics, etc. Initiate action plan development.

E (Establishing) – Establish goals and priorities, complete action plan

A (Acting) – Research and develop solutions to process problems. Expand successful process improvements to entire organization

L (Leveraging) – Prepare for the next cycle through the IDEAL model. Apply the lessons learned to refine the SPI process

From how IDEAL treats goal setting in the Leveraging phase it seems that the model considers an SPI program to be equivalent to one IDEAL cycle.

Since NMP already had an existing SPI program, it is justified to leave the 'Initiate' phase out of this comparison and concentrate on the remaining four steps of the model.

Comparing the early (1996) activities of the NMP global SPI program to the IDEAL model shows that they correspond closely to the *Leveraging* phase: a new set of SPI goals were established, commitment obtained, the need for new infrastructure

identified through studying the current problems and lessons learned from past SPI efforts, and a new program established to meet the goals.

The next activities after initiating the NMP SPI Program bear resemblance to both *Establishing* and *Diagnosing* phases. The setting of objectives and requirements for the local level, and getting local level commitment belong to the former, while some of the requirements dealing with collecting and reporting status data belong to latter. More specifically they cover the first two steps of the Diagnosing phase. However, the order of the phases is reversed at the global level, and the baselining activity is missing altogether at this point. In the IDEAL model the current state analysis from the Diagnosing phase is expected to be available for defining the objectives but this was not what happened in the case.

The goals were established based on Nokia corporate level targets and data from the 'previous cycle' (i.e. past SPI efforts), as it would be unfeasible to do a comprehensive assessment step in a short period of time across a large organization in order to establish a baseline in the sense IDEAL defines it. Instead a global level SPI program has to resort to establishing the first cycle objectives based on very little data and the objectives for the subsequent cycles are then based on the data gathered during the previous cycle. A major difference between the NMP SPI Program and the IDEAL cycle in establishing the objectives was that the NMP SPI Program goals were at much higher abstraction level and control over local level activities much weaker than what the IDEAL appears to expect. This, however, was a necessity as NMP was already at that time a very large organization with very different sites, and a culture that fosters diversity. It was considered most reasonable to have local level apply their first-hand knowledge of what is needed and what works, and give a broad direction for improvement, rather than imposing a rigid set of targets from the global level.

After the local level SPI strategy and action planning was initiated, the global level SPI program can be considered to have entered the *Acting* phase. The local level also performed measurement and assessment activities. This – from the global SPI program viewpoint – is *Diagnosing* phase step 3, i.e. conducting the baselines, although this activity was, from global perspective, made in a piecemeal fashion, not concurrently across all sites.

Activities to strengthen and improve the infrastructure were also ongoing in parallel with all other activities throughout the cycle. This again resembles the 'Revise Organizational Approach' –step from the *Leveraging* phase.

At the agreed checkpoint the status reviews were made, goals for the next cycle were established and measurement objectives re-evaluated. Here again we see multiple IDEAL cycle phases represented. The SPI infrastructure review corresponds to the *Leveraging* phase, with the exception that it was only concerned with gathering and communicating the lessons learned, not initiating a new SPI program. The SW Process status review in turn corresponds to the *Diagnosing* phase steps 5 and 6, i.e. developing the *global level* findings and recommendations report and communicating them to the organization. The goal setting corresponds to the *Establishing* phase and measurement objective review covers the *Diagnosing* phase steps one and two.

During the second and third cycles the same pattern emerged, although the need for having several goal sets in parallel for sites in different phases of progress is a major difference to the IDEAL cycle, which clearly expects to have one set of goals for each cycle. The existence of global level SPI projects is somewhat parallel for having local

level SPI actions ongoing, the difference being that the NMP SPI Program had direct control over them as opposed to very loose control it had over local SPI activities. In addition the local level having "old" SPI activities from the first cycle is again somewhat different from what the IDEAL expects, as the assumption is more towards that of the cycle being not finished until all SPI objectives are met.

