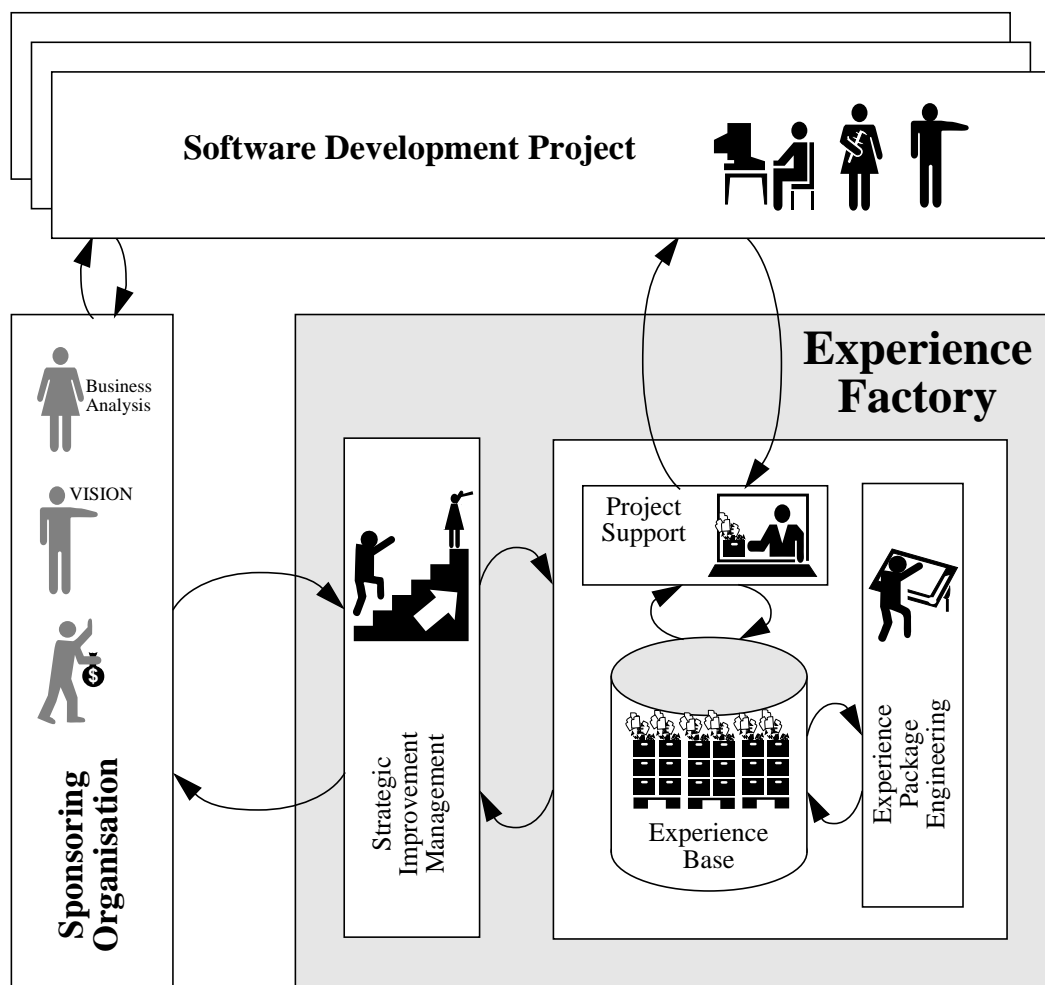


A booklet from the  
**Perfect**  
ESPRIT project 9090

# Handbook

## PIA Experience Factory - The PEF Model -





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# 1. Executive summary



## *What is an Experience Factory?*

An Experience Factory (EF) is a logical and/or physical organisation that is responsible for the collection and reuse of important experiences made in the software projects in an organisation [Bas94].

## *Why have an Experience Factory?*

Experience is used to improve the performance of the projects and the quality of the developed products. The main medium for the improvements are the organisations software processes, including tools and methods. Collecting and reusing experience is part of the organisational learning and is aiming at two aspects of learning, Process Control and Process Change. Process control is the way to use the experiences to make a new project exceed its normal performance by improving predictability of important factors like development time, development cost and product quality. Process change is the way experiences is be used to understand if a change in the process will actually improve the performance of the software projects, e.g. shorten development time, lower development cost or increase product reliability. Both these aspect are important parts of evolutionary continuous process improvement and will help your organisation continuously improve its performance.

## *What is the PEF model?*

The PIA Experience Factory (PEF) model clarifies which activities a functioning EF should engage in. It explains how the EF will act together with the software projects to ensure gathering and reuse of experience. It points out how the management of the organisation should support and use the EF. It also describes how the EF should work internally to ensure that the experience is used for improving the performance of the projects. The PEF model includes a small set of principles, called “principles for improvement” and they give essential guidance of how to achieve improvements with the PEF model. And improvements are what the PEF model is here to support.

## *How will the PEF model help?*

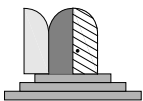
The PEF model explains how a fully functioning EF works in an organisation. The model will give you important insights in how an EF should function. Each part of the EF is described pointing out the purpose of the part, stating goals and gives a detailed process description for how the activity shall be performed. It gives you an understanding of the problems and the possibilities of an EF. It will give information for how to run an EF, giving guidelines that will help you perform systematically and thereby successfully.

## *What should I be aware of?*

An EF will cost money but it will surely pay back more, if it fulfils its task. But that is a minor consideration when looking at the whole picture. You are probably aware that today all organisations must improve just to stay in business. Establishing an EF will mean that the culture of your organisation might change. The quote “Measurement is the way we do business here” [Basi95] gives a reflection of the mature behaviour of the EF in NASA/SEL. You also must understand that the EF can’t act more mature than the software projects and the management/leadership. If you

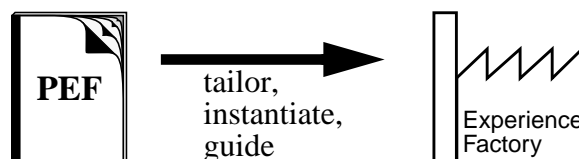
don't let improvements go all the way, the full benefit will not be achieved.

## 2. Introduction



This booklet presents a model for how an Experience Factory (EF) can work together with the software development projects and the management of an organisation, to ensure that the organisation gathers experience from projects and that the other projects take advantage of that experience, i.e. the PIA Experience Factory (PEF) model. An executing EF is a tailored instantiation of the PEF model and it can use the PEF model as a means to guide its progress. See figure 1.

**Figure 1: The PEF model and an executing EF**



In turn the PEF (the PEF model) is an extension and augmentation of the Experience Factory concept defined by Basili, [Basi94, Basi95]. The PEF model describes the different roles and responsibilities in an organisation that are directly involved in and affected by an EF. It describes three activities/roles that will be present in one shape or another as part of the management of the organisation, EF Sponsor, Vision Owner and Business Analysis. It also describes three activities/roles of a software development project, Project Management, Software Engineering and Project Measurement Program. Each of these activities/roles are performed by the project but can be supported by the EF and the experiences provided via the EF. The mentioned activities/roles are only described in enough detail to give a quick understanding of the activities/roles. This since each implementation will be substantially different in a real organisation. See also [Scenario].

The major part of this booklet and the PEF model is the description of the EF according to PIA. The EF part is divided in three main functions plus the experience base. The three main functions of the EF are, Strategic Improvement Management (SIM), Experience Package Engineering (EPE) and Project Support (PS). The experience base is described in its own booklet, [ExpBase].

The SIM is focused on the “management” aspects of an EF and thereby the process management strategies of the organisation. How does our organisation best take advantage of processes and experience? This includes running process Improvement Programmes, evaluating new technologies and introducing new technologies.

The EPE is focusing on the periodical re-packaging of the experiences that are made in projects, analysing, synthesising, generalising and packaging the experiences for reuse. How do the EF select and package processes and experience to make it re-useable? This includes the documentation of process models, setting up measurement program to compare efficiency and effectiveness of process and, analysing and generalising the experiences made by the projects.

Finally the PS is focused on “coaching” and technology transfer of the process and experiences to the software development projects. How can the EF best support the projects with experiences and coaching? This includes activities to ensure the use

of the process models in the project, to support the establishment of a effective measurement program in the project, and to select and adapt experiences to each project and project situation.

The functions in the EF are described in some detail, but the intention is not to make it a commandment. Use the PEF model as a vision for what you could do, and then start with what you think is most important in your organisation. The better understanding of your desired organisation you have, the smoother the transition will be. See also the [Launch] booklet.

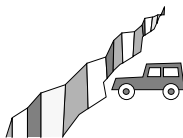
## 2.1 Purpose of this booklet



- Set a context for the EF i.e. projects and sponsoring organisation
- Specify the responsibilities of the EF, the projects and the sponsoring organisation
- Describe the main activities an EF must engage in
- For activities in the EF responsibility areas, describe the process, methods, working products, roles, guidelines and experiences made by the applications in the PERFECT project
- Give suggestions for how the PEF-model can be used to implement an EF

In this document we describe how to organise an Experience Factory according to PIA, which should give you the necessary knowledge to set up your own improvement programme and especially how to organise your own Experience Factory.

## 2.2 Problem Statement



After an organisation has taken the decision to establish an Experience Factory, the next questions arise. What activities should the EF actually perform? And how should the rest of the organisation work together with the EF?

The PEF model takes a full grip on how to organise the activities of an EF, internally and as a part of the whole organisation.

## 2.3 Context within the PIA

The PEF model is a important part of the PERFECT Improvement Approach [PIA]. Other parts of the PIA include the Platform, the Methods and the Experience Base, which all are important to implement the PEF model and its improvement principles. In the PERFECT project other activities have affected the PEF model as described below.

### PIA-steps (QIP)

The top level of the PIA is based on the six steps of the QIP. In the PEF model all process models are based on the principle of the PIA steps as well as the fundamental idea for how to apply them together. See the [PIA] booklet.

## Applications

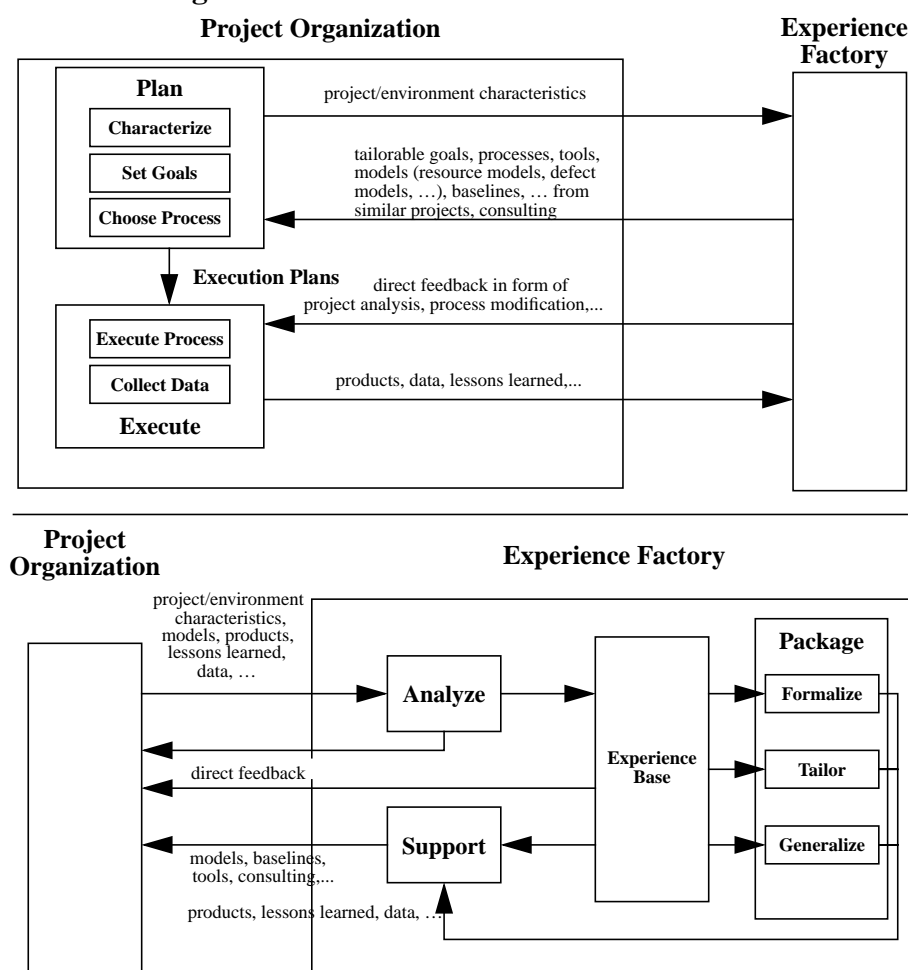
The application projects have been implementing the PIA and given feedback continuously to the development of the PIA and thereby the PEF model. The experiences made in the applications have directly influenced the structure and contents of the PEF model. Experiences from the applications are described in the A-PIA booklet. See the [APIA] booklet.

## 2.4 Background: EF at Nasa/SEL

The Experience Factory concept was invented, evolved and made known by the Software Engineering Lab run by NASA, University of Maryland and GSC.

The Experience Factory is a logical and/or physical organization that supports project developments by analyzing and synthesizing all kinds of experience, and supplying that experience to various projects on demand. It packages experience by building informal, formal or schematic, and product models and measures of various software processes, products, and other forms of knowledge via people, documents, and automated support [Basi94].

**Figure 2: The EF at NASA /SEL/**



This principle implies the logical separation of project development (performed by the Project Organization) from the systematic learning and packaging of reusable experiences (performed by the Experience Factory).



This EF by NASA/SEL is the main building block for the PEF model. It gives support for an organisation to implement continuous improvement using experiences and goal oriented measurements.

## 2.5 Document Overview

Read this booklet as a *recommendation* for what an EF can do and how it can operate. Nothing, except the principles, are meant to be mandatory. Use this booklet as a guide and implement the EF concept with the focus on what your organisation want to achieve.

This first chapter gives a management overview of the concept of the PEF model.

This second chapter gives a short overview of and context to the booklet and its background.

The third chapter covers shortly the different features that the PEF model is based on and which an EF should apply. This chapter highlights the different aspects of improvement and learning that are integrated in the PEF model.

The fourth chapter describes the PEF model, a consistent model for an Experience Factory, where all basic techniques presented in the previous chapter are integrated.

The fifth chapter presents the guiding principles for the PEF model, the principles that should be taken into account when running an EF. If these principles are not followed experience shows the chances of successful improvements decreases.

In chapter six some frequently asked questions are answered regarding warning signal for when an improvement programme is in danger. This is done since we cannot always provide a recommendation for how to do, but only what not to do. This is sometimes just as helpful.

In chapter seven some direct suggestion are given for how the PEF model can be used.

There are two chapters providing references.

In the appendices the more detailed descriptions of roles/activities and the processes of the PEF are gathered. They are described in “process” like form as a help to, after tailoring, plan and execute the activities in your own organisation.

### 3. Abbreviations and key words

This section contains a list of abbreviations and explanations of key word used in this booklet. If available, references to the sections which treat or use the abbreviation/word is given. This makes it possible to use this list as a subject index.

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<b>Activity</b>	A part of a process that analyses inputs and /or produces outputs and that leads to a result.
<b>Agent</b>	An actor (human or machine) who performs a process element.
<b>Circle diagrams</b>	See Dependency Graph.
<b>Dependency Graph</b>	An illustration of the interrelationships between certain events, actions etc. Also called system model [Seng94].
<b>EF</b>	Experience Factory according to [Basi94].
<b>Experience</b>	Knowledge gained by analyzing information and relating it to situations and events.
<b>GQM</b>	Goal/Question/Metric. A systematic way of finding what metrics to collect, to measure if a goal is fulfilled.
<b>IPC</b>	Improvement Program Cycle.
<b>Life-cycle model</b>	Defines the primary states that a product reaches as it matures over its useful life.
<b>Metrics</b>	Any measurement which relates to a software system, process or related documentation, e.g. measures of size in lines of code.
<b>Model</b>	A model is a simplified representation of a system. See process, product, system and quality model.
<b>NTInv</b>	New Technology Investigation.
<b>NTIntro</b>	New Technology Introduction.
<b>O-EP</b>	See Organizational Experience Package.
<b>Organizational Experience package</b>	An organizational EP prepares a software development with a definition of measurements, quality models and circle diagrams.
<b>PCE</b>	Process Control Engineering.
<b>PCS</b>	Process Control Support.
<b>PEE</b>	Process Experience Engineering.
<b>PEF</b>	The Experience Factory according to PIA.
<b>P-EP</b>	See Project Experience Package.
<b>PES</b>	Process Experience Support.

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<b>PIA</b>	The PERFECT Improvement Approach.
<b>PME</b>	Process Model Engineering.
<b>PMS</b>	Process Model Support.
<b>Process</b>	A sequence of steps performed for a given purpose; for example, the software development process.
<b>Process drivers</b>	Any key characteristics that directly affects an activity.
<b>Process model</b>	A set of partially ordered steps intended to be used to reach a goal. It includes technical and management activities that are carried out in production and maintenance of software.
<b>Product model</b>	Describes different types of produced objects and their relationships.
<b>Project Experience package</b>	An Experience Package template (see below) together with measurements, analyzed information and collected experience from a project.
<b>QIP</b>	The Quality Improvement Paradigm. An iterative, goal-driven framework for continuous improvement of software development.
<b>Quality model</b>	A functional relationship between measurable attributes of given entities and a factor of software quality.
<b>Role</b>	A coherent set of process elements to be assigned to an agent as a unit of functional responsibility.
<b>Standard development process</b>	A process that all projects in an organization use. It is tailored to fit the projects' different needs and goals.
<b>System models</b>	See Dependency Graph.

## **4. Basic Aspects of the PEF Model**

There are many aspects involved in running improvement initiatives. The PEF model tries to integrate some of those aspects into one consistent improvement model. To understand this model, its purpose and relevance, it is important to point out some of those basic aspects. This is done in this chapter. If you are already aware of these features then go directly to the next chapter, where the PEF model itself is presented.

### **4.1 Experience**

Is experience the same as learning? Hardly, but it can be an important part of efficient learning. If learning is defined as understanding of something followed by a change in behaviour due to that understanding, how would then experience be defined? Maybe as awareness of situations and the possible results of some action in that situation. Experience can be used to recognise similar situations, to avoid old mistakes and/or to know what has worked before. As our experience increases, we will start to understand more and can then set up hypothesis about the underlying reasons.