3.2   ISO 15504-7 Cycle vs. NMP SPI Program

The ISO 15504-7 model for SW process improvement cycle states up front that a program may have long-ranging improvement goals that are achieved by going through several iterations of the improvement cycle. The model has a total of 8 steps. These are:

1. *Examine organization's needs* to identify drivers for, objectives of, and goals for SPI
2. *Initiate Process Improvement* as a programme of its own right, including planning and resourcing the program in an appropriate manner
3. *Prepare for and conduct a process assessment* in order to identify process strengths and weaknesses of the organization
4. *Analyze assessment output and derive action plan*, including prioritizing improvement areas, defining specific improvement goals and setting targets
5. *Implement the improvements* in order to improve the SW process
6. *Confirm the improvements* against agreed targets
7. *Sustain improvement gains* by institutionalizing the improved process
8. *Monitor the performance* of both the SW process and the SPI program

The ISO 15504-7 model's corresponding lead-in phase (step 1) has less emphasis than IDEAL model's first step on building something from a scratch. As such it fits better into a situation where the objectives of an existing SPI program are revised to the extent that it can be considered to be a new improvement program. This is also consistent with the fact that ISO 15504-7 considers it possible for an improvement program to go through several cycles, and the reviewing and revising of the goals and targets in step 8 is presented with being more 'adjusting' than 'renewing' in nature. Conversely the Leveraging phase in the IDEAL model is more 'renewing' in nature.

For this reason the activities of the NMP SPI program in the beginning of the first cycle can be considered to match the steps 1 and 2 of the ISO 15504-7 cycle. The Nokia level initiative made NMP to revise its goals thoroughly and a set of new goals were established (*step 1*). To facilitate achievement of these goals the NMP SPI Program was initiated (*step 2*). It started to plan the improvement program, form the new approach and revise the SPI infrastructure.

During this time local level requirements were also defined, including requirements to collect and report status data, e.g. process maturity reports from self-assessments, which roughly corresponds to the purpose of ISO 15504-7 *step 4*. The global level requirements were, however, defined before any of the data was available. The global level did not establish specific improvement goals, targets or an action plan as required by the model. Here the NMP SPI Program activities clearly conflict with ISO 15504-7 cycle model, which expects the organization to first conduct an assessment (*step 3*) and then go through an analysis and prioritization

phase. The difference to the model is similar to that of the IDEAL model as discussed in the previous chapter, for the same reasons. Substitutes for the global assessment are the measurement and assessment activities at the site level and these, from global point of view, are continuously ongoing across the organization. This is explicitly included in ISO 15504-7 step 8, which means that the step 3, from global SPI program viewpoint, does not exist. Furthermore there is little sense in establishing a detailed action plan at the global level, as expected by the ISO 15504-7 step 4, since different sites may have different problems. Instead, identifying a broad scope or area for the improvements and allowing the local SPI programs to draw the action plans is a more practical approach.

After the global objectives were established, local level went on planning their respective SPI strategies, action plans and change projects. From global viewpoint this corresponds to the *step 5* of the ISO 15504-7 model.

At the checkpoint the infrastructure and software process status were reviewed, and a new set of objectives for the second cycle was established based on both the review and the evaluation of the achievements. These activities bear resemblance to *step 6*, *step 8*, and also to some extent *step 4*.

Step 7 is not easily found from the activities of the first cycle of the NMP SPI Program. This step includes deployment of the improvements to all applicable entities, but this did not take place in a globally enforced fashion in NMP. While the general objectives were similar to all sites, the NMP SPI program did not attempt or have the responsibility to "roll out" a change that was developed and piloted in one site to other sites. Based on the previous experiences, such inter-site deployment was considered to be impractical for NMP at the time. As NMP is a very heterogeneous environment, the practices for carrying out a specific activity are not easily transferable to another site. Instead the NMP software process architecture had been structured to make a difference between "What" and "How" levels of process execution, where the former is to ensure process outcome and interface compatibility, and the latter is left for the local level to develop or borrow from other sites. Another activity in step 7 is monitoring the use of the new process, which is something that the global SPI program did do, through the standard measurement and assessment reports.