In an EF it is important to gather the experiences that will be the most crucial to reuse in the next project. To make observations and maintain measurement data involves a cost, and it is therefore critical to identify the factors with dominant impact. From the experience point of view, the EF must identify the dominant factors that influence the software development, in which way they do so and how to control and improve them.

### **4.2 Experience packaged for Reuse**

#### **4.2.1 Process Models**

A process model is a description of a process being performed or to be performed. It includes

- product models showing relations between the work products of the process,
- ordered activities that manipulate the products,
- roles that perform the activities,
- methods explaining the technical and logical manipulations within the process,
- examples and templates to speed up its use, and
- training material to speed up the introduction the process users.

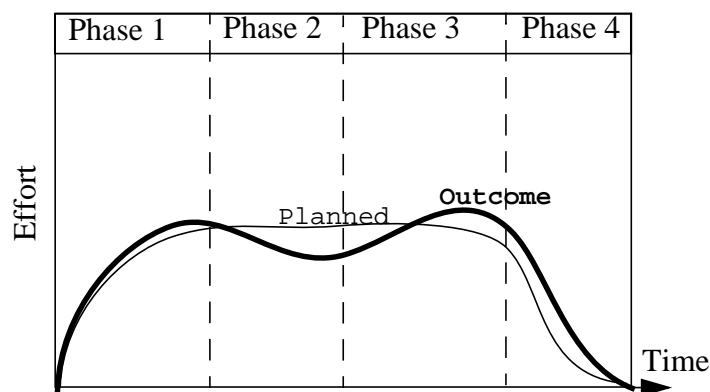
The process model is the base for making process improvements. In the process model an organisation can store its experiences for how to best perform a task. As the process is being better understood and then improved, the efficiency and effectiveness of the agents applying the process can increase.

#### **4.2.2 Process Control Models**

A process control model is a mechanism for controlling the performance of a proc-

ess and thereby the result of the process, in our case the software product. The term control does not indicate that people should be controlled. Rather the opposite, by providing involved persons quantified feedback of the process performance everyone will easier see the consequences of their decisions. This understanding will make it possible for everyone to improve the process and thereby the result of their work. Process control models involve goals for what to control/investigate, goal breakdown structures (GQM abstraction sheet, see [GQM]), hypothesis of the impact of different factors, measurement definitions, measurement collection procedures, visualisation and analysis of the measurement data.

**Figure 3: A process control model showing effort distribution over project phases**



The process control model is the quantitative way for enhancing the understanding of the process performance in a project. The control models must be analysed and interpreted by the persons with the best understanding of the actual situation, i.e. normally the project members. The control models are an important input to the development of reusable experiences, indicating what, when and how to be reused.

#### 4.2.3 Process Experience

Process experience is all knowledge, both quantitative and qualitative, gained by measurements, interviews, feed-back sessions and analyses. Process experience consists of process control models with data, measurement database, feed-back reports, improvement recommendations, dependency graphs and project characteristics.

The process experience is the base for systematic learning. Learning is achieved when understanding a problem situation and then changing the behaviour to avoid repeating problems that arise in similar situations, i.e. gain experience and act appropriate.

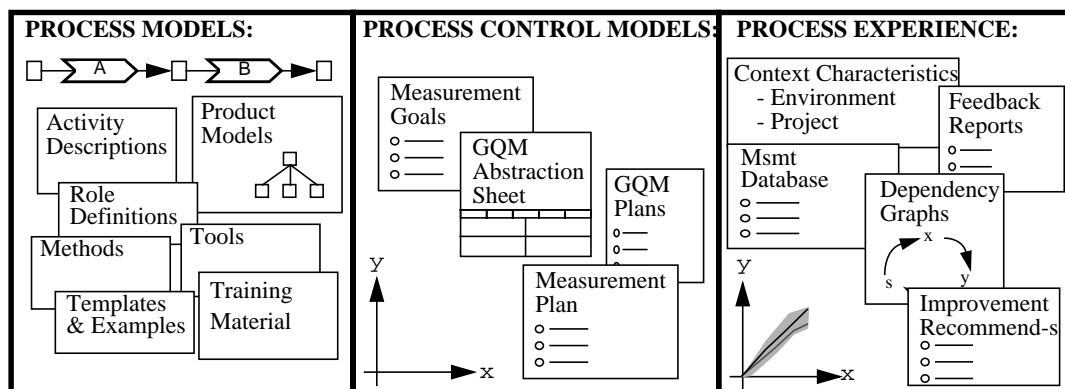
Depending on the situation of the organisation, e.g. market stability, product life span, etc., the type of experience that are vital for real organisational learning and thereby process improvement might differ substantially. In an organisation with stable market and long term products, the experiences might be directed to how to achieve best cost/benefit from the development (process) e.g. reducing errors that otherwise will require high maintenance cost. On an unstable market with short term products, the important experiences may be how to develop new products with short lead time and maximum functionality, e.g. the market needs, technology evaluation and introduction of new technology.

#### 4.2.4 Experience Package (EP)

An Experience Package is a collected set of consistent process models, process control models and process experience that form an consistent unit. The Experience Package is the main work-product within the EF and it models the knowledge of the organisation by three supplementary views.

Figure 4 shows a refinement of the Experience Package content.

**Figure 4: An overview of an Experience Package.**



The first view covers the process model including a work product model i.e. what has to be developed and how to do it. It will document the best practises of the organisation for how to perform different activities.

The second view covers the Process Control Model i.e. models for how to evaluate how well the product is/was developed. Quantitative models visualising the relationship between typically quality (reliability), time and cost related parameters (impacting factors) and the process and product model. It includes the goals for the control/investigation, the questions used to break down the goals and the measurement definitions as well as the measurement collection procedures that were used, and the methods for how to visualise/analyse the data. It will document the most important factors for a project to track to be in control of the PQTC factors.

Finally, the third view covers the explicit knowledge of using the process model and by evaluating it with the quality models i.e. quantitative and informal experience. The quality models will now be filled with data and can be used for visualising e.g. mean values and confidence. Dependency graphs can be used to capture the experiences made for what factors do influence other factors and how they are related, especially to point out limiting factors to success and explaining the cause of problems.

In an organisation with an EF, the experiences made in one project will be generalised to be reused, if applicable, in other projects. The basic way of doing so is by generalising the projects' processes to standard processes for the organisation. In the PEF terminology this is described as Project Experience Packages and Organisational Experience Packages. This is further described below.

#### Organisational Experience Package (O-EP)

The EF is, on behalf of the organisation, developing and maintaining Experience Packages to be used by the projects. The EF must describe, document and formalise

a process to make it useable in a project. The EF should also develop and document the general process control models for all processes. If possible, the EF should also derive predictions for the performance of the process prior to its use in a project. This will be documented and stored as an Experience Package in the experience base.

After one or more projects have applied the process, the EF should analyse, synthesise and generalise the experiences made by the project. The process and process control models can be fine tuned, while the process experience should fully integrate the experiences made in a reusable form. As the experiences are analysed and packaged they update the organisational Experience Package to a new version.

### **Project Experience Package (P-EP)**

The project selects an organisational Experience Package to be the base for the execution of the project. The process and process control models are tailored and the process experiences are used to derive predictions for the project. The adaptations made by the project is documented as the project Experience Package. During the project other experiences maintained by the EF can be consulted to improve project control. After the project, the quantitative and the qualitative experiences must be documented in the project's Experience Package. This will be used to improve the organisational Experience Package.

#### **4.2.5 Experience Base**

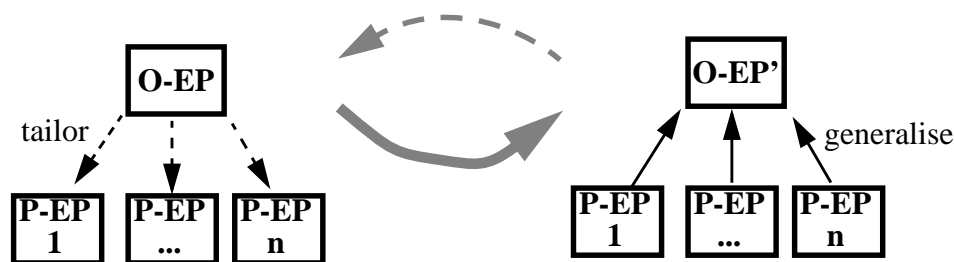
The experience base is the repository for storing the Experience Packages. It can take different forms and supply different levels of automation and services. It can be centralised or each project can maintain its own.

The PEF model is not based on any specific assumptions of how the EB should be implemented. Any implementation, on paper or as an automated interface to a database, is sufficient even though convenience might wish for automation. Some abilities of an automated interface can be useful for e.g. training and prediction.

See the [ExpBase] booklet.

### **4.3 The Experience Package Life-cycle**

- (1) When a "new" process is introduced to the Experience factory it is documented as an Organisational Experience Package (O-EP) and stored in the Experience Base (EB). The process and general process control models are documented. See figure 5.
- (2) When a new project is initiated, an O-EP is selected and tailored to the projects needs and an project Experience Package (P-EP) is created. Additional process control models can be created based on the goals of the project. Available experiences will be used as a base for making predictions of the project performance. During project execution measurement data is collected and analysed, project members are interviewed, etc. to gather experience for managing the project as well as understanding the process in relation to the project goals. After the project, these experiences are documented in the P-EP and stored in the EB.

**Figure 5: The Experience Package Life Cycle**

- (3) It is then the Improvement Programme that decides when and how to update the O-EPs. There might be one or more P-EPs stored in the EB that is based on the same O-EP. At some point of time these P-EPs should be used to update the O-EP. The update can be minor, which means merely to integrate the new project's experiences with the experience part of the O-EP, or major which includes updates of the process models and the quality models of the O-EP. In the case of major updates the O-EP' will be stored as a new version of the O-EP. This activity will be performed by the Experience Package Engineering function in the EF.
- (4) The new O-EP' is then ready for use in new projects.

## 4.4 Feedback Loops

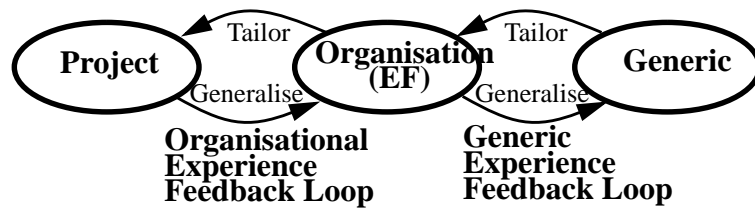
### 4.4.1 Overview

There are three levels of knowledge identified as important in the PIA. The generic level denotes the “public domain” knowledge represented by the software engineering community. The organisational, or EF level, is the knowledge owned by and specific to one organisation. The project level is the knowledge that is specific to one specific project. It is by the experience feedback loops the knowledge and thereby learning can be achieved. And it is by the control feedback loops the control and thereby management of activities can be achieved. The control feedback loops should take advantage of the experience loops both at project initiation and project execution. When the control of the project is based more on experience the organisation can ensure both process control of the project as well as the introduction of new technologies into projects.

### 4.4.2 Experience Feedback Loops

An experience feedback loop consists of two activities, tailoring of a general model to a specific use, and the generalisation of the specific usage to synthesised experiences for general reuse. By a feedback loop a specific project can learn from the joint knowledge of the organisation and take part of the further learning by contributing with its additional understanding.



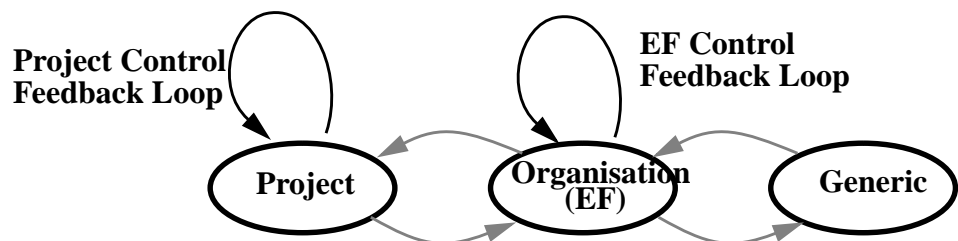
**Figure 6: Experience feed back loops**

The first feedback loop is called organisational experience feedback loop and is established as a bridge of experience from one project to the next. Experiences gained in one project can be reused in the next and the experiences can be further augmented. Projects need to set up measurements not only for the management of their own project and product, but also to improve the understanding of the process and the product for coming products and for improvements. This supports learning from project to project via the EF.

The tailoring activity takes part before as well as during the execution of the project. Before the project start the organisational models i.e. organisational Experience Packages (O-EP), is used as a base for tailoring and prediction. During the project experiences in the EB can be consulted to help the project make decisions. The project can use the EF as a learning support system where events and actions can be evaluated in respect to the available experience within the EB.

The other experience feedback loop, from the EF to the generic level is not integrated in the EF model described in this document and will therefore not be further elaborated on here.

#### 4.4.3 Control Feedback loops

**Figure 7: The Control feedback loops of the EF**

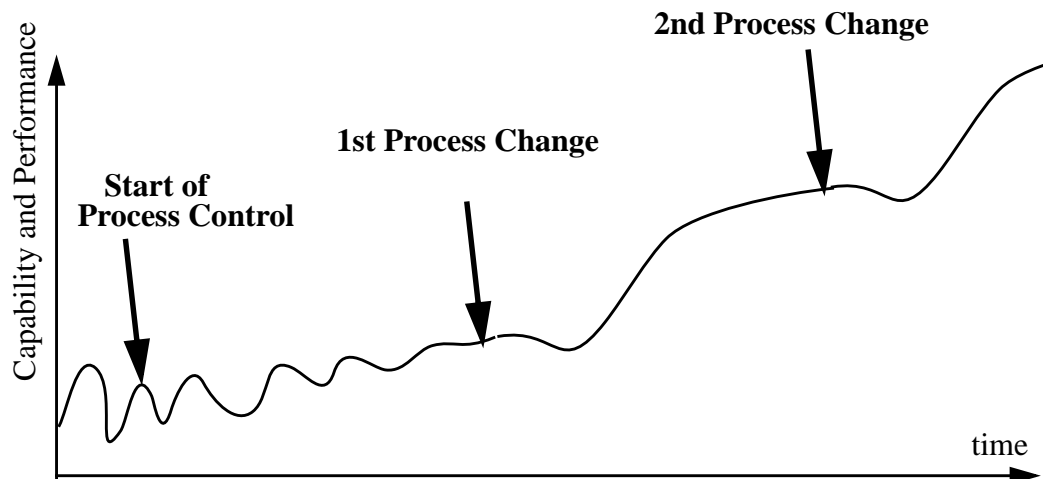
The first feedback loop is called project control feedback loop and is executed during the execution of an project. Projects use measurements for the management of their project and product. The project can via the measurement programme monitor the consequences of decisions taken and evaluate those in relation to the predictions. From the monitoring the project must be controlled, i.e. taking corrective actions and replanning. This loop involves important project management aspects that should be fed back to the organisational experience feedback loop.

The second feedback loop is called EF control feedback loop and involves the interaction between the EF and the sponsoring organisation. It is established to improve the total ability of the organisation to improve its processes and to manage them for business purposes in the long and short term.

## 4.5 Evolutionary Process Improvement

What does process improvement mean? The term can be described by the two separate but interrelated activities, Process Control and Process Change. Both are essential parts of making improvements and should be applied in the right order and with the focus that gives best leverage in each project and organisation.

**Figure 8: The impact of Process Control and Process Changes**



### 4.5.1 Process Control

Process control is focusing on how well the current process can be implemented to achieve primarily efficiency and predictability. Fine-tuning is a relevant synonym. It is about understanding the basic characteristics of the process, when it can be applied, how it should be applied in different situations, how to monitor it and how to correct slippage during the process execution by feeding back that information to the persons implementing the process. As a result of process control the projects will be better and better at predicting their results and minimising the risks of the product as well as the project.

### 4.5.2 Process Change (or Innovation)

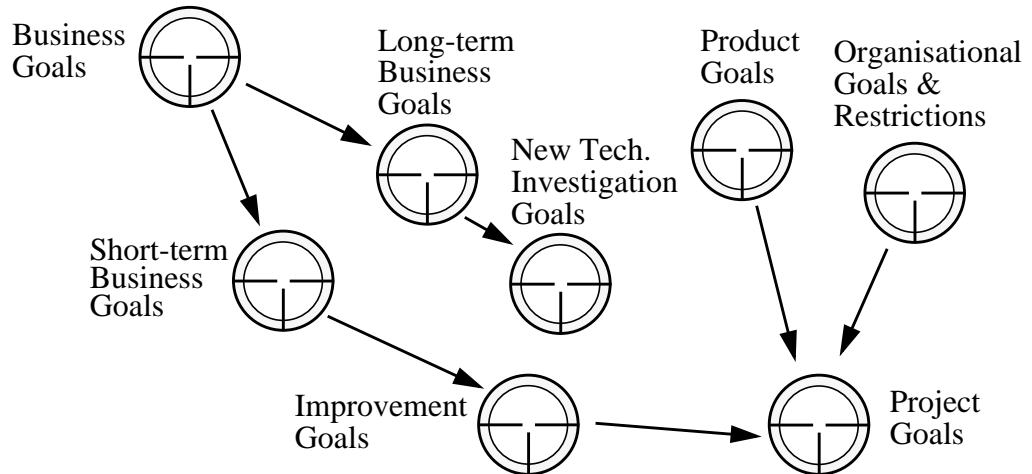
Process Change is focusing on changing the process by replacing parts or the whole process to achieve effectiveness. The focus is on measuring, analysing and evaluating comparable processes to understand their applicability, strengths and weaknesses in relation to each other. The most effective process should then be selected and introduced in the projects to achieve better performance than what was possible with the previous process. Initially when a process has been changed, predictability and risk will naturally decrease, and so will most often the effectiveness as well. But as a long-term result of the process change the overall effectiveness of the process and the projects should increase.

## 4.6 Business Goals and related Goals

The initiative to make improvements should be based on some business goals that are set by the organisation that has implemented an Experience Factory. The Experience Factory's task will be to support the projects to improve and thereby achieve

the business goals. But for the operation of the Experience Factory it is necessary to refine the business goals some what. Below follows derivations of the business goals.

**Figure 9: Derivation of goals from Business Goals**



The business goals are based on the requirements of the organisation's domain, the organisation's owners will and the goals of the organisation's management. The business goals can be broken down to long-term and short-term business goals. The division in long and short term is done based on the time frame of the organisation and based on the time frame to take action e.g. implement improvements. The long-term business goals is used to investigate new technology. The short-term business goals are broken down to improvement goals for Improvement Programmes. The goals for each software development project will be based on improvement goals, product goals from the customer and other organisational goals and restrictions. See also [Scenario].

## 4.7 Goal Oriented Measurement

Measurement is an important task of any improvement program. Measurement is in fact the key for the ability to understand, discuss and present:

- the current capability of the organisation and projects,
- the effect of the changes introduced in an improvement program and
- how we are progressing towards the long-term goals

Measurements are also the main input when building up the quantitative Quality Models in the Experience Packages.

The success of using measurements in an organisation are very related to knowing why using measurements and how to use it. Thus, the most important task in a measurement program is not to define a number of metrics, but to understand the purpose and use of them. The key in achieving this is to be goal-oriented. The main characteristics of goal oriented measurements are to:

- always have a clear purpose, a goal for the measurements,
- to define metrics based on the measurement goal

- always have a clear view of how to analyse (use) the outcome.

GQM (Goal Question Metrics) is a method supporting goal oriented measurements [GQM].

When using goal oriented measurements (or any measurement program) the following is important to keep in mind:

- Start smoothly when introducing measurements, giving the ability to build up experience and commitment in steps.
- Do not only address if improving but also why, supporting the decisions for the future.
- Involve all stake-holders, getting commitment and buy-in for the measurements

## 4.8 Improvement Programmes

The Improvement Programme is assigned the task of improving the organisation and its projects' performance. The Improvement Programme is run by the Experience Factory. The Improvement Programme must operate in a goal oriented fashion and process control and process change are the strategies. The Improvement Programme works through the software development projects. The Improvement Programme is responsible for the support activities to the projects.

Separate from the Improvement Programme other activities can be ongoing in an Experience Factory, e.g. investigation of new technologies, experience base management and data collection from projects outside any improvement programme.

Typically an Improvement Programme will have the focus of improving the understanding of some aspects of the organisation, e.g. establishing a performance baseline, this can be extended with the purpose to improve the predictability (process control) by enlarging or detailing the current baseline. Another focus can be to improve the actual performance in the projects, either by introducing new technologies that has been proven useful or to identify needs and possibilities from the experiences of previous projects. Normally an Improvement Programme will make process changes initially and then put focus on infusing them and finally package the measurement and experiences to package a performance baseline. See also [IDEAL].

## 4.9 Change Management

A major restricting factor to introducing changes in an organisation is the way the changes is perceived by the humans affected. The human effects should not be underestimated and all persons involved in change activities should have basic knowledge of Change Management.

Aspect that must be understood are the implementation climate for the change (history of change and stress), the organisational readiness for change (tug-of-war, chaos, unified), the transition model of change (un-freeze, transition, re-freeze), and the way people respond to perceived negative or positive change. See [SPC92/93/94].

## **4.10 Statistical Analysis**

When the same process has been executed several times by projects (or the same process part, e.g. inspection process, in the same project) statistical analysis can be used to draw conclusions based on data with measurable confidence over process effectiveness and process efficiency in relation to different influencing factors. It can show how different factor relate to each other, by e.g. mean value, standard deviation and probability range, to provide better ways of controlling the process and thereby the results of the projects. It is important to remember that every process execution, i.e. project, will be unique in many aspects. But by setting up each project as a scientifically based experiment the important influencing factors can be identified and tracked to show real difference and similarities between projects. When the organisation really starts to understand its performance in terms of quantified data, then the possibilities for making carefully considered trade-offs in negotiations with customers will be possible.

## **4.11 Coaching**

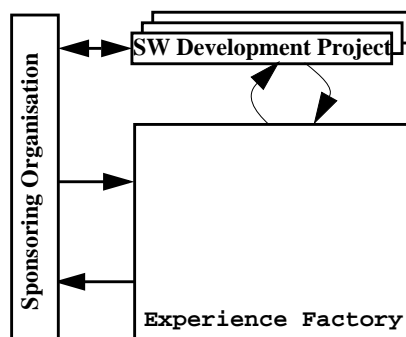
Coaching is an important activity used to bring out the best in people. It issues the fragile understanding of humans and their impact on project performance. Coaching can be used for activities like building commitment, encouraging people, transferring technology, solving problems and assessing project status. A coach isn't always just a coach - sometimes he/she puts on the role of a trainer, counsellor, mentor, assessor or expert. Coaching is a very important part in succeeding with making changes in an organisation. Within the Experience Factory each software project should be assigned a process coach that supports the project with knowledge about the process models, the process control models and the process experience available in the experience base.

## 5. The PEF Model

### 5.1 PEF Model - Overview

The PEF model organises the activities of an EF and how projects and other parts of the organisation interact with the EF. The PEF model is based on the three major building blocks, the management of the organisation, the software development projects and the EF. The model gives a brief description of a software development project to visualise the activities in the project that is essential for the EF and process improvement. It points out a few roles/activities in the organisation that represents the management view of the organisation that is essential to a well functioning EF. The major part of the model is the description of the EF, its functions and the essential activities that it performs.

**Figure 10: The main parts of the PEF model**



The Sponsoring Organisation which in fact is the whole organisation, e.g. a company, department, division, or unit within the company, including all employees and managers. But to simplify the model the sponsoring organisation in the PEF model is highlighted with three roles/activities that is more connected to management. These do absolutely not have to be explicitly appointed, but the activities as such are helpful for an EF. Business analysis, analysing and predicting the future business situation for the organisation and its products. The Vision owner that is driving the transition of the organisation including both the establishment of a full fledged EF as well as all the improvement suggestions that will be introduced via the EF. And the EF sponsor that is taking the financial perspective on the EF, allocating resources, following up the cost and benefits of the EF and the improvements made, and in much acting customer to the EF.

The software development project is described in three phases, the pre-project phase, the project execution phase and the post-project phase. In the pre-project phase the project is characterised and relevant process and experience in the experience base are identified and tailored. During the project execution phase the project is instantiated, including planning and estimation; executed which means the software is developed, the project is managed and a measurement program is executed on the project. In the post-project phase the experiences from the project are gathered, analysed and documented.

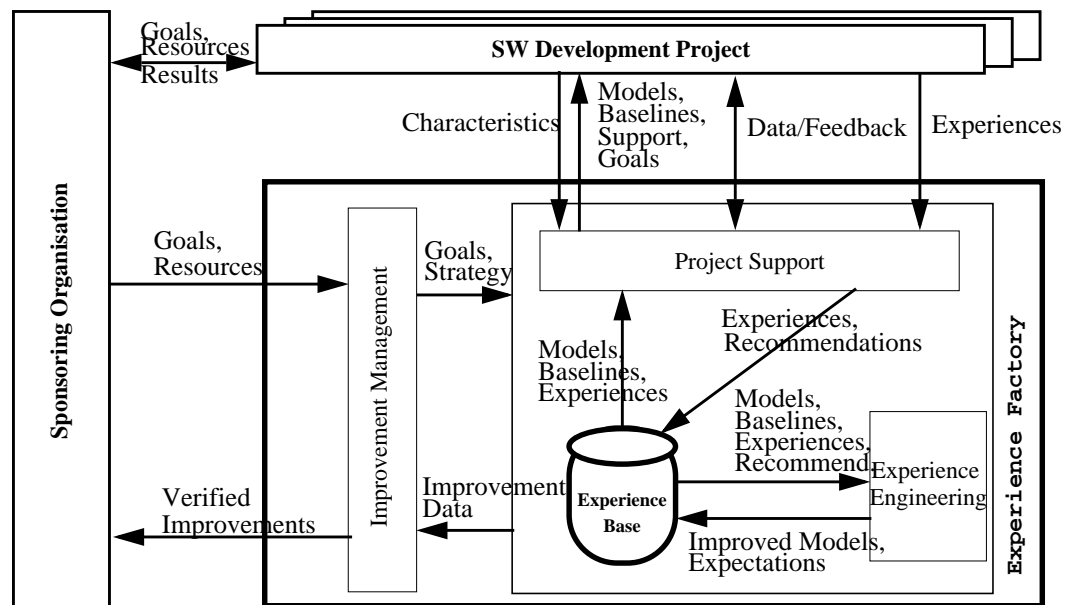
All three project phases are actively supported by the EF. The EF helps the project to use its process in the most effective and efficient way. The EF supports the measurement program to set up appropriate measurement goals, and to analyse, under-

stand and suggest improvements to the project management. It also supplies experiences from previous project to all project activities i.e. software development, project management and the measurement program. The experience in the experience base should be analysed and adapted to the relevant context of each project, to make it applicable and helpful.

## 5.2 Information flow in the PEF model

Any improvement is based upon learning, and essential for learning is the presence of accurate information. Further more organisational learning normally means that several individuals need to act on the same information, which implies the need of documenting and spreading information. While the Experience Package is the main information element for an EF, there is still a need for several other types of information. Goals must be stated and documented. Resources assigned and tracked. Characteristics identified and maintained. Models analysed and tailored. Baselines documented. Measurements collected and analysed. Recommendations and feed back exchanged. Experience and improvement suggestions documented. Business, strategic and action plans developed and documented. And so on. In figure 11 an overview of these work-products are shown.

**Figure 11: Information flow within and around an EF.**



The EF is working with the software development project and the sponsoring organisation. Primarily, the software development project will interact with the EF. The projects are supported by reuse of the processes and experiences maintained by the EF. Secondary, the sponsoring organisation will interact with the EF as well as the software development projects to achieve the business goals. The sponsoring organisation is responsible for business at the whole and must develop business plans including business goals to initiate EF activities, provide necessary resources to the EF and verify whether improvements are made in line with the business goals.

### 5.3 The flow of control in the PEF model, one example

This section explains one way that the PEF model can function but as it is a over simplified description of the control flow in a real EF organisation it must be taken for what it is, one simple example. The control flow of the PEF model describes how the different parts of the PEF model are initiated, execute and terminate.

The starting point could be that the Business Analyst has made a new business analysis showing the future demands on the organisation. The Vision owner will see how the EF can be used to handle some of these demands. The vision owner and the EF-sponsor agrees on which goals and resources should be provided to the EF for doing this. The Improvement programme manager of the EF and the new technology investigator will now get into the discussion and after a while agree to pursue these goals.

The NTInv can now set up experiments and studies to find solutions for the long term goals that faces the organisation, while the IP manager sets out to tackle the short term goals over a shorter time frame. Both activities can now use all processes in the Project Support and Experience Package Engineering functions to implement important activities in their programmes. The NTInv will normally develop process models and Process control models according to Process Model Engineering and Process Control Engineering process for the new process ideas. And then conduct experiments from those process descriptions.

The IP manager will typically make an study, Process Experience Engineering, to investigate the direct potential for improvement via improved process control and/or process change. If process change is suggested the PME will be engaged to make the necessary process descriptions and PCE to make updates for how the organisational measurement programme should be integrated with the changed process. The first pilot project will get support from the EF via Process Model Support, which coaches the use of the process, Process Experience Support that can give expert guidance on the parts of the process that are known and Process Control Support which will help to set up a relevant project measurement program and then supports the monitoring and analysis of the measurements. For each project the Improvement Programme will set up improvement goals for the results of the project. The IP will follow up the results continuously and at the end of the project. The improvement goals for the projects will normally get higher and higher as experience of the process grows and process control is regained.

When all projects in the improvement programme is executed the IP is summarised and the improvements results are evaluated against the initial improvement goals. The vision owner and the EF-sponsor are presented the results from be the IP manager and the gain of the improvement programme and the EF can be evaluated.



## 5.4 Roles involved



Below follows a suggestion<sup>1</sup> for how responsibilities and activities can be distributed on a set of roles in the organisation, the projects and the EF.

- **Experience Factory Worker roles (Agent)**

Roles responsible for performing the activities of the EF:



- **New Technology Investigator:** Investigates possible techniques that can help the organisation achieve its long-term business goals.
- **Improvement Programme Manager:** Manages an Improvement Programme to achieve the defined improvements goals.
- **Experience Package Engineer:** Takes ownership of the Experience Packages, and maintains and improves the process models, process control models and process experiences, for reuse.
- **Project Supporter:** Supports the projects with how to use the process, the process control models and the experience. Supports all roles in the project with relevant experiences for their activities.

- **Sponsoring Organisation Manager roles**

Roles in the organisation directly involved in the improvement initiative:



- **Business Analyst:** Understands the business domain and the business situation of the organisation, and makes business plans covering long-term and short-term goals for the whole organisation.
- **Vision Owner:** Drives the change of the organisation towards an 'internal vision' that supports the organisation achieving its business goals, by initiating and supporting the introduction of an EF and the evolvement of the processes, the projects, the EF, and the organisation.
- **EF-Sponsor:** Defines realistic improvement goals for the EF, makes pay-off (ROI) calculations on the EF and its improvements, assigns sufficient resources to the EF, and follows up results achieved by EF and projects.

- **Software Project Member roles (User)**

Roles in the projects that are directly involved in the improvement activities:



- **Project Manager:** Tailors and instantiates the process in his project. Is responsible for the project process and executes the project management process. Summarises the experiences made in the project during and after the project.
- **Software Engineer:** Develops the software by refining the requirements into an implementation and tests the code against the requirements, by executing the software engineering process. Supports analysis of project.
- **Project Measurement Responsible:** Develops the measurement plan, collects measurement data and updates process control models continu-

1. This does neither mean that an individual must play only one role, nor that a role cannot be played by more than one individual, nor that a role has to be explicitly appointed.

ously during the project. Feeds back measurement results to the project.

## 5.5 How to team-up the Roles

This section contains some suggestions for how the roles in the PEF model can be used to create effective teams with has enough information and authority to implement control and change.

- EF-steering team

As a steering committee for the EF, the Improvement Programme Manager, the EF-Sponsor and the Vision-Owner can point out directions regarding the internal development of the EF. The responsibility is to make the EF achieve its assignments efficiently.

- Future looking team

To make decisions about which long-term business goals to address and how, the New Technology Investigator, the Improvement Programme Manager, the Business Analyst and the Vision-Owner needs to take a holistic view of both arising needs and opportunities.

- Improvement Programme team

The Improvement Programme Manager, the Project Supporters and the Experience Package Engineers form the driving force of the EF. This team is operationally responsible for achieving the improvement goals and have the power to make it a joint commitment with the projects to actually do so. The information exchange in between these roles is crucial for the success of the EF.

- Project Experiment team

The Project Supporter, together with the Project Manager and the Project Measurement Responsible should form a team with responsibility of using the project resources as efficiently as possible to achieve the project goals.

If a role is implemented by several individuals, they should typically also form a team. Other teams and constellations can be used to address other problems e.g. problem solving task forces.

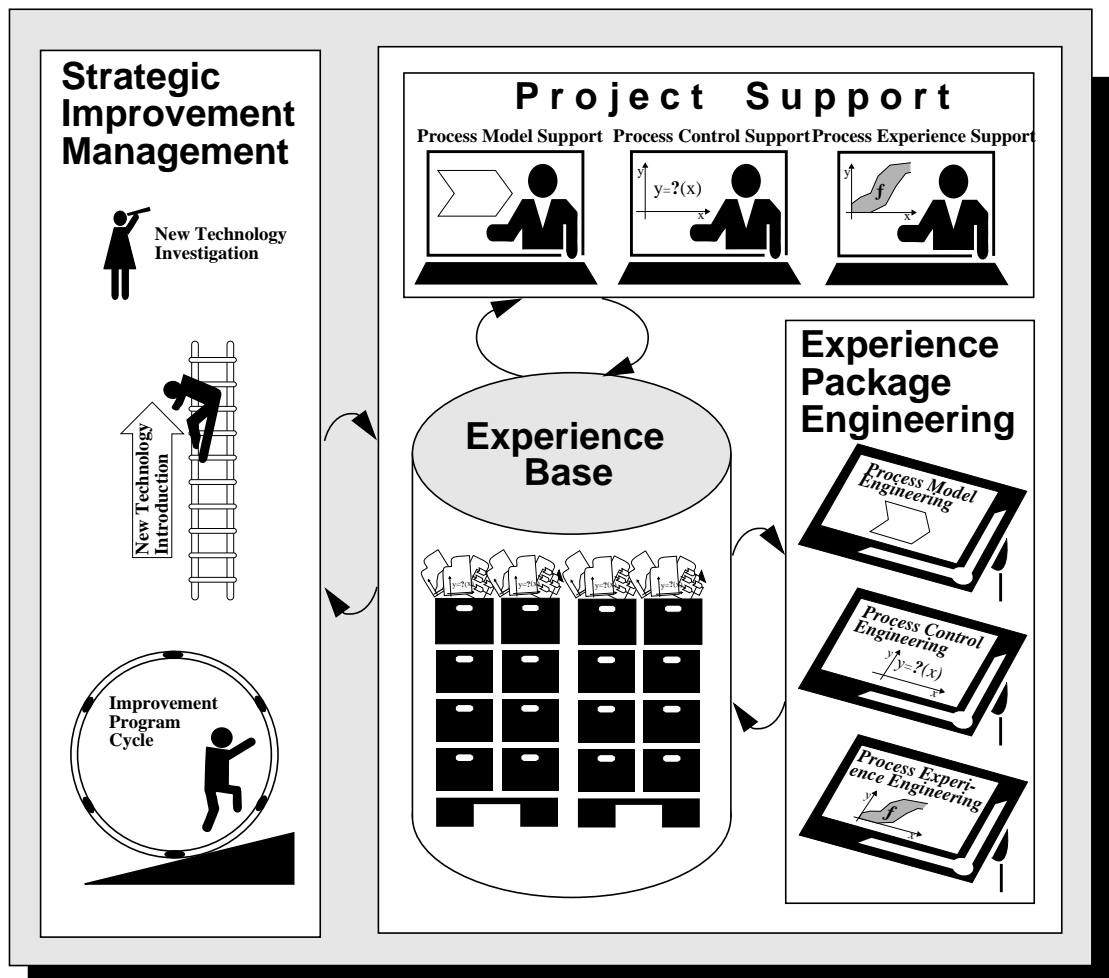
## 5.6 The Experience Factory (EF)

An important issue when establishing an EF is to understand what an EF has to do and how to organise those activities. The PEF-model introduces three main functions for an EF to organise its tasks around. It is the 'Strategic Improvement Management', the 'Experience Package Engineering' and the 'Project Support'. The three areas are presented separately in the PEF model but in real world situations they must interact intensely. The separation is made to promote understanding.