As stated earlier, the pattern was very similar during the second and third cycles. Having several sets of objectives, because of sites advancing at a different pace, and having some SPI activities carried over from the previous cycle does not appear to be an issue from ISO 15504-7 model viewpoint. The model acknowledges that several iterations of the cycle may be needed to achieve the final goals.

3.3 Cycle Comparison Summary

Although the analysis confirms that the global SPI program indeed has similar activities as the two cycle models describe, the sequence and distribution of these activities in case cycle differs from that of the model cycles. In addition some of the activities identified in the models are missing or are not carried out as expected. As a result the projection feels somewhat artificial and it is rather safe to state that the global SPI program presented in this article does not follow the SPI program cycle as defined in either of the models.

4   Comparison to Continuous Activities

Both IDEAL and ISO 15504-7 identify certain activities which are beyond the cycle itself, mostly related to managing of an SPI program, and as such can be considered to be more or less continuous or done on-a-need -basis. In this chapter the continuous activities of both cycle models are compared to the NMP SPI Program activities.

4.1   Continuous Activities from IDEAL vs. NMP SPI Program

The IDEAL model lists six tasks under "Manage SPI program". The overall objective of this 'phase' is to provide oversight to the improvement projects and resolve issues. The tasks are:
- Setting the Stage for Software Process Improvement
- Organizing the SPI program
- Planning the SPI program
- Staffing the SPI program
- Monitoring the SPI program
- Directing the SPI program

In addition the IDEAL model recommends that a program that performs activities in a corporate context has the following responsibilities:
- Establishing infrastructure and links to support and coordinate the organization programs
- Looking outside the corporation for "process reuse"
- Supporting organizational activities through resources, common practices, communication, etc.
- Spreading findings, practices, information, etc., across a wider base within the corporation
- Acting as a focal point for outside process improvement influences, such as those from the Software Engineering Institute (SEI), etc.

There are two ways to view these activities. If the NMP SPI Program is considered to be the program itself, a steering group for the program should then for the most part carry out the continuous activities. In the case studied here the steering group did carry out some of the directing activities, and the Nokia -level initiative, through reports it required from the NMP, carried out the monitoring activities. However, the NMP SPI Program itself was largely responsible for the rest.

Another approach to the continuous activities is to project the NMP SPI Program activities to them, and indeed it would appear to be more fruitful approach. The early events and actions in the beginning of the first cycle are clearly *setting the stage for SPI* – the new requirements from the corporate level, the analysis of problems in the process and infrastructure, etc, all can be considered to be part of this phase. The first activity of the new NMP SPI Program was to *organize* itself, and define the infrastructure (of which organization is a part) for the entire SPI initiative, and this was indeed a continuous activity throughout the cycle. The *staffing* was another important issue, although it was considered to be part of the work on infrastructure (organizing), rather than a separate activity. The activities across the NMP were

monitored through the reports, and the end-of-cycle checkpoint was used to review the status, across NMP, get lessons learned, and establish a new set of objectives – i.e. to *direct* the overall program that encompassed all SPI activities in NMP, both at global and local level.

As for the recommended activities, improving the infrastructure was indeed a central continuous effort, and the global part of the NMP SPI Program also had a notion that they act as an interface between the external sources for SPI issues, in order to get the latest ideas but also to verify their usefulness and applicability for NMP purposes, which corresponds to the second and last bullet. They also had an explicit responsibility to foster communication and support the local SPI activities, as identified in the third and fourth bullet, although the support role was more that of a consultant than resource pool and the process improvements were collected but not effectively disseminated, as discussed in the earlier chapters.