The three functions are typical for many similar activities e.g. software reuse and product development. There is one function for handling the real development of the process, one function for supporting the projects to use the process and one function that manages the work and makes strategic predictions.

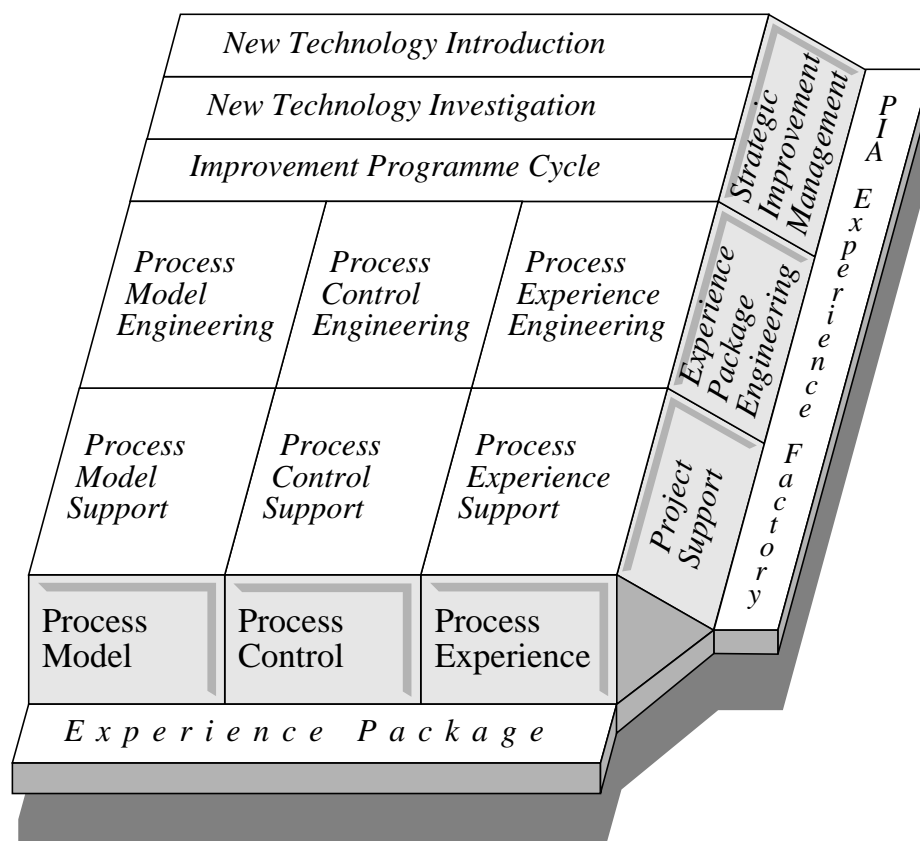
Each of these three functions is then divided in three processes representing the different aspects of necessary activities. The reason why there are three processes in both the Experience Package Engineering and the Project Support function, is that an Experience Package consists of three distinct areas i.e. process model, process control and process experience. Each of these areas needs to be handled differently and that each part has its dedicated processes. But for a supported software development project, the three processes should preferably be performed fully integrated, especially in the case of Project Support.

**Figure 12: The functions and processes in the EF part of the PEF model**



The different functions and processes will be presented as follows. For an overview of the names and the naming conventions see figure 13. Notice how the names of the different parts of the Experience Package (i.e. Process Model, Process Control and Process Experience) are repeated in the names for the corresponding processes. Also part of the function names are repeated in each belonging processes, i.e. Support and Engineering. The exemption is the Strategic Improvement Management which is not directly related to the structure of the Experience Packages.

**Figure 13: Naming Overview: The PEF box**



- **‘Strategic Improvement Management’**  
Handles the management and strategic aspects of the EF. See 4.7 on page 29.
  - **‘Improvement Programme Cycle’** (IPC). See 5.7.1 on page 27. This process describes how to run an Improvement Programme from setting up improvement goals, identifying and implementing improvements, running projects and verifying the results.
  - **‘New Technology Introduction’** (NTIntro). See 5.7.3 on page 29. This process describes how to handle the changes when introducing a new technology into the organisation.
  - **‘New Technology Investigation’** (NTInv). See 5.7.2 on page 28. This process describes how to efficiently, effectively and systematically evaluate new technology before introducing it into the whole organisation.
- **‘Experience Package Engineering’**  
This function handles the documentation of the Experience Packages and the synthesis of their contents. See 4.8 on page 33.

- **‘Process Model Engineering’ (PME)**. See 5.8.1 on page 31. Describes how to document a process with related parts in a process model.
- **‘Process Control Engineering’ (PCE)**. See 5.8.2 on page 32. Describes how to introduce measurements and visualisation of the main long-term aspects of the process and the products.
- **‘Process Experience Engineering’ (PEE)**. See 5.8.3 on page 33. Describes how to analyse experiences in project Experience Packages to find improvement potential and how to synthesise experiences from several project.
- **‘Project support’**  
This function describes all activities that the EF can support an project with. See 4.9 on page 37.
  - **‘Process Model Support’ (PMS)**. See 5.9.1 on page 35. Describes activities for supporting the project to follow its processes.
  - **‘Process Control Support’ (PCS)**. See 5.9.2 on page 36. Describes how the EF can support the project in setting up the project measurement programme.
  - **‘Process Experience Support’ (PES)**. See 5.9.3 on page 37. Describes activities for how experiences can be used to improve the performance of the project.

The areas in the PEF-model help an improvement initiative to drive its progress in a result-oriented manner and to make progress visible. It sets focus on the need to support the project closely, to secure the project’s use of the models provided as well as ensuring the capturing of experiences and the reuse of experience. It also describes ways to document, analyse and synthesise the models and experiences in the EB.

The appendices gives detailed work flows for how the processes of the PEF model can be executed. See “Appendices” on page 60.

## 5.7 Strategic Improvement Management



### Purpose

Maximise the effectiveness and efficiency of the organisation and its projects in fulfilling the business goals of the organisation, by strategic improving the processes of the organisation and their use.



### Overview

There are many issues to handle when you try to make evolutionary process improvements. Thus there are many activities/processes in the PEF model. But the main idea is still to start and run improvement initiatives that can show results. To do this you need some activities to develop and maintain the actual process descriptions and the gathered experiences. That is the focus of the 'Experience Package Engineering' function. You will also need to make sure that the processes are used as it was intended and that the relevant experiences are gathered and saved after each project. That is what the focus of the 'Project Support' function.

Remaining are the management of the Improvement Programme to drive the improvement work, the investigation and selection of the new technologies to infuse in the organisation, and the handling of the change management aspects of transforming the behaviour of the organisation. This is the focus of the 'Strategic Improvement Management function'.

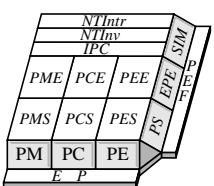
In "Strategic Improvement Management" (SIM) continuous improvement is supported by a process for systematically executing an 'Improvement Programme Cycle'. New technologies are selected by 'New Technology Investigation' and introduced in the organisation by 'New Technology Introduction'.

'Improvement Programme Cycle' (IPC) describes one cycle in a continuous improvement initiative. It describes activities for an Improvement Programme. How to get an understanding of the current situation and the needs for improvement, the goals for improvement and to select and prepare for running the software projects. It also describes the follow-up of the projects and the oversight of the Improvement Programme and its goals. Finally it describes the overall analysis of the improvement projects and the packaging of the experiences and the current baselines. It will use the EPE and PS functions to handle issues in their focus areas.

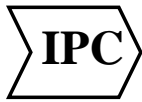
'New technology investigation' (NTInv) describes the systematic ways to evaluate and select the technologies that are candidates to be infused in the organisation.

'New Technology Introduction' (NTIntro) covers the add-on or support activities necessary to ensure a smooth introduction of larger changes in the projects and the organisation. It can be used as an add-on to an Improvement Programme i.e. the IPC process. Changes will typically affect several subsystems in the organisation, e.g. technological, managerial, human, cultural, and strategic. To introduce a change successfully the impact on these has to be anticipated and acted on early.

"Strategic Improvement Management" is about improving competitiveness by using the processes of the organisation as the improvement tool they actually are.



## 5.7.1

**Improvement Programme Cycle (IPC)****Purpose:**

Continuously run Improvement Programmes to encourage and support an organisation in systematically fulfilling its short-term business goals by evolutionary process improvements.

**Goals:**

- Establish continuous process improvement activities for the organisation's processes
- Systematically execute an process Improvement Programme aiming at evolutionary improvements in a controlled manner
- Utilise every project as an experiment to improve the organisation's understanding of its software, software processes and projects.

**Fundamental for performing:**

- The organisation is aware (or becomes aware) of the need for improvement
- Business plan including short-term (1-3 years) business goals refinable to reasonable process improvement goals
- Always respect the guiding principles for improvement. See "Guiding Principles for Improvement with PEF" on page 43.

**Activities performed in the process:**

- Keep the sponsor organisation committed to support the Improvement Programme and ensure sponsor visibility in the improvement programme
- Inform about the need for improvement to keep the motivation
- Maintain a characterisation of the organisation's processes and related areas
- Identify continuously improvement needs (weaknesses) with largest leverage and propose ways to improve
- Negotiate and agree improvement goals based on short-term business goals
- Maintain and implement a plan for how to manage, track and correct the Improvement Programme with its experiment projects
- Monitor and verify the achievement of the improvement goals
- Analyse and package the results of the Improvement Programme as a basis for continuous improvement

In the appendices is a work flow description for this process. See 10.9 on page 64.

### 5.7.2 New Technology Investigation (NTInv)



New Technology  
Investigation

#### **Purpose:**

Systematically recommend new methods and process technologies in the area of software engineering that will be the most favourable for the organisation's ability to fulfil its business goals.

#### **Goals:**

- Make systematic evaluations of promising new methods and technologies.
- Identify, baseline and recommend new methods and technologies that best can match the long term process requirements and goals of the organization.

#### **Fundamental for performing:**

- Clear understanding of the characteristics of the current process technology within the organisation in quantified terms
- Long-term goals of the organisation.

#### **Activities performed in the process:**

- Identify the best candidate methods and technologies at each point in time based on the long-term business goals
- Develop, implement and maintain an evaluation plan for the evaluation of the candidate including a measurement plan
- Make necessary preparations for the experiments and pilot projects
- Evaluate the effectiveness of candidates by desk-pop evaluation, laboratory experiments and possibly evaluation in real projects.
- Continuously evaluate of the experiments and pilot projects, and take necessary actions based on the result.
- Analyse and package the results as recommendations for the organisation to use when deciding about whether to introduce the candidate or not.

In the appendices is a work flow description for this process. See 10.10 on page 67.



### 5.7.3 New Technology Introduction (NTIntro)



#### Purpose:

Systematically support the introduction of selected new process technology into the organisation by enhancing the 'Improvement Programme cycle' with considerations for technology transfer

#### Goals:

- Introduce new process technology with a minimum cost for the organisation.
- Establish a effective, consistent and remaining use of the new technology

#### Fundamental for performing:

- The technology to be introduced must have been evaluated, to minimise risk
- Commitment from the sponsor organisation for the new technology

#### Activities performed in the process:

- Characterise the impact of the new technology will have and is having in the organisation by all necessary aspects
- Develop, implement and maintain a transition plan as part of the Improvement Programme plan
- Charter change allies to smooth off the transition
- Establish support infrastructure for the new technology including training material
- Keep all concerned persons informed about their relation to the change
- Track the transition and make necessary corrections
- Analyse and package experiences from the introduction of the new technology and suggestions for improvement

In the appendices is a work flow description for this process. See 10.11 on page 70.

## 5.8 Experience Package Engineering



### Purpose

Develop, maintain, analyse and improve reusable Experience Packages (i.e. process-models, process control models and process experience) that can make projects effective and efficient in achieving their goals.



### Overview

There are many tasks that should be taken care of in an EF. The 'SIM' function is focusing on the selection of new technologies, the introduction of them and the running of the Improvement Programmes. The 'PS' function will assist the projects in how to re-use the experiences made and in how to gather relevant re-usable experiences. Then there is task to develop, document and maintain the processes and the experiences made. These are stored as Experience Packages and they include process models, process control models and the process experience. The processes must be developed and documented in a consistent and conforming way to aid understanding. The experiences must be synthesised and generalised to aid reuse. This is the focus of the "Experience Package Engineering" function.

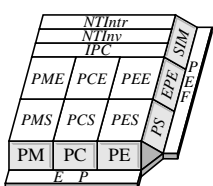
The main work-products in the EF is the Experience Packages (EP). An EP consists of three parts and because of that this function has been described as three processes. One process for to handle each part of the EP. 'Process Model Engineering' focuses on developing and updating the process according to the guidelines of the organisation. 'Process Control Engineering' focuses on what is relevant to monitor and track during a project as well as to understand to help other projects. 'Process Experience Engineering' focuses on how process experiences can be generalised and packaged to be useable and relevant for future projects.

Process Model Engineering (PME) captures, or creates, and documents a process model. The process model can be derived from current practices or elsewhere. It will typically use by the 'SIM' function to document new process technologies and to make changes/improvement to the existing process models, i.e. work products, activities, methods and roles.

Each process model should adapt the standard processes control models that is considered and over time have shown most import for managing, comparing and learning from a project. The Process Control Engineering (PCE) process augments the process model with features for measuring, monitoring and gathering experience of its use. Typically the Improvement Programme (IPC) will influence the goals for which factors of the process to control.

The Process Experience Engineering (PEE) can generalise the experiences made in projects for several purposes. To give the projects a better base for process control/predictions. To identify improvement needs. To analyse and synthesise proposals for process change/improvement. To identify best practises from different processes in relation to different goals. And to document all of this.

To change/improve EPs is necessary when running an Improvement Programme, and reusable EPs is the way for EF to modify project operation.



### 5.8.1 Process Model Engineering (PME)

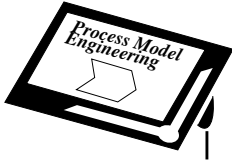


#### **Purpose:**

Develop, document and maintain a reusable software development process, including e.g. product models.

#### **Goals:**

- Develop a consistent process (including product models) from internally and/or externally used processes
- Document the process in such a way that makes it time and cost effective to introduce and use by software development projects
- Maintain the process description to keep it consistent with normal process evolution and changing context, and to be able to fulfil new process goals



#### **Fundamental for performing:**

- Organisational guidelines for how to document the organisation's processes and additional process components i.e. the process architecture
- Organisational infrastructure for storing and distributing documented processes

#### **Activities performed in the process:**

- Capture the input process, its activities, methods, roles, criteria and work products e.g. by interviews and study
- Tailor the life cycle of the work products to the organisation
- Tailor the activities involved to the organisation
- Tailor the methods involved to the organisation
- Tailor in, out and non-variance criteria to the organisation
- Tailor the roles involved are tailored to the organisation
- Document the resulting process according to the organisational guidelines

In the appendices is a work flow description for this process. See 10.12 on page 72.

## 5.8.2 Process Control Engineering (PCE)

### PCE

#### Purpose:

Augment a organisational process with features for gathering experience of its performance i.e. creating quality models, based on the organisation's long-term goals<sup>1</sup>.

#### Goals:

- Integrate quality models into an organisations process to support the effective evaluation of the processes' performance
- Establish a long-term, domain-specific measurement program for all the organisations' processes

#### Fundamental for performing:

- Organisational guidelines of how to document quality models, measurements and measurements definitions together with the process i.e. an Experience Package template
- Domain knowledge and long-term business goals

#### Activities performed in the process:

- The organisational process documented according to the organisation's guidelines is the basis for the quality models
- From the organisation's long-term goals derive sub-goals related to the software engineering process, the project management process and the process management process based on the domain knowledge
- Develop models i.e. Quality models, that can visualise the process' performance in relation to the sub-goals
- Integrate the quality models into the process descriptions
- For each quality model identify measurements, and document the measurement definitions
- Define criteria for validation of the measurements

In the appendices is a work flow description for this process. See 10.13 on page 74.

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1. A goal in this context is set for the reason of improving the organisation's processes by making them comparable. It will hereby be possible to identify the process (or process part) with relatively best performance. Typical areas includes productivity, quality and lead time.

### 5.8.3 Process Experience Engineering (PEE)



#### Purpose:

Update information about the experience of the processes that is collected in the EB, both for improved process control in projects and for possibilities of process changes (innovation) for Improvement Programmes



#### Goals:

- Keep the organisational experiences in the EPs updated or predicted
- Understand the improvement potential of existing processes in quantitative terms for specific process improvement goals
- Proposals for experimental improvement of the organisational processes are derived based on the synthesised experiences and needs from the projects
- Best practises are identified
- Understand the causes of recurring problems and eliminate the source of those in the processes of the organisation
- Organise the activities necessary to change and update an EP

#### Fundamental for performing:

- Several instances of use of an organisational process where quantified experience of its performance and properties have been documented

#### Activities performed in the process:

- Synthesise the experiences from each instance of use of the process
- Update the contents of the quality models of the process
- Identify candidate process parts with relatively high performance from other organisational processes
- Identify which process parts are most suitable to replace considering risk management and cost/benefit
- Replace the selected process parts and update process descriptions
- Update the contents of the quality models considering the new process context
- Make predictions for performance of changed process parts
- Make analysis to estimate the improvement potential of specific processes, in relation to specific process goals
- Organise the process model engineering and the quality model engineering activities necessary to change and update an EP

In the appendices is a work flow description for this process. See 10.14 on page 77.

## 5.9 Project Support



### Purpose

Support software projects in their use of the software engineering, project management, and project measurement program. This implies that the activities are executed in close cooperation with the project in an “on-line” fashion. It includes such activities as coaching, training, measurements derivation and collection, and reuse of experience from previous projects.



### Overview

A hard thing in an Improvement Programme is to get people to follow the process. And it is maybe all about urgency and priority. The time and support to read and practise the processes, is not available everywhere. But in a process mature organisation it is essential and it is the task of the EF to make it happen.

The ‘Strategic Improvement Management’ function is focusing on the selection of new technologies, the introduction of them and the running of the Improvement Programmes. The ‘Experience Package Engineering’ function develops and maintains the actual process descriptions and the gathered experiences. But these activities are not focused on the main vehicle for improvement, the software projects and the people doing the actual work. A project is involved in software engineering and project management, and to its help it runs a measurement programme. And as the base for these activities the EF maintains process models and experiences. But the EF must ensure that the projects get all the support they need to use the processes.

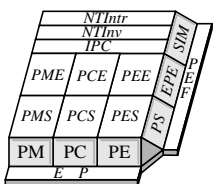
The ‘Project Support’ (PS) function supports the projects with all the experience and knowledge available in the EF. The function is described as three processes in consequence of the three parts of the Experience Packages. But it can be considered as one support activity that integrates activities requested by the software projects.

The ‘Process Model Support’ (PMS) focuses on supporting the use of the process model in the projects. Ways of doing this can be information, training, coaching and counselling/problem solving.

The ‘Process Control Support’ (PCS) helps the projects measurement programme setting measurement goals, defining measurements and establishing collection procedures. During the project execution, analysis of the measurements is supported.

The ‘Process Experience Support’ (PES) helps the projects before and during the execution to control the project by providing quantitative and subjective experiences. Performance predictions can be developed before the project starts. When unforeseen events occur, conclusion can be drawn about the cause and then relevant actions can be recommended or dismissed based on available experiences. After the project execution important experiences are gathered and stored.

The Project Support function is focusing on coaching the projects to improve their performance by improving the way the process is used, by tracking and analysing what is happening, by adjusting/improving the processes, by supplying relevant experiences and by capturing important experiences of the processes.



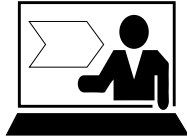
### 5.9.1 Process Model Support (PMS)



#### Purpose:

Support software projects in their use of the software process model. This implies that the activities are performed in close cooperation with the software project in an on-line fashion. It includes activities like coaching, training and so on.

Process Model Support



#### Problems:

Why is it hard to start and run a process improvement program? One of the main reasons is that people must first act predictable and repeatable before they can improve. If people do not act predictable they do not use and follow a software process. The first important step is to make people use a software process model, no matter how bad it is. From there we can start to systematically improve the software process.

#### How Process Model Support will help:

Process Model Support contributes with a systematic approach to use the software process model. It focuses on getting the software process model understood and then used by the project. Process Model Support performs training sessions for how to use the software process and coaches the project continuously to build commitment for it.

To facilitate improvements of the software process and the support activity, a project specific feed-back loop runs throughout the project. Information about how the software process is used, what parts are not used, why they are not used and what kind of support the project needs is taken care of during the feed-back loop. The feed-back loop is implemented by continuous feed-back sessions and supports learning about process and project performance.

#### Principles for Process Model Support:

- First when people act in a predictable and repeatable manner, they can improve
- People under stress might not use the process without continuous support and coaching
- To make people follow a software process is mainly about removing hinders and barriers and to empower them
- Coaching must be used to continuously build commitment for the software process
- People do what they see a need for
- Structured interviews is a good way to increase understanding of humanics
- The software process should be the base for planning

In the appendices is a work flow description for this process. See 10.15 on page 79.

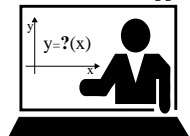
## 5.9.2 Process Control Support (PCS)

PCS

### Purpose:

Support software projects to set-up measurement programs and to analyze and monitor measurements. This implies that the activities are performed in close co-operation with the software project in an on-line fashion. It includes activities like deriving measurements, deriving measurement plans and analyzing collected data.

Process Control Support



### Problems:

Why is it hard to start and run a process improvement program? One of the main reasons is that we do not collect measurements that are usable and understandable. When we set up measurement programs, we must know what to measure, i.e. the goals, otherwise we will not be able to evaluate if any improvements were made. You can't improve if you don't know what you measure.

### Why Process Control Support will help:

Process Control Support contributes with a systematic approach to start and run a measurement program. It focuses on getting a relevant measurement program understood and run by the project. Process Control Support continuously helps the software project to understand, derive, collect, validate, analyze and monitor measurements.

To facilitate improvements of the measurement program and the support activity, a project specific feed-back loop runs throughout the project. Information about how the measurement program runs, if made analyses are correct or not, if collected measurements are valid and what kind of support the project needs is taken care of during the feed-back loop. The feed-back loop is implemented by continuous feed-back sessions and supports learning about measurements and measurement programs.

### Principles for Process Control Support:

- Measurements should be used to monitor progress to facilitate project management
- Goals must be measurable
- A software company can collect too much data - always start small
- A software project must be responsible for implementing and running its own measurement program
- What you can't measure you can't improve
- What you set out to measure/understand (i.e. the goals) is what you will improve
- The first step is always to measure and control cost, quality and time-to-market

In the appendices is a work flow description for this process. See 10.16 on page 84.



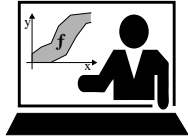
### 5.9.3 Process Experience Support (PES)



#### Purpose:

Support software projects in their use of experiences from previous projects. This implies that the activities are performed in close cooperation with the software project in an on-line fashion. It includes activities like presenting experience from previous projects, presenting predictions of process performance and suggesting corrective actions based on experience.

Process Experience Support



#### Problems:

Why is it hard to start and run a process improvement program? One of the main reasons is that we don't collect and reuse experiences from previous projects. We often make the same mistakes again and again. The Project Managers and project members have all a lot of undocumented experience. If we, one way or the other, can capture and document all that experience we will be able to reuse it to become wiser and to facilitate improvements.

#### Why Process Experience Support will help:

Process Experience Support contributes with a systematic approach to collect and reuse experiences. It focuses on getting Project Managers and project members to learn and avoid mistakes by presenting relevant experience. Process Experience Support continuously presents predictions of process performance, experiences of similar projects and suggests corrective actions based on experience.

To facilitate improvements of the Experience Packages and the support activity, a project specific feed-back loop runs throughout the project. Information about how the presented experience is used, how corrective actions are used and what kind of experiences the project would like is taken care of during the feed-back loop. The feed-back loop is implemented by continuous feed-back sessions and supports learning about experiences and Experience Packages.

#### Principles for Process Experience Support:

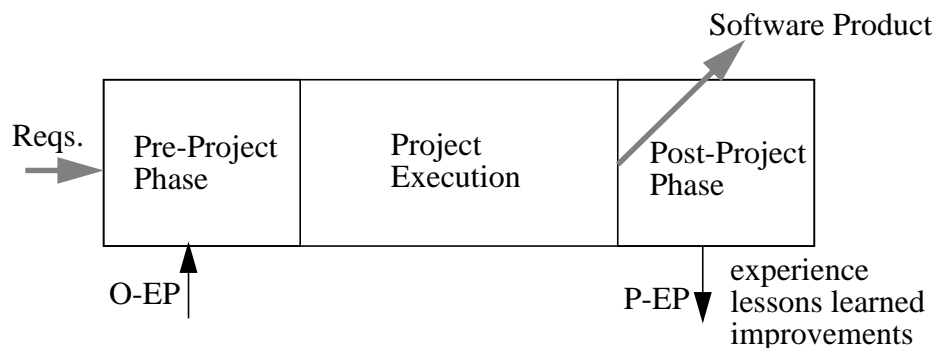
- Don't collect measurement data that you don't use or reuse
- If you have experience, use it to become wiser
- We learn best from experience but we never directly experience the consequences of many of our most important decisions
- Analysis of experience is often a nonexistent exercise due to the complex issues that cross organizational areas
- There are both quantitative (measurement data) and qualitative (subjective) experiences
- Important qualitative experience is experience of human behaviour and factors

In the appendices is a work flow description for this process. See 10.17 on page 89.

## 5.10 The Software Development Projects

The task for software development projects is to develop a software product. To do so successfully and in a way that the organization will benefit from, the project is responsible for executing a number of activities. The organization ensures conformant behaviour in the projects by documenting rules for these activities in process models. Those activities and process models can be characterized as product engineering, project management and project measurement activities and any combination thereof. For the projects to interact with the Experience Factory, some additional activities must be performed before and after the execution of the project i.e. pre-project and post-project activities. Figure 14 shows the phases of a software development project. For the purpose of this thesis, a short description of the activities is sufficient to give an overview of what kind of activities an Experience Factory must support.

**Figure 14: The phases of a software development project**



### 5.10.1 The Pre-Project phase

#### Purpose:

Establish a project process, that is tailored to project's situation, as a framework for the project execution, to minimise the risk by reuse of experience i.e. process models, process control models and process experience.

#### Goals:

- Select or develop, in conjunction with the EF and the sponsoring organisation, the best possible Experience Package (Process model, quality models, experience; EP) to form the framework for project management (estimation, planning, tracking), software engineering and project measurement programme for the project
- Tailor the EP to the specific situation of the project and make necessary adjustments to the current goals for the project

The Pre-project phase ensures organizational reuse of experience for the projects in the organization. It includes activities such as

- characterization of current project
- selection of the organizational process to be used by the project
- tailoring of the process to the project's situation

- instantiation of the process within the project

When these activities are performed the project is established and starts the execution phase i.e. instantiating its process.

The appendices contain more detailed descriptions for this area. See 10.4 on page 61.

### **The Project Act phase**

During the project act phase, project execution activities are performed. The activities are performed in a project specific feedback loop, which supports organizational learning and continuous improvements. This phase includes activities such as project management, software engineering and project measurement. All these activities run in parallel during the project act phase and it is where most of the interaction between the Experience Factory and the software project takes place.

#### **5.10.2 Project Management**



##### **Purpose:**

Develop the software product according to the requirements, goals and restrictions set up for and in the project

##### **Goals:**

- Facilitate the product development
- Within the given restrictions achieve the projects goals
- When available, reuse experience from previous projects to minimise the risks for the project and also provide data for reuse in future projects

Project management is aimed at making sure the software engineering activities can be performed by the project within its restrictions and limitations. This normally includes the planning of the software engineering, estimation of product and project related issues, committing personnel and other resources, tracking, managing and controlling the efforts in the project, replanning when necessary and communicate with internal and external customers about the progress.

The appendices contain more detailed descriptions for this area. See 10.5 on page 62.

#### **5.10.3 Software Engineering**



##### **Purpose:**

Develop a software product to the customer's satisfaction in a, for the company, favourable way

##### **Goals:**

- Produce a software product that the customer is satisfied with and/or according to the customer's requirements
- Minimise the resources taken from the company and/or use them, in a long- and

short-term, cost effective way for the future

Software engineering is the main activity of the software development project. This includes activities for transforming and designing the customer requirements into the delivered software product. Normally this includes the requirements management, system specification, system design, detailed design, coding, unit testing, integration, integration test and system test. Additional activities can include configuration management and reviews.

The appendices contain more detailed descriptions for this area. See 10.6 on page 62.

#### 5.10.4 Project Measurement Program



##### **Purpose:**

Collect measurements within the project, for the project and the organisation, to better understand and manage the software, the project and the process.

##### **Goals:**

- Identify factors that have significant impact on the software, the project and/or the process
- Understand how those factors actually impact the characteristics

The project measurement programme is run by the software development project or in direct conjunction with it. The measurement program is based on the goals of the project which may include project management goals, short-term improvement goals and long-term understanding goals. Measurements must be based on those goals and integrated into the project plan. The collected data is an important input to project management as well as the Experience Factory to improve the organizational understanding of the processes and thereby allowing process improvements. The following activities are performed by the measurement program:

- Characterize project and identify project goals (supported by PMS, PCS)
- Identify measurement goals and produce GQM plans (supported by PCS)
- Produce measurement plan (supported by PCS)
- Collect and validate data
- Analyze data (supported by PCS)
- Support the packaging of experience (by PMS, PCS and PES)

The appendices contain more detailed descriptions for this area. See 10.7 on page 62.

#### 5.10.5 The Post-Project phase

##### **Purpose:**

Develop and gather experiences from the project, so that coming projects can improve their performance and minimise their risk to maximise the usefulness of the project for both the customer and the company

**Goals:**

- Establish success and disaster factors for the project
- Add to the organisation's understanding of its software, software development, project management and continuous process improvement
- Make experiences reusable

The Post-project phase ensures organizational learning by collecting experiences from the project. It includes activities such as analysis of the project measurement data in relation to the process used, drawing conclusions by post-mortem analysis of project execution activities, understanding relations between important factors and making suggestions for improvement.

The appendices contain more detailed descriptions for this area. See 10.8 on page 63.

## 5.11 The Sponsoring Organisation

The purpose of the sponsoring organisation is to effectively run the company in according to its owners directives, e.g. making profit, satisfying customers' needs, increasing competitiveness. This implies a great number of responsibilities that lies outside the scope of this document. For the purpose of process improvement, three areas of responsibility is of major importance, 'business analysis', 'vision management' and 'sponsoring of the EF'.

The business analysis provides the organisation including the EF, with domain understanding, long-term and short-term business goals. Keeping an "ear" on the market, business analysis updates the goals and finds new business opportunities.

The vision management drives the organisational internal change towards a organisation better fit for acting on the business opportunities. It is responsible for the all parts and aspects of the total organisation, where software process improvement is merely one. It must motivate the need for an EF for the organisation. In the process improvement context the vision is represented by the PEF model tailored to the organisation.

To sponsor an EF implies that realistic improvement goals must be set, assigning resources to EF, supporting changes introduced by EF and follow up progress and results by the EF.

### 5.11.1 Business Analysis

**Purpose:**

Analyse the business situation, make conclusion and set up business goals for the whole organisation.

**Goals:**

- Produce software products that the customer is satisfied with
- Set up requirements, goals and restrictions for the software projects

- Set up business goals for the whole organisation

The appendices contain more detailed descriptions for this area. See 10.1 on page 60.

### 5.11.2 Vision Management



#### **Purpose:**

Drive the internal organisational change towards a organisation better fit for acting on the business opportunities.

It is responsible for the all parts and aspects of the total organisation, where software process improvement is merely one. In the process improvement context the vision is represented by the PEF model tailored to the organisation and the improvements that is introduced via the EF.

#### **Goals:**

- Change the organisation internally, to improve its capability to produce products efficiently and to satisfy customers requirements

The appendices contain more detailed descriptions for this area. See 10.2 on page 60.

### 5.11.3 Sponsor of the EF



#### **Purpose:**

Take overall responsibility for the EF to make the EF operate, in each different situation, in the best possible way for the organisation situation.

#### **Goals:**

- Set up requirements, goals and restrictions for the EF
- Supply sufficient resources to the EF
- Track progress and follow-up the activities of the EF
- Verify the benefits of the EF

The appendices contain more detailed descriptions for this area. See 10.3 on page 60.

## 6. Guiding Principles for Improvement with PEF

When instantiating and executing an EF there are some guiding principles that always should be considered. The principles are based on recurring and general experiences gained when running improvement programmes. The principles presented here seems to be necessary but probably not sufficient for achieving real improvements.

- (1) Improvements must be driven by need

All improvement initiatives (including e.g. product improvements), must be coherent, linked to and driven by business needs

- (2) All improvements must be based on testable/validatable data

To be able to verify an improvement it must be possible to compare it quantitatively to an objective baseline

- (3) All improvement/change must have a local relevance (localness) e.g. for the individual or project

Persons affected by change must get positive response in their own local environment

- (4) No improvements can be made in isolation

Process improvement must address other issues e.g. structural, organisational culture, leadership, strategic, short term commitments, long term commitments, technological, personal, and financial etc. as well.

The EF focus on improvements directly related to software processes and their usage, but has relevance on systemic improvements as well.

- (5) The type of experience collected decides the degree of improvement leverage

The optimal experiences collection and use of experiences are primarily directed by the business situation (low/high turbulence, long/short time frame, key business factors etc.)

- (6) There is no single way to introduce changes, but each change requires its own strategy to succeed.

There are no general cook book solutions on how to make something change and become an improvement, but each change needs a strategy (and a strategy) of its own.

- (7) The EF's capability is aligned with the organisation and projects capabilities

The EF acts in a system with the projects and the organisation. No part can excel on its own. The parts must be in tune.

The principles described above must be kept in mind to minimise the risk for Improvement Programme failure. Consistently referring to the guiding principles during the instantiation and execution of an Improvement Programme within the EF, will help to avoid the faults already experienced elsewhere.

## 7. **Warning signals in improvement effort**

In this section we describe some classical failures in improvement initiatives. Some rules are presented to avoid such problem. These rules are very general and need further information to be fulfilled. We are convinced that the PEF model brings most of this new information.

An improvement initiative may have a lot of effect on the organisation, the techniques, the behaviour of people. As there is no reliable model for representing the behaviour of an organisation, any improvement initiative has a part of unpredictable risk. The business goal and its decomposition in sub-goals is fundamental for the success of the improvement program. The Experience Factory model offers a way to better plan, manage, control and update improvement program, but keep in mind that the human being is the only one who is really responsible of the success of an improvement program, it is his responsibility to use the available supports (tools and methods) in the best possible way.

### 7.1 **General warning signals**

#### **Are people relationship important in the success of improvement program?**

Often improvement program is based on business goal and improvement plans do not take enough care to people, in particular they:

- deny the humanity of people
- ignore relationship issues
- resolve relations by discussing technology
- treat people the same way they treat machine
- ignore the principle of change

#### **Can I start an improvement program without taking care of the organisational culture?**

No, changing an organisational culture is very difficult and never trivial. Improvement effort should be aligned with the existing culture if at all possible. If a shift in culture is an absolute requirement for success, it must be understood that this is a significant undertaking that will require an extended, consistent reinforcement.

#### **People are fed up of all the successive improvement programs, how can I assure them that this one is different?**

History is very important in an organisation. At the lowest management levels, and particularly among those who have no management responsibility, these past initiatives are often viewed as having been dismal failures that did nothing but waste people's time. Successful initiatives often include a significant effort to capture the lessons of history, ensure that past mistakes are not repeated, and communicate the differences in approach to all organisational level. The EF plays an important role in that direction.