Evidently the only activity missing is the identifying, planning, and executing the actual SPI actions, which were carried out both at the local and global level. Of course this is the essential part of any SPI program, so the omission is not to be overlooked. The reason is, naturally, that these are covered in the cycle activities of the IDEAL model but in the case study the SPI actions did not necessarily have all the elements of a complete IDEAL cycle – this is most evident in the case of global SPI actions. Hence the assumption that the NMP SPI program would be just the complete set of IDEAL cycle phases and continuous activities does not quite match the case.

4.2   ISO 15504-7 Continuous Activities vs. NMP SPI Program

Like IDEAL model, the ISO 15504-7 considers management of the SPI program a separate task that covers organizing, planning and measuring SPI and reviewing SPI activities, although IDEAL appears to have more extensive list of the management activities. As with IDEAL, the ISO 15504-7 activities to *Manage the Process Improvement* are easy to map to the activities of the NMP SPI Program.

The early activities of the NMP SPI Program were much concerned about the establishing an infrastructure, corresponding to the ISO 15504-7 activity *Organizing for Process Improvement*. As already discussed this was also a continuous action that the global part of the NMP SPI Program was carrying out throughout the cycle, and expected the local level to do the same. After the initial work on infrastructure, the global objectives and the stepwise approach for getting to the corporate level goals were planned, which matches the *Planning for Process Improvement* -activity. *Measuring Process Improvement* was carried out in a 'continuous' fashion, although most of the metrics and assessment reports were filed in only twice a year. Finally the *Reviewing of Process Improvement Activities* was done at the end of the cycle.

Again, the missing parts are the SPI activities and the discussion in the previous chapter (4.1) about this gap applies to the ISO 15504-7 model as well.

4.3 Continuous Activity Comparison Summary

The continuous activities identified in the models fit fairly well with the global SPI program activities, although they omit the SPI actions themselves, for a good reason. However, assuming that the NMP SPI Program was just a complete set of cycle activities and management activities does not quite match the case. The global level SPI activities did not constitute an entire SPI cycle, and in addition some local SPI actions were also merely a group of separate SPI projects rather than a full-fledged SPI program. Furthermore nothing in the both models' continuous activities suggests a cyclic process, and the case study program was clearly progressing through a cycle.

5 Discussion

From the case study it is apparent that while the global SPI Program activities were progressing through a cycle, with long-term objectives and a step-wise approach to them, there is only a partial match to the cycles presented in the IDEAL or ISO 15504-7. This suggests that the current models cannot be straightforwardly scaled up as such and a different cycle model may be needed.

The most notable difference to the cycle model activities of both IDEAL and ISO 15504-7 is how the baseline data was taken in the case study program. Although as a single deviation this does not appear to be much, it points out a deeper philosophical difference in improvement planning between the global cycle and the literature models. Both models expect the SPI program to perform a thorough baselining phase in order to find out improvement opportunities, which are then used to plan and initiate SPI actions for the current cycle. For a multi-site SPI program conducting such a baseline phase is neither feasible nor desirable for several reasons:

1. Executing a detailed diagnosis simultaneously in all sites is not feasible. This would be a huge task (to coordinate alone) and disruptive for the company. If performed within a tight time frame, there will be some local units to which the timing is poor, e.g. occurs during a critical project phase. This can potentially have a major negative impact on business and certainly has a negative effect on SW practitioners' attitude towards SW Process Engineering.
2. The company (if it has enough sites) would simply run into a problem of getting enough training capacity and qualified lead assessors.
3. If the baselines are carried out sequentially (over a period of time), it is likely that when the final baselines have been conducted, the findings from the first ones are no longer relevant since actions have been already done to change the situation.
4. In a multi-site organization the sites are likely to be very heterogeneous, which means that they may also have different problems. Making a diagnosis and, based on that, establishing same SPI actions across all sites may not be possible.
5. In a multi-site organization, micromanaging all the SPI actions is not feasible for the global SPI program. A more sensible approach is to establish local level SPI programs that establish and manage the local SPI actions. For that reason there is less need for the global level SPI program to have a detailed understanding of the exact strengths and weaknesses of each site.