**In what sense an improvement program is different to a “standard” project?**

In theory there is no difference, if you applied the classical rules for managing a project you will avoid the following problems:

- substitute prayer for preparation
- hope rather than plan
- follow a plan blindly, no matter what happens
- demand an immediate productivity increase
- ignore the need to manage the transition
- don't monitor progress
- keep rewarding the same behaviour as before
- don't make a clear ending

In an improvement program the actors are not the same, the time frame is not the same, the domain is not the same and many functions are diffuse, it is why the PEF model, has built a model for helping people to select among all the possible activities, those which are specific to manage the improvement and change and then to make a better control on it.

**How can I know if I have appropriate improvement goal?**

If you have chosen that improvement goal it should be because you had enough valuable information for selecting it. Then during the improvement program, you should define way to control the progress. You may discover that the goal is not the most appropriate but in that case it is justified by measure.

On contrary, if you have no measure for assessing the appropriateness of the improvement goal you will be in danger just to measure the corresponding project.

The strength of the PERFECT model is to make the criteria for introducing a change in a process explicit.

**Why is the concept of experience so important in the PIA?**

In the PERFECT improvement approach (PIA), we emphasize the concept of continuous improvement. Continuous improvement implies a notion of time and progress during this time. As software engineering is an intellectual work, this progress will be driven by the behaviour of software engineers and then their experiences. Managing their experiences means managing:

- basic knowledge in software engineering
- their skill
- their ability to use or reuse the best practices (tools and methods)
- their ability to infer from past experience to innovative solution

The Experience Factory is the place where all these pieces of experience should be managed. The Experience Factory brings also a set of methods to perform this experience management in a more reliable manner.

### **How do you select the pieces of experience you want to manage?**

Among all the available pieces of knowledge, we select the one which have a real meaning for each improvement program. It allows to start small and to fill the experience with useful information which will grow over time.

The selection of pieces of experience is then driven by the business improvement goal. As these capturing task and packaging is fully part of the Experience Factory organisation, the gathering task should be done systematically.

And other way of selection, is to analyse the major request coming from the software project for reusing experience to collect and package such experiences.

## **7.2 Sponsorship rules for failure**

### **How can I choose the right technology?**

This is a main responsibility of the sponsor organisation, and the PERFECT project has recognized this activity as a fundamental one. An operational Experience Factory, should help the sponsor in its decision, in providing the necessary data, or recommendations for selecting the right actions according to business goals. The Investigate New Technology is aimed at just this problem.

### **Why many improvement programs stops too early?**

It is because the sponsor commit to a too short term, and when that term is over the sponsor considers that the resources are better needed elsewhere and the improvement program stops. It is the responsibility of the Experience Factory to explain to the sponsor what the implication of such improvement goal are.

Often the expectations of an improvement program are unrealistic, here again it is the responsibility of the Experience Factory to analyse the risk (in term of cost, changes, delivery time) of conducting such a program.

But the bottom line is that if the improvement programme costs more than it saves it should stop itself. The problem is to agree on the time until pay back.

### **Why are results of an improvement program not the expected ones?**

It is often due to a lack of communication between the sponsor organisation and the two others one. Often sponsor assume you know all you need to know, of course it is an error and bad interpretation implies a bad implementation. The role of the EF is fundamental because it explains, plan, manage, and control the improvement program like any other projects.

### **What are the errors the sponsor organisation should avoid?**

- assign the wrong people
- expect them to have all the skill they need
- “shoot the messenger”
- assign the improvement effort as a tax
- demand instant result

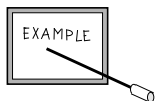
- cut the training program

### **How can we manage the resistance to change?**

First of all you have to understand how important is this resistance, do not:

- force resistance underground
- ignore or deny feedback you don't want to hear
- underestimate the cost
- encourage competition instead of cooperation
- involve people who will have to change
- The New technology introduction process is aimed at this problem.

## 8. Example of usage

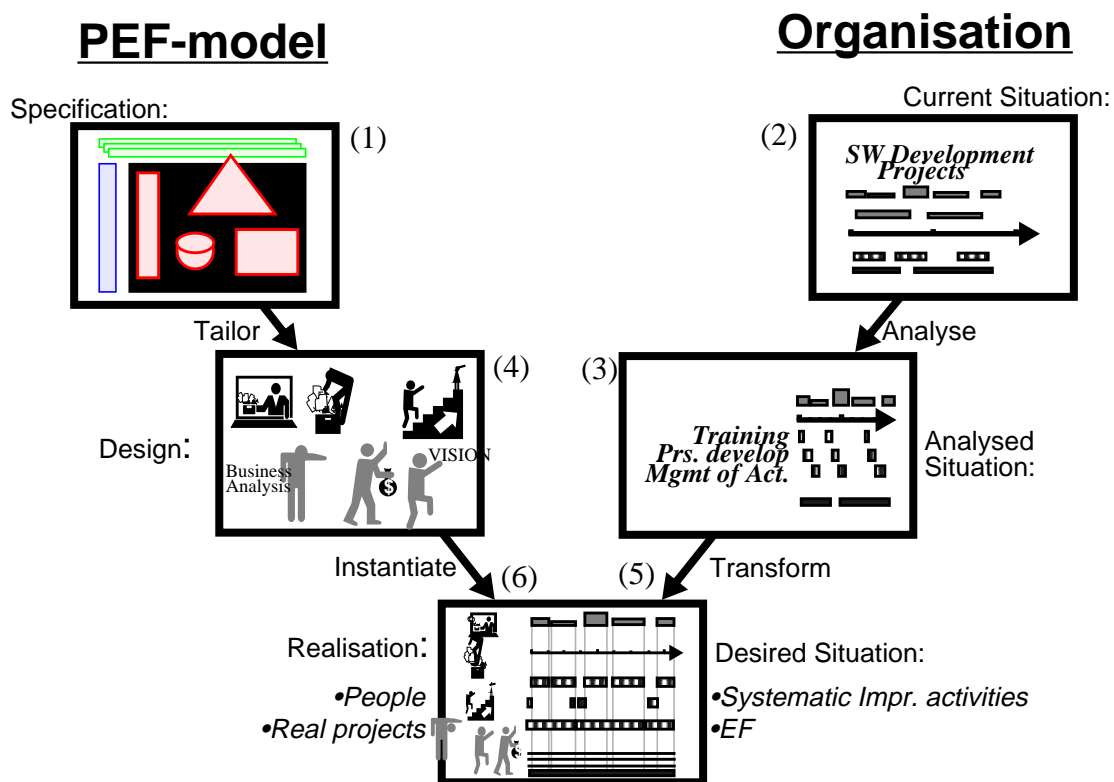


This document describes a virtual perfect organisation for managing continuous improvement program by using the Experience Factory paradigm. The EF functions which are described in the following sections are coming from the analyse of the best practises within this field and can be viewed as a sort of vision state for an EF.

### 8.1 To establish an EF in a company

When you are going to establish an EF in a organisation, you must tailor the different activities described here to its needs and situation, and then instantiate them in the way you find best. The steps to go through are shown in and described below.

**Figure 15: Usage of PEF to establish an EF in an organisation**



- (1) Study PIA concept and especially the PEF model.
- (2) Study the current activities in the organisation such as projects, organisational activities and support activities.
- (3) Analyse the activities and group them into the three functions of the PEF, the projects and the sponsoring organisation.
- (4) Add any missing activities necessary to establish the three feedback loops involving EF and the life cycle for the EPs. Describe roles.
- (5) Make an transformation plan for the establishment of the EF.
- (6) Build necessary support infrastructure and instantiate the transformation of the organisation according to the plan.

Refined from the overall principles for the PERFECT improvement approach the following principles apply directly to the PEF model and its instantiation as and EF:

- (1) Use explicit improvement processes (based on the scientific principle i.e. QIP) to plan, monitor and correct activities of the improvement effort.
- (2) Support project as well as organisational learning, aiming at improvement of quality aspects of the product, via closed feedback loops.
- (3) The improvement effort has to be explicit, continuous, committed throughout the organisation and supplied with sufficient resources and budget.
- (4) Goal oriented measurement used to continuously monitor progress and to verify results against improvement goals.
- (5) Projects selects and tailors processes to develop the product, manage the project and to continuously monitor important aspects of the project and the product.
- (6) Support explicit modeling and reuse of process, knowledge and experiences.
- (7) Provide a coherent framework to all the actors of an improvement programs, from sponsor, to software project participants via specific role for managing improvement programs and experiences

## **8.2 To introduce the EF to potential sponsors and projects**

When introducing the EF concept to the persons that might become involved as sponsors or as project members, it is important to aim at describing how an EF can address the problems they currently feel are important. Remember that the PEF model might introduce a lot of new concepts that not especially interesting nor especially important for persons not involved in the an EF. The step to go through are at least:

- (1) Study PIA concept and especially the PEF model.
- (2) Study the current activities in the organisation considering process modelling and adherence, measurement and data collection and validation, Experience Package, analysis and reuse.
- (3) Tailor the PEF to describe a desired state and describe how the whole situation in the organisation would improve.
- (4) Analyse the business situation for improvement and identify main business needs.
- (5) Present the business case, how the EF would help improving the business and how the EF would work.

## **8.3 Assessing your organisation from the EF view**

One usage of this document can be to assess your improvement organisation capability by comparing its current activities to the ones describe here.

Each function in the EF is described by three processes, all in all nine processes,

that will be used to smaller or larger extent depending on the capability of the improvement organisation. The main purpose is to help you to better understand how you can evolve your improvement organisation by the ideas of the Experience factory concept.

## **8.4 Answer to question**

If you have some specific questions at this point, jump to chapter 7 to find a set of common questions and answers.

## **8.5 A simple scenario**

In this scenario we assume that the company is a small software developing organisation. That can imply something like 5-10 software developers, developing software products for customers, one to three concurrent projects. The type of product and the similarities between the products are not crucial except in the sense that the company must understand the type of experience that will be collected. In the scenario we assume that an EF is already launched and established. The focus will be to explain how the EF uses the PEF model to broaden the activities and the support that is provided to the projects.

In the initial situation the PEF model has been used as the basis for setting up the EF. The EF is this case one of the more experienced project managers that is working part time in the EF and part time as the product responsible. He has a general knowledge of software process improvement and is studying the PEF model to prepare and guide him in the activities that he need to conduct. The EF person will take on all the roles in the PEF and will thus only implement them to the extent he finds realistic. As the base for the activities of the EF he makes plans by tailoring and simplifying the PEF processes.

Initially an Improvement Programme (IP) is set up according to the Improvement programme cycle (IPC) process. The main goals for the IP are to identify crucial performance factors and based on these establish a baseline for the project performance, including current and recently concluded projects. The baseline is established primarily for performance factors such as reliability, time, cost and predictability broken down to suitable detail. The baseline is decided by gathering available measurement data as well as collecting additional data. From the baselining a standard measurement programme is established in which all projects from now on will collect a standard set of measurements. The Process Control Engineering (PCE) process is tailored and adapted to set up the standard measurement program. Each project also appoints a measurement responsible, to on part-time collect, validate, compile and visualise the data according to the measurement plan and quality models.

Part of the baseline is to document the basic activities of the projects, as process descriptions, as the base for interpreting the baseline measurements. One goal for the EF and thus this IP is to give the projects support to improve their performance. As a base for that activity the Process Model Support (PMS) process is studied and tailored. At this stage it is not easy since the amount of data will be limited and possibly not always what is requested, but the EF will share the experiences that is

available as well as possible. In this case that includes the personal experience of the EF-person himself, the available data and process descriptions. The EF and the project managers, team up periodically to discuss problems and possibilities in the project. The EF-person present the measurements to all project members as well to get feed-back and to improve this understanding of the data. The main pay back for the project is that the project manager shall evolve from fire-fighting to more proactive behaviour.

In the next phase of the EF life a new IP is established. This time with the goals to improve the performance of one project by picking up the problems of the project from the project itself and then to suggest and implement changes based on the suggestions of the project itself again. A important aspect of the improvement is to establish a sense of follow the process or else change the process. "Share good ideas and do as well as we know we can". That means that the EF-person that is responsible for the process works closely with the process users in the project to be able to refine the process descriptions, to pick up the proposals for change that are found and to help the process users to apply the process in a effective manner. The project will now implement not only the standard measurement programme but will also collect some additional data that is used to show how well the goals for this project is achieved. This project measures how well the process is followed and also the attitude within the project to the use of the process. Several Improvement Programmes are set up after this, to support one or more projects to improve their performance through process control.

Continuously the projects and the EF-person is introducing more and more specific goals and measurements in the project, to get a better understanding of what works well and what does not during the projects. The standard process of the company is now used as the base for the project planning and the execution of the projects. When changes are proposed to improve the process the EF-person discusses the changes with all affected persons at bi-weekly meetings of the development personnel. The EF-person has during this time studied some assessment methods and has become better at judging the cause of the problems and which part of the process needs improvement to prevent the problems. The development personnel have taken more and more responsibility for their own results and have started to work much more as project team. The team idea has work very well since everybody already knew one another in this small group.

The EF-person then started to apply more statistics to the standard measurement data that has been collected for all project for some time. Based on the statistical analysis the processes can be supported with clear indications of average and normal deviations. But also how different factors of the projects and products will influence the project performance and product quality. These activities are based on the Process Experience Engineering process (PEE) in the PEF-model. The process descriptions and measurement data is now collected as a centralised and more formalised experience base, stored in a data base. The projects, especially the projects managers, are able to them self find and use the experience that is gathered in the experience base. The EF-person is called in to discuss how to handle problems that the projects have not encountered previously. Since the projects could manage well without too much support from the EF-person, the EF-person could now look into more of the possibilities of changing the current processes with new methods and

tools. This was done according to a tailored version of the new technology Investigation process (NTInv) of the PEF-model. One of the first methods he investigated were a team process. The development group and the project managers had gradually started to work more and more as teams, so it was a natural step to make the team work a cornerstone for the project execution. Processes and project practices were changed gradually to this way of working. The next to investigate was a case tool that promised to shorten the development time significantly. Since this would be a major undertaking for the company to introduce such a change in their tool environment and their working processes a deeper investigation was performed by the EF-person. He started with a simple Impact Analysis by asking the developers what impact the new tool would have on the different steps in the current process. By this he got a better judgement of the real improvement that could be achieved in this company. After this he conducted several experiments for the steps of the standard process and analysed how the tool was best used, at the same time as he documented a new development process for the tool. When the decision was made to introduce the new tool, the real introduction was made. As a help for how to introduce the new tool the New Technology Introduction (NTIntro) was studied. The necessary infrastructure, support functions, training and information was conducted and put in place and a Improvement Programme was started to introduce the new process and the tool in two pilot projects. The pilot projects collected all standard measurements as well as some additional for judging the transition and the long-term performance of the new process and tool.

The EF now works hard with establishing the necessary level of experience of the new process and tool. Also tuning the type of goals and measurements that is most helpful for the new process. The projects are tracked to pick up ideas and suggestions for how to improve the process, as a part of the continuous improvement work to gain process control. The EF is also following the development of new technologies and investigates their positive impact on project performance and product quality.

## **8.6 PEF's "Goal 'and Measurement'" scenario**

This scenario highlights how the goals for improvement are used as the base for the measurement activities to verify whether the expected improvements were made or not. The scenario will explain how the different levels of goals are handled by different processes in the PEF model and how these interconnect. The be able to verify improvements against the improvements goals is essential for an EF.

### **The Organisation NodeCom**

The high requirements on both having control over and improving TTM, Cost and Quality lead the software part of NodeCom to starting up an Experience Factory several years ago:

- Experience Factory is in place and functioning well
- Organised and followed software processes
- Experiences are collected and used
- Experiences regarding the success factors in the domain (TTM, C and Q) are



continuously collected.

Every year a market analysis is done, setting up or revising the long-term and short-term goals regarding TTM, C and Q.

### **Starting point**

As all years a market analysis has been made for the organisation (from now on called NodeCom). Based on the domain factors, i.e. Time-To-Market, Quality (Reliability) and Cost, and requirements from the market (both explicit and potential) the long term and short term goals were revised.

The main result from the analysis were:

- Long-Term Goal:
  - Improve quality with 50% in five years,
  - with shortened Time-To-Market (TTM) and
  - get a better understanding of how the cost could be cut.
- Short-Term Goal:
  - Shorten TTM with 25% in one year,
  - with better or same quality,
  - with lower or same cost.

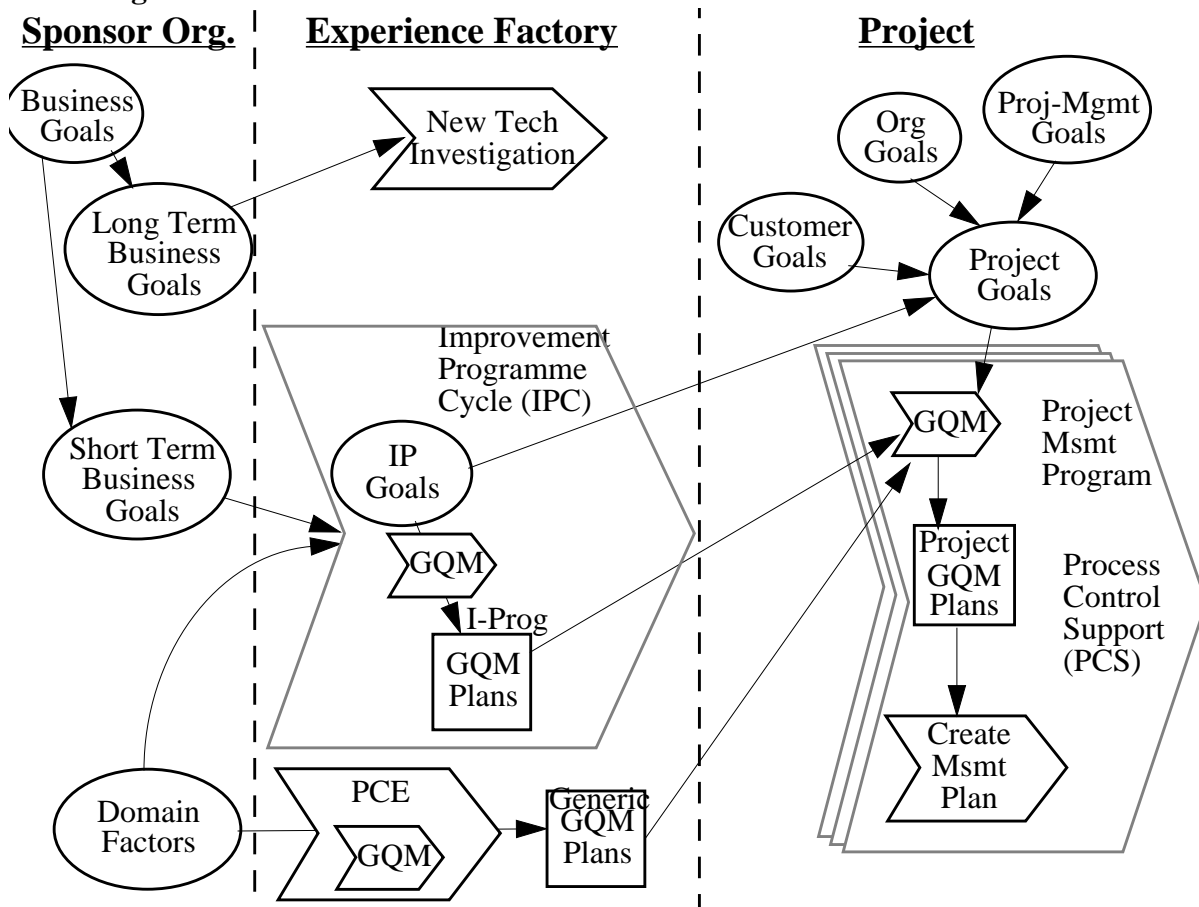
NodeCom is starting to get behind their competitors in quality, and the market will become more aware of the cost of poor quality in the future. Thus, competing in quality will be a much stronger factor in the future. However, in short term, to be able to keep getting the large number of contracts, the TTM must get shorter.

To handle these long-term and short-term goals the EF-sponsor initiated two activities in the EF. First, to tackle the long-term goals an investigation-group is set up to work according to the New Technology Investigation to find possible ways to achieve the long-term goals. Second, an Improvement Programme is started to tackle the short-term goals by working according to the Improvement Programme Cycle.

The result of this step resulted in an input of the two goals, long and short time, to the two activities New Technology Introduction and Improvement Process Cycle in the EF.

### **Overview**

The picture below tries to illustrate how the goals from the sponsor are transformed into measurement plan of each software project.

**Figure 16: Overview of the flow from Business Goals to Measurement Plan**

### The Long term investigations

According to the long-term business goals, the long term investigations must focus on improvement of the reliability of the delivered products. The improvement with respect to this long term goal can however not be done without keeping the TTM down. Experience within the EB shows that poor quality is the greatest impacting factor on the cost, so focus will be on improving quality and controlling cost and TTM.

In order to find improvements with respect to reliability the New technology Investigation process is started. For every action the following can be described:

#### *Identification of new candidate methods and technologies*

A group of experts identifies a number of improvement proposals. One of the proposals is to introduce a specific kind of review after each sub-process in the software development process. It is decided to investigate in the long term effects of this change proposal.

#### *Desktop evaluation of new methods and technologies*

The change proposal is analysed with the impact analysis method. The change proposal is anticipated to increase the reliability with around 20%, but to increase the cycle time of project with around 5%. The required effort in projects are not anticipated to change due to the introduction of the change proposal. It is decided, together with the sponsors, to further investigate in the change proposal in

experiments and pilot projects, since the improvement of reliability seems to be probable, and the increased cycle time is not enough significant to hinder the introduction.

#### *Preparation of experimental evaluation*

Based on the results of the last activity and expert judgement a plan for the experimental evaluation of the change proposal is negotiated with the sponsors. One experiment is designed, where the new inspection technique is evaluated off line to the organisation's projects, and one pilot project investigation is planned.

#### *Off-line experiment*

The experiment designed in the last activity is performed. The result of the experiment indicates that the change proposal should be introduced in the organisation.

#### *Pilot project*

The pilot project is executed as any other project of the organization, but with the new inspection technique included. The result of the pilot project indicates that the change proposal should be introduced in the organisation.

#### *Evaluation of laboratory experiment and pilot projects*

The results of the desktop evaluation, the off-line experiment and the pilot project are compiled and presented to the sponsors. A decision is taken to introduce the change proposal in the organisation.

#### *Recommendation of new methods and technologies*

The results of the desktop evaluation, the off-line experiment and the pilot project are stored in the experience base.

### **The Improvement Programme**

Based on the short-term business goals a new Improvement Programme was started by the EF at NodeCom SW.

#### *Start Improvement cycle*

The Improvement programme started with trying to figure out if and how the short-term business goals could be achieved. A pre-study was done to understand and characterise the short-term business goals and the possibilities for improvement of the processes, as well as other factors. The EB and results from NTI was consulted for their conclusions and improvement proposals.

A few improvement strategies were developed, and improvement proposals and the improvement potential was evaluated. This potential was evaluated by Impact Analysis. The best strategy was the base for the negotiation.

The goals were negotiated with the sponsoring organisation, and realistic improvement goals were agreed. The potential for improvement of TTM were about 25% and but 28% was agreed as the improvement goal. Further more the quality goal was set to an improvement by 5%, while the cost goal was unchanged. The goal regarding improved quality was set to initiate actions for better understanding of the quality problems and to motivate improvement suggestions.

#### *Make process changes*

Then it was decided which process changes would be necessary to reach the improvement goals. The process changes were done and documented by PME in a new Experience Package (EP), and the quality models in the EP were updated by QME to ensure measures of the domain factors. The experience in the EP were used to make hypothesis for the changed parts of the process by EE.

#### *Prepare for pilot projects*

To be able to monitor the progress of the pilot projects and the Improvement Programme itself, a GQM plan were developed based on the improvement goals and for management of the Improvement Programme (IP).

The improvement goals were now distributed on the pilot projects.

- 1st pilot was to establish a baseline for the new process and to search for further improvements.
- 2nd pilot was to fully perform the new process and to establish any changes made in the first pilot.
- 3rd pilot was to fully implement the changed process and perform successfully to achieve and preferable exceed the improvement goals

The first pilot were planned to making an 12% improvement of TTM since it was the first user of the changed process. The remaining projects were planned for 25% and 30% improvement of TTM. All projects were planned for the 5% quality improvement goal and they were also expected to implement the extra measurements of the costs from the GQM-plan of the improvement programme.

Part of the plan were that the pilot projects should use the new, changed process (i.e. EP) but that they must understand that it was an experimental change made and that the project should pay attention to ways to improve it throughout the project.

#### *For Each Pilot*

These activities were similar for all three pilot projects and is described here only once.

As a support for the project, the EF assigns an “Experience Coach” to the project that can support all activities in the project based on the his knowledge and the knowledge in the EB. The coach takes responsibility for implementing all necessary parts of project support (PS) of the PEF-model.

#### *Project Overture*

The project characterised and evaluated its situation, among other, in relation to all project goals and the assigned new process. Project Goals were partly project management goals, partly organisational goals, partly customer/external goals and also the improvement goals from the Improvement Programme.

The project goals were now agreed between all involved goal setters, customer organisation, EF and the project. The improvement goals were kept!

The process were tailored to the project and necessary extra resources from EF were agreed and planned.

Both the generic GQM plan, derived from the Domain goals, and Improvement Programme GQM plan were input to the development of a project specific GQM

plan and an measurement plan for the project.

#### *Execution of Pilot*

The project was instantiated. The roles in the project were assigned. The pilot project started to execute and the coach worked with the project to make the process effective in use. The measurement programme collected data for the project manager and the coach to analyse. When deviations from the plans were made the coach advised the project which corrective actions to make. The coach also analysed the data in relation to the improvement goals and kept the Improvement Programme informed about the progress.

#### *Analyse Outcome of project*

At the end of the project, the coach and the project analysed the results of the project. All project goals were considered, conclusions were drawn and improvements suggested. Everything were written down in an project experience report by the coach and it was then stored in the EB.

The improvement analysed the outcome of the pilot project in relation to the its plans and the improvement goals. It was under control and no changes were needed. The improvement proposals from the projects were implemented and the experiences made were used to update the experience part of the Experience Package.

#### *Conclude the improvement programme*

The results of all pilots were analysed together. The first pilot actually exceeded its TTM goals (15% improvement against 12% goal), the second made its goal only just (25%) while the third missed its slightly 28% against 30%). This was a success but the quality goals were not met by any of the project (0%, 2%, 4% against 5% goal) and the main reasons for that were identified by the projects. The extended measurement programme were a great help of improving understanding of the quality problems in the process. The understanding of the cost were also improved even if the total cost was still somewhat unpredictable, even between the projects. How the Improvement programme itself were executed were also analysed and it seems to have been as successful as when used previously.

The project results were now documented in an Improvement Programme experience report and presented for the EF-sponsor. Some articles were published and the used process were presented to other parts of the organisation and introduced there. The software process were now considered the organisation's main process for this type of product development to be used from now on. The long-term trends for the domain factors were updated. The Improvement Programme had achieved or exceeded the short-term business goals.

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## 10. Appendices

The appendices includes detailed descriptions and work flow models for the processes in the PEF model and the roles in the projects and sponsoring organisation.

### 10.1 Business Analysis

The Purpose and the Goals have been presented previously. See 5.11.1 on page 41.

**Fundamental for performing:**

- Business domain competence

**Activities performed:**

- Characterise the whole organisation's situation, externally and internally, to develop a business plan including main domain characteristics, long-term business goals and short-term business goals
- Assign resources and functional, non-functional, product, quality, and process requirements to each software project
- The software projects are followed up and their results are verified and validated

### 10.2 Vision Management

The Purpose and the Goals have been presented previously. See 5.11.2 on page 42.

**Fundamental for performing:**

- Knowledge about EF's impact on an organisation

**Activities performed:**

- Develop and commit internal visions for all aspects of the organisation including the software process area
- Create reward systems that promotes both short-term and long-term, strategic achievements
- Initiate the launching of an EF
- Motivate the need for an EF for the organisation
- Advocate the evolvement of the EF
- Initiate the investigation of new technologies that will support the internal visions
- Track progress and follow up the vision activities

### 10.3 Sponsor of the EF

The Purpose and the Goals have been presented previously. See 5.11.3 on page 42.



**Fundamental for performing:**

- Sponsor is personally committed to continuous improvements
- EF fits in with the vision for the organisation

**Activities performed:**

- Take management responsibility for the launching of the EF
- Initiate Improvement Programmes in the EF and set up realistic improvement goals based on the short-term business goals
- Initiate new technology investigations in the EF based on the long-term business goals
- Initiate general measurement programmes to improve understanding and to track the main business domain characteristics
- Assigning sufficient resources to EF activities
- Take decisions of introducing new technology into the organisation
- Changes made in the organisation by the EF, are actively supported, followed up and verified against their goals e.g. by establishment of organisational policies, standards and directives
- The EF is followed up and its results are verified against the projects' results
- Inform the organisation about the improvement results made

## 10.4 Pre-Project Phase

The Purpose and the Goals have been presented previously. See 5.10.1 on page 38.

**Fundamental for performing:**

- Organisational EPs are available or developed with the project

**Activities performed:**

All activities are actively supported by the EF

- The project is characterised based on its project goals<sup>1</sup> and its actual and predicted situation
- An organisational Experience Package (EP) is identified and selected based on the project's characteristics
- The organisational EP is tailored to the project's needs and is documented as the 'project process'
- The project process is used to support product engineering, project management and project measurement activities in the project
- The project is monitored, analysed, controlled in relation to its characteristics and its process

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1. E.g. resources, functional, non-functional, product, quality, and process requirements/goals.

- The project informs the EF when deviations from the project process, formally or informally decided, are done

## 10.5 Project Management

The Purpose and the Goals have been presented previously. See 5.10.2 on page 39.

### **Fundamental for performing:**

- Sufficient resources for managing the project

### **Activities performed:**

All activities are actively supported by the EF

- The project plan is updated to achieve the current project requirements
- The projects activities and achievements are followed up based on the project plan
- Re-planning and current commitments are based on the current project plan
- Provide EF with data or subjective information about the activities, including process problems, changes to the process and process improvement proposals

## 10.6 Software Engineering

The Purpose and the Goals have been presented previously. See 5.10.3 on page 39.

### **Fundamental for performing:**

- Sufficient resources and competence for the software product engineering

### **Activities performed:**

All activities are actively supported by the EF

- Management of software requirements
- Estimation of important product characteristics
- Specification, design, implementation, integration and test of software product
- Management of configurations of work products
- Provide EF with data or subjective information about the activities, including process problems, changes to the process and process improvement proposals

## 10.7 Project Measurement Program

The Purpose and the Goals have been presented previously. See 5.10.4 on page 40.

### **Fundamental for performing:**

- An infrastructure for collecting and validating measurements
- The goals to be investigated are agreed to by the Sponsoring Organisation, the

project and the EF.

**Activities performed:**

All activities are actively supported by the EF

- The derivation of the measurements are based on the project's goals
- The measurement plan is integrated with the project plan
- The measurements are defined explicitly
- Models for how to visualise the measurements (Quality-models) are defined
- The measurement collection procedures are established
- The measurements are collected, validated and included in the Q-models
- The measurements are monitored and analysed in relation the project's goals<sup>1</sup>, plans and estimates.
- Conclusions from the analysis are used for improving the project (project feed-back loop) and also packaged for reuse in future projects (organisational feed-back loop)

## 10.8 Post-Project Phase

The Purpose and the Goals have been presented previously. See 5.10.5 on page 40.

**Fundamental for performing:**

- Project and EF personnel are involved and working together

**Activities performed:**

All activities are actively supported by the EF

- The project is characterised based on its assignment<sup>2</sup> and the actual outcome of the project
- Product engineering, project management and project measurement activities in the project and the impact of good and bad factors are analysed
- The outcome of the project in relation to the goals, the plans, the process and the process improvement activities are analysed
- Experiences are packaged for reuse

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1. A goal in this context is set for the reason of either understanding the software, managing the project or improving the process from a project point of view.

2. This includes resources and, functional, non-functional, product, quality, and process requirements.

## 10.9 Improvement Programme Cycle (IPC)



The Purpose and the Goals have been presented previously. See 5.7.1 on page 27.

### **Work flow:**

Input to the Improvement Programme is the short-term business goals which will be called 'improvement goals' for the Improvement Programme (IP).

#### **A. Plan the Improvement Programme (IP) roughly**

Develop an 'improvement plan' (I-Plan) for the whole Improvement Programme based on your IPC process, get it approved, and maintain and refine it continuously. *The closer in time, the more details in the plan!*

#### **B. Motive the IP in business terms and make initial commitment**

Analyse the business situation. Identify some main limitations to or problems for improvement. Make a rough cost estimation of the cost of those problems for the organisation today. Make rough calculations on the return on investment of the IP. Present the motivation for important (preferably all) affected by the IP, i.e. in the sponsoring organisation and in the projects. Agree with the sponsor on the budget for the IP, in competence, resources and time as well. Refresh the vision of the EF for everyone. Get agreement on the purpose, scope, initial goals, and evaluation methods for this IP.

*Make it clear that there is a lot to gain, for everyone.*

#### **C. Characterise the organisational situation for the IP**

Refresh the domain characteristics and identify any changes. Clarify the business situation. Identify the starting point (baseline) situation, with respect to culture of change, experience from previous Improvement Programmes, leadership culture, management situation, past, current and future projects, competence, crises mode, awareness, maturity and so on. Use internal or external reference models like P-CMM from SEI where suitable. Decide on the reference model for the process characterisation, e.g. the experience in EPs in the EB, input from the new technology investigation activity or external models like CMM by SEI.

Make all characterisation in relation to the initial improvement goals. Identify in all activities and for all aspects, opportunities for improvement.

*Don't over-do it! Build on current understanding and tailor the effort to the need!*

#### **D. Decide on strategy for the IP**

Based on the understanding of the organisational situation suggest and discuss different alternative strategies for the implementation of the improvement programme. Consider risks and opportunities. Ensure commitment for the one most promising strategy. Evaluate how different improvement opportunities can be integrated for greatest impact and success. Identify suitable projects to host the improvements and distribute the improvement goals on them in escalating manner. Commit the projects to participate in the IP.

*Don't forget an early winner!*

#### **E. Evaluate and agree on improvement goals**

Based on the organisational situation and the improvement strategy, analyse the

possibilities of fulfilling the initial improvement goals by identifying possible improvements and evaluating their joint impact. Negotiate with the sponsor about the improvement goals to make them realistic. Agree, spread and document goals.

*Unrealistic goals will kill you, whatever you do. Except miracles.*

#### **F. Develop evaluation and monitoring instruments**

Break down the agreed improvement goals to measurable goals. Create an measurement plan (i.e. GQM-plan) for the IP and the projects in the improvement programme. Develop quality models to visualise progress. Develop an follow-up plan for each project.

*One accurate measurement is worth more than ten precise but inaccurate.*

#### **G. Make process changes**

Use 'Experience Package Engineering' to decide on what changes to make (EE), to changes the process models (PME), the quality models (QME) and make possible hypothesis after the changes (EE). Updated EPs are stored in the EB.

#### **H. Agree on support of the projects**

Make support plans for how the 'Project Support' should support each project, in using the process models (PMS), the quality models (QMS) and reusing experience (ES). Work together with the project to identify needs and opportunities.

*No one will come to you and say they won't make it. Monitor progress*

#### **I. Run the improvement projects**

Start of the projects and their 'project support'. Integrate the improvement goals with the other project goals. Monitor the progress of the projects and take corrective actions as necessary. Initiate an update of the experiences part of the Experience Packages in the experience base after each project or after the last one.

#### **J. Analyse the results form the projects**

Analyse the outcome of the projects in relation to the improvement goals of the projects and the improvement programme. How did it go in relation to the plans, to the adherence of the processes, to the experiences and to the expected improvements? What problems were encountered? Which are the limiting factors? What is the overall result? What was unforeseen? How can we improve the processes? The Improvement Programme and the improvement strategy?

#### **K. Write experience report**

Document conclusions and experiences form the Improvement Programme and suggest improvement for coming Improvement Programmes.

#### **Work products**

- Improvement Plan
- Project Follow-Up Plan
- Project Support Plan
- Experience Report

**Supporting methods: -**

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## 10.10 New Technology Investigation (NTInv)



The Purpose and the Goals have been presented previously. See 5.7.2 on page 28.

### Work flow:

#### A. Identification of new candidate methods and technologies

This is a highly innovative activity, and there are no specific methods proposed for supporting it. The result of the activity depends much on factors like experience and engineering judgment of the persons responsible for it. Some typical sources for identification of new methods and technologies can however be identified to be from

- the literature
- conferences
- recorded improvement proposals from the Process Experience Engineering process.