A global level SPI program uses the best current understanding of the overall status in the company (from the measurement data available, rather than through a specific global baselining phase or action) as a source of the global level objectives. The data is collected in parallel with SPI activities and used to support planning of the next improvement cycle, rather than to plan activities of the current cycle – a clear difference to the way assessment data is treated in both models. While data collection can be considered to be a form of baselining, it is spread out in time as opposed to being conducted in a way that provides a snapshot status of the organization's SW process. In a global SPI program the baselining phase is thus either missing or is split up into 'Collecting data' done in parallel with the SPI activities, and 'Analyzing data' done prior to proposing objectives for the new global SPI cycle.

While the cycle itself does not appear to scale up effortlessly, the global SPI Program activities can quite easily be mapped to "continuous activities" identified in both models. However, the literature models consider these activities to be non-cyclic (continuous) or ad hoc in nature, and for that reason place them outside the cycle itself. Yet, as stated, the NMP SPI Program was clearly progressing through a cycle.

We argue that the 'continuous activities' are, in fact, projections of a global level cycle, viewed from the local level. Although the models identify them as "continuous", this does not exclude the existence of a higher-level cycle. It should be kept in mind that the models are primarily intended for a local SPI program [17], and hence reflect the local view to the matter.

The final interesting finding is the issue of control over SPI activities. While the models assume that the SPI program has direct and tight control over all SPI activities being executed – a reasonable assumption for a local level initiative – the global SPI program appears to have more complex control structure. The program goals in the case study indicated the areas for improvement and thus a direction that the SPI program in its entirety should be progressing. However, the individual SPI activities (local level actions) were semi-autonomous within the global framework and had even the power to break away from it if this was seen justifiable. This would correspond a situation where an individual SPI action would inform the SPI program that it is focusing on different things than where the SPI program initially focused it on, because it finds those other issues more important. This is an important difference between a global and a more 'traditional' SPI program. The global SPI program has only moderate control over the local SPI programs and while the local SPI actions have limited initiative of their own, they still can act on their own volition. The reason for this is again in the heterogeneous nature of a global organization. Apart from the global needs the local SPI program is also responsible for answering the local needs and there are cases where the two have a priority conflict. In the case organization it was considered to be a "lesser evil" to have the local SPI organizations have the right to focus on local needs at the expense of global needs. The general idea of the SPI initiative was to make it business as usual. Centrally enforced actions had a risk of causing resentment and stifling local enthusiasm for SPI. Although this may be due to the company culture, the finding can also imply that the nature of management activities of the global SPI program may be more guiding than controlling.

In our opinion the evidence from the case study points out that while the current models have elements that are similar to what occurs in the global level, the models can not be used to establish and guide a global level SPI program. However, this is

not to say that the current models are flawed in any manner. Instead it is apparent that the models are tailored and suitable for running local SPI programs and already have elements – the continuous activities - that work to bridge the local level SPI cycle and global level activities. Rather than trying to modify the existing models to cater also global needs a more sensible approach is to devise a different model for the global SPI program and establish more precisely defined interfaces between the two levels. The rough model presented on section 2.5 is a step towards a global SPI program cycle model, but clearly falls short in great many aspects and must not be mistaken for a proper model. More studies of such programs and activities are needed before the key steps and their actual nature emerge as a pattern.

6 Conclusion

In this article we have studied one cyclic global SPI program and compared its activities to the two most well-known SPI program life cycle models – IDEAL and ISO 15504-7 – to see if the global SPI program followed one cycle model or the other.

The findings suggest that the current models, as far as the cycle itself goes, do not scale up in a straightforward fashion, as they have been tuned for local (single-site) SPI programs. While all activities can be found if both cycle and continuous activities are taken into account, the phase structure does not match the global level cycle, nor is there a provision for multiple hierarchical levels (which are an obvious part of a global program).

However, we feel that there is no use to change the existing models as such, since they seem to apply well for the purpose they've been defined for. Instead the models should be expanded to contain a hierarchical structure, a global level cycle model, and the interaction between the global and local cycles. Although in this paper a very rough global cycle has been presented, it is clearly an oversimplified one and more case studies are needed to define a proper one. In addition the QIP model should be evaluated against industry cases to see if it has a better match to the processes of a global SPI program.

References

1. Basili, V., Green, S.: Software Process Evolution at SEL. IEEE Software, July (1994) 58-66.
2. Basili, V., McGarry, F.: The Experience Factory: How to Build and Run One. Tutorial TF01, 20th International Conference on Software Engineering, Kyoto, Japan (1998)
3. Basili, V., Weiss, D.: A Methodology for Collecting Valid Software Engineering Data. IEEE Transactions on Software Engineering, November (1984) 728-738
4. Culver-Lozo, K.: Software Process Iteration on Large Projects: Challenges, Strategies and Experiences. Software Process – Improvement and Practice 1 (1995) 35-45
5. Diaz, M., Sligo, J.: How Software Process Improvement Helped Motorola. IEEE Software, September/October (1997) 75-81
6. Dion, R.: Elements of a Process-Improvement Program. IEEE Software, July (1992) 83-85

7. Dion, R.: Process Improvement and the Corporate Balance Sheet. IEEE Software, July (1993) 28-35
8. Haley, T.: Software Process Improvement at Raytheon. IEEE Software, November (1996) 33-41
9. Hollenbach, C., Young, R., Plufgard, A., Smith, D. (1997) Combining Quality and Software Improvement. Communications of the ACM 6, Vol. 40 (1997) 41-45
10. Humphrey, W.: Managing the Software Process. Addison-Wesley, Reading, Massachusetts (1990)
11. Humphrey W., Snyder, T., Willis R.: Software Process Improvement at Hughes Aircraft. IEEE Software, July (1991) 11-23
12. ISO/IEC: 15504-7 Information technology – Software process assessment – Part 7: Guide for use in process improvement. ISO/IEC TR15504-7: 1998(E) (1998)
13. Karjalainen, J., Mäkäräinen, M., Komi-Sirviö, S., Seppänen, V.: Practical process improvement for embedded real-time software. Quality Engineering 4, Vol. 8 (1996) 565-573
14. Kinnula, A.: Software Process Engineering in a Multi-Site Environment – An architectural design of a software process engineering system. PhD thesis, Univ. Oulu, Dept. Information Processing Sciences. Acta Universitatis Ouluensis A333. Oulu Unmiversity Press, Oulu (1999) URL: http://herkules.oulu.fi/isbn9514253035/
15. Kinnula, A.: Software process engineering systems: models and industry cases. Acta Universitatis Ouluensis A372. Oulu University Press, Oulu (2001) URL: http://hercules.oulu.fi/isbn9514265084/
16. Laporte, C., Papicco, N.: Software and Systems Engineering Process Development and Integration at Oerlikon Aerospace. Software Process Newsletter 11 (1998) 10-17
17. McFeeley, R.: IDEAL[SM] – A User's Guide to Software Process Improvement. CMU/SEI-96-HB-001, Software Engineering Institute, February (1996)
18. NSPI Launch Letter by Matti Alahuhta, and corresponding slide sets (Nokia internal documents) (1996)
19. Paulk, M., Weber, C., Garcia, S., Chrissis, M., Bush, M.: Capability Maturity Model for Software, version 1.1. SEI-93-TR-024, Software Engineering Institute, February (1993)
20. Pulford, K., Kuntzmann-Combelles, A., Shirlaw, S.: A quantitative approach to Software Management: The ami Handbook. Addison-Wesley, Wokingham, England (1996)
21. Shewhart, W. A.: Statistical Method From the Viewpoint Of Quality Control, Dover Publications, New York (1986) reprint of the 1939 original