Proposals from these different sources should be merged and organised into a number of different specific proposals of candidate method and technologies. When this is done the result is a set of proposals. The main objective of the new technology investigation process is to analyse these proposals one by one. This is done in the other activities of the process. For every identified proposal, it can first be evaluated in desktop evaluations, and then, if it still is identified as being interesting it can be evaluated in laboratory experiments, and if it still is identified as interesting, it can be evaluated in pilot projects. These evaluation steps will be further explained below.

#### B. Desktop evaluation of new methods and technologies

When a new method or technology has been identified as an interesting process improvement proposal, this proposal can be evaluated in a desktop evaluation to find out whether it is likely to achieve long-term organisational business goals or not. The advantage of a desktop evaluation compared to experiments is that no process must be executed, and hence less effort is required. Therefore desktop evaluations are a natural first step before experiments. The desktop evaluation can be done in two steps:

- Basic impact analysis, where the overall impact is directly anticipated.
- Advanced impact analysis, where the estimated overall impact is derived from the anticipated impacts on local process parts.

The basic impact analysis and the advanced impact analysis are further described in [ImpactA], where an advanced impact analysis method is presented that can be used to predict a process change proposal's impact on product reliability, and project productivity and lead time.

For every method and technology that is evaluated a decision should be taken whether to further analyse it or not. This decision should be taken by the right authority, based on the organisation's long-term business goals.

The result of this activity is a method or technology that, based on long-term business goals, is identified as interesting.

### **C. Preparation of experimental evaluation**

When a new method or technique has been identified as being interesting to evaluate in experiments and pilot projects, a plan must be made for the further investigations. This plan should cover the different experiments and pilot projects that should be made and the planning should be done based on the long-term business goals and the result of the desktop evaluations. The plan should include:

- Descriptions of evaluations. All experiments and pilot projects should be described.
- Choice of projects for pilot projects. The project should handle the extra risk it implies to use a new process. In some cases pilot projects must be allowed to account for a higher cost because of the new process.
- Criteria for interpretation of the results. The criteria that are defined should be based on long term business goals, and should cover if results of experiments indicates that a change proposal should be further analysed or that a change proposal should not be further analysed.
- A measurement plan that covers the measurements that must be made to be able to evaluate all experiments and pilot projects performed in the activity.

The plan should be approved by the right authority.

The result of the activity is a plan for the experimental evaluation of a new method or technique.

### **D. Evaluation in laboratory experiments**

New methods and techniques can be evaluated in laboratory experiments and pilot projects before they are introduced as a standard method or technique in the organisation.

Laboratory experiments are characterized by being conducted off-line compared to real projects. Two different kinds laboratory experiments can be identified:

- Limited experiment
- Full experiment

A limited experiment can be limited in a number of different ways, such as: the size of the experiment is unrealistically small, the improvement proposal is investigated stand-alone and its relations to other project activities are not covered, or only some aspects of the new method or technique is covered.

In the literature it is reported from a number of different limited experiments, such as [Basili94], [Porter94] and [Wohlin95].

In a full experiment a full development process is executed, but with the limitation that the delivered products do not have to be delivered to any customer, and the context of the process may be simulated. Because the execution of the process is not intended to result in any delivered products, this means that the requirements on the development are lower than in real projects.

Definition of, and gathering of, experience of the full development process may be done with support from the Experience engineering function and the Project support function.



**E. Pilot project evaluation**

The difference between a pilot project and a full experiment is that a pilot project is expected to result in products that can be delivered to real customers. Therefore a pilot project can not be limited in any way.

Definition of, and gathering of, experience of the full development process is the responsibility of the Experience engineering function and the Project support function

**F. Evaluation of laboratory experiments and pilot projects**

The experiments and pilot projects described above should continuously be analysed and the results of performing the experiments and the pilot projects should be compared to the criteria in the evaluation plan.

For every experiment and pilot project that is performed a decision should be taken whether to continue to analyse the new method or technology or not. This decision should be based on criteria in the evaluation plan and it should be taken by the right authority.

**G. Recommendation of new methods and technologies**

The result of every desktop evaluation, laboratory experiment and pilot project should be packaged and stored in the experience base. The result includes for example the anticipated or measured impact on different quality attributes and the result whether or not to introduce the new method or technique

The result of the new technology investigation process is recommendations of new process models. The new techniques methods and techniques that are identified are the methods and techniques that according to all evaluations performed according to the evaluation plan are anticipated to fulfil the organisation's long-term business goals.

The new recommended processes can be introduced in the organisation by the New technology introduction process.

**Work products: -**

**Supporting methods:**

- Impact analysis method [ImpactA]

**References**

[Basili94] V. Basili, S. Green, "Software Process Evolution at the SEL", IEEE Software, Vol. 11, No. 4, pp. 58-66, 1994

[Porter94] A.A. Porter, L.G. Votta, "An Experiment to Assess Different Defect Detection Methods for Software Requirements Inspections", Proceedings IEEE International Conference on Software Engineering, pp. 103-112, 1994.

[Wohlin95] C. Wohlin, P. Runeson, J. Brantestam, "An Experimental Evaluation of Capture-Recapture in Software Inspections", International Journal of Software Testing, Verification and Reliability, Vol. 5, No. 4, 1995.

## 10.11 New Technology Introduction (NTIntro)



The Purpose and the Goals have been presented previously. See 5.7.3 on page 29.

### **Work flow:**

Input to the 'New Technology Introduction' is a new technology<sup>1</sup>, tested out by the New Technology Investigation process and approved for introduction in the organisation by the sponsoring organisation. Also the improvement goals for the Improvement Programme have to be considered.

#### **A. Make initial plan the introduction**

Make an initial plan for the introduction, document it and get it approved by the sponsoring organisation. Keep it updated.

#### **B. Understand the impact of the change**

Characterise the new technology and the experiences made during the investigation. Consider the impact on today's organisation, i.e. the need for new infrastructure build-up, training, information etc. Create the vision for how the desired organisation shall look like. Write a change contract with important persons if necessary.

#### **C. Develop a change strategy**

Develop a strategy for how the introduction can be made effectively from all aspects of the organisation e.g. technically, organisational, human, risk, etc. Consider

- how the change shall be lead,
- what should drive it to make people interested in participating,
- how to evaluate progress objectively,
- how to make commitments explicit and measurable,
- how to visualise progress and commitments,
- what infrastructure is needed to support the normal behaviour after the change and
- what extra activities and support is needed to introduce the change.

#### **D. Commit the sponsoring organisation to the change strategy**

Get managers involved in refining the change strategy to make them committed.

#### **E. Agree on introduction goals**

Set goals for the introduction which are specific, measurable, trackable, relevant and limited in time, and follow up the progress by these goals continuously.

#### **F. Make fall-back plan**

Make fall-back plans if the changes does create to much turbulence. Inform affected persons about the fall-back plans.

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1. Technology in this sense can be process, development approach, tool support, language, or other major changes to how projects will be performed.

**G. Make preparations for the introduction**

Establish necessary infrastructure for using the new technology. This can include necessary training material, support activities, maintenance and management issues. Prepare all affected personnel for the introduction and inform everyone about what is going to happen, how they will be involved and what change aims at establishing.

**H. Introduce the change**

Instantiate all infrastructure and start executing the first projects according to the improvement programme. Monitor the change activities and the impact of the changes. Take corrective actions as appropriate.

**I. Analyse the results of the project**

Analyse the results of the introduction and draw conclusions for why things happened. Especially unforeseen event must be analysed.

**J. Write experience report**

Package the results of the introduction on a experience report from the improvement programme. Make improvement proposal for how the introduction process and the introduction strategies can be improved.

**Work products**

- Introduction Plan
- Experience Report

**Supporting methods:**

- Change Management

**References**

[MPI], "Managing Process Improvement", SPC, 1993

## 10.12 Process Model Engineering (PME)



The Purpose and the Goals have been presented previously. See 5.8.1 on page 31.

### Work flow:

#### A. Characterise the process

- *Define the product life-cycle* that is to be modelled. The life-cycles can differ from one product-line to another.
- *Make a rough evaluation of the process* Evaluate the usefulness, based upon process drivers<sup>1</sup> like:
  - Investments (hardware, software environments, training etc.)
  - Organisational policies, procedures, practices and standards.
  - Government rules and regulations.
  - Performance goals
  - Business goals

The evaluation is also based upon the experience passed along from the experience Package Improvement process.

#### B. Set goals for the process

- *Set priority and weighting to the process drivers.* Decide which process drivers are most important.
- *Document any constraints on the processes.* Identify limits for what can be done. Limits are defined by e.g. investments. A solution could be too expensive to realise.
- *Make a plan for the Process Development.*

#### C. Identify process parts and methods

- *Analyse the proposed process parts and methods* to:
  - Identify the factors that threaten success of the goals.
  - Analyse risk areas for the likelihood of occurrence and impact if they should occur.
- *Select process parts to use.* Choose the process parts that will be used for the standard development process. Use the process drivers priorities to compare and select process parts. The selection can be supported by interviews with key personnel.

#### D. Develop and document the process

- *Document the standard process.* Documentation should be done according to the standard process template of the organisation.
- *Monitor and review.* Continuously monitoring process development helps to

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1. Process drivers are key characteristics that directly affect the development of the standard process.

maintain control over associated costs, schedules and risks.

- *Validate and verify process.* The process or part of process is validated against the objectives, process goals and success criteria.
- *Review process.* All stake-holders should participate in a final technical review of the process and agree that the process satisfies the requirements they were intended to serve.

#### **E. Review and update**

- *Review the process.* The process developed is reviewed to investigate if it fulfils the goals and the requirements placed upon it for the cycle.
- *Get approval.* Affected persons evaluate if the process is acceptable or if it should be further developed.
- *Make decisions of approval.* If not approved make updates and re-review. If approved store the process description on the experience base according to the procedure for doing so.

#### **Work products**

- Process Model Template/Guide of the organisation
- Process Model

#### **Supporting methods:**

- Process Model Handbook

#### **References**

[I-24A-1] “Process development using experience”

[D-A1.2-QLabs4-2] PERFECT Consortium, Process Modelling in Process Weaver, D-A1.2-QLabs4-2, ESPRIT Project 9090 Perfect, 1996.

[D-231] “Process Template Description”

[PMHb] SPC, “Process Modelling Guidebook”,

## 10.13 Process Control Engineering (PCE)



The Purpose and the Goals have been presented previously. See 5.8.2 on page 32.

### Work flow:

#### A. Characterize the process

- *Investigate process drivers.* Find everything that effects the standard development process and the development of an Experience Package template. Process drivers are identified in the Process Development process.

The expectations on the Experience Package template should not be unrealistic, therefore there must be a selection of process drivers and a definition of their relevance to the standard development process. This will be like a weighting of the importance for the development.

- *Collect information about process drivers.*
  - *Investigate their relevance to the process.*
- *Investigate current experience regarding the process.* The standard development process is developed from current practises and internally and/or externally used processes. There probably exist experiences from using these in some form. Experience will be investigated by interviews with involved persons and/or studying documents. There will also be experience to collect from the development of the standard development process itself e.g. the risks identified.
- *Relate the experience to the process drivers* to classify the importance of the experience.

#### B. Set goals for what process property to study

- *Set goals* for measuring the risk areas, to control the weaknesses in the process part and to get quality aspects on it. The goals should describe the quality aspects to be measured and its particular context. The goals can be defined as GQM goals that involve five attributes
  - **Object.** Describes the entity that is the object of the measurements.
  - **Purpose.** Specifies why measurement must be performed. This will be the weaknesses that are identified.
  - **Focus.** Describes the quality aspects that are to be investigated. The way to control the weaknesses and avoid risks identifies the quality aspects.
  - **Viewpoint.** Describes what role the quality focus regards. This can identify the role responsible for collecting the metrics.
  - **Environment.** Specifies the organizational context of the goal.
- *Identify possible quality models.* The goals stated in the previous sub-activity describe what to measure and why a measurement has to be done. On the basis of this, quality models that provide the control are identified. If the Process Control Engineering process is executed after an improvement of the standard development process, experience from using the standard development process will provide information about the quality models that have been used, and suggest quality models that should be used. This information has been analyzed in the Expe-

rience Package Improvement process and the result, i.e. suggestions for quality models to use, are passed on to this process.

- *Select quality models.* In the “Identify possible quality models” activity, possible quality models are identified. Among these, there may be quality models that will not be possible to perform because of lack of e.g. tools or time.

### C. Select measurements

- *Define the factors that have an impact on the goals (quality aspect).* These factors are the ones that need to be measured. This is done by creating questions that describe a goal’s quality aspect and characterizes the object of measurement. The questions are created by interviewing persons that have knowledge on the area. Persons to interview are identified by e.g. the view-point of the goal. Several people should be interviewed to decrease the risk of making incorrect conclusions. There can be several questions connected to each goal.

Cycle diagrams can also be used to find factors that have an impact on each other.

- *Identify possible measurements.* All kinds of metrics that should be collected from the process part are identified. Metrics will be derived from the questions stated in the previous activity. The metrics should provide information that answers the questions. If the Process Model Engineering is executed after an improvement of the standard development process, experience from using the standard development process will provide information about metrics that have been used and suggest metrics that should be used. This information has been analyzed in the Process Experience Engineering and the result, i.e. suggestions for measurements to use, are passed on to this process.
- *Select measurements.* In the “Identify possible measurements” activity, possible measurements are identified. Among those, there may be measurements that will not be possible to perform because of lack of e.g. tools or time.
- *Investigate if there are any other types of experiences* that should be collected for this part of the standard development process. Experience that will not be expressed in quality models or measurable data e.g. the staff’s subjective conclusions.

### D. Develop Experience Package

- *Determine metrics context.* Besides from just defining the metrics, the Process Control Engineering process should:
  - Determine objects to which a metric is related. A metric may be related to one or several objects.
  - Determine when to perform measurement. Decide if it will be done periodically or be triggered by an event.
  - Determine who has to perform measurement. It is important to have someone responsible for collecting a metric.
  - Determine how to perform measurement. Decide if it will be done automatically or manually.
  - Determine the impact of metrics’ values on the entry/exit criteria for the

process steps and phases. Values of metrics can be starting and ending conditions for a process part.

These bullets are based upon requirements for metrics integration into project plans.

- *Document the selected quality models* according to an experience base standard defined for the organization.
- *Integrate the quality models and the standard development process.* Define when and how the quality models should be used and for what reason (what the quality model will show). E.g. measure the source code growth rate during the implementation phase and use it as a progress indicator.
- *Document the selected measurements* according to the standard of the organization.
- *Define warning signals and connected circle diagrams.* The circle diagrams can have well defined connections but they can also lack some connections that will be defined as experience grows.
- *Develop/update Experience Package part.* The process part and its selected quality models and measurements are packaged according to the Experience Package standards/guides.

#### **E. Review and update the Experience Package**

- *Review the contribution to the Experience Package template* to get acceptance from the stake holders. It is important to get acceptance from all affected persons. Otherwise there will be a lack of commitment and the result will not pay off the effort.

#### **Work products**

- Quality Model template/Guide
- Process Control Model (also called Quality Model)

#### **Supporting methods:**

- GQM

#### **References**

[MHbfSD] Landis, McGarry, Waligora, “Manager’s Handbook for Software Development”, SEL, 1990.

[SMG-SEL] Bassman, McGarry, Pajerski, “Software Measurement Guidebook”, SEL 1994.

[SMG-SPC] SPC “Software Measurement Guidebook”, SPC, 1992.



## 10.14 Process Experience Engineering (PEE)



The Purpose and the Goals have been presented previously. See 5.8.3 on page 33.

### Work flow:

#### A. Characterize the available Experience Package(s)

- *Identify relevant Experience Packages.* From the available Experience Packages in the Experience Base, based on the requirements from the Improvement Programme (or other initiator) for the improvements, identify relevant Experience Packages. Experience packages can be selected on the basis of e.g. product life-cycle or domain.

#### B. Set goals for the improvement

- *Set goals for improved process control.* If the task is to improve the control of a process, then state goals for the factors of which control should be improved.
- *Set goals for investigating possibilities of process change.* If the task is to investigate potential for process change and suggest possible ways of doing so, then state which factors of the process that should be improved.

#### C. Select processes and methods

- *Select the relevant Experience Packages.* Select all the Experience Packages that are relevant to the stated goals.
- *Identify candidates by:*
  - *Investigate the Experience Packages* identified in the characterise activity. Better process elements can be derived from the tailoring of the organisational development process and the process feedback reports. If the issue is to improve process control, the reports can contain suggestions for measurements and quality models that could be better to use.
  - *Investigate experiments* that have been done internally or externally. There may be new process parts and methods that will provide a better result. Suggestions might come from the experiments performed by the New Technology Investigation process.
  - *Investigate process ideas.* There may be an idea for how the process should work both in project feedback reports or elsewhere.
- *Analyze the candidates* to see which ones provide the best improvement. This could be done by interviewing the key persons identified in the characterize activity. Consult the experience to see if there are any problems connected to improvement by using these candidates.

One way to analyze the impact of introducing the candidates is to use the Impact Analysis method[ImpactA].

#### D. Improve Experience Package

- *Update the selected Process Control models* with the statistics of the available project Experience Packages. If new process control models were selected, make the necessary gathering of data and the calculations to fill them in. Typically mean and standard deviations will be used. If the task is process change

make calculations of which process is most effective.

- Compare and estimate possible improvement. Based on the available statistics, estimate how much improvement could be made by changing the process in different ways. Integrate “best practises” in the process to investigate its potential for improvement. Make an improvement calculation including also the risk factor.

#### **E. Review the result**

- *Review the result* to ensure that its is in line with the goals and that the result is plausible. The Impact Analysis method can be used for sanity checks by experienced project personnel.

#### **Work products**

- Organisational Experience Packages
- Improvement potential and proposal reports

#### **Supporting methods:**

- Statistical Analysis
- Impact Analysis

#### **References**

[ImpactA] “Impact Analysis”.

## 10.15 Process Model Support (PMS)



The Purpose has been presented previously. See 5.9.1 on page 35.

### Goals:

- Support projects in their use of their process models, to become successful
- To make sure that the process model is reused in the most favourable way for the project

### Fundamental for performing:

- Organisational processes suitable for this project are available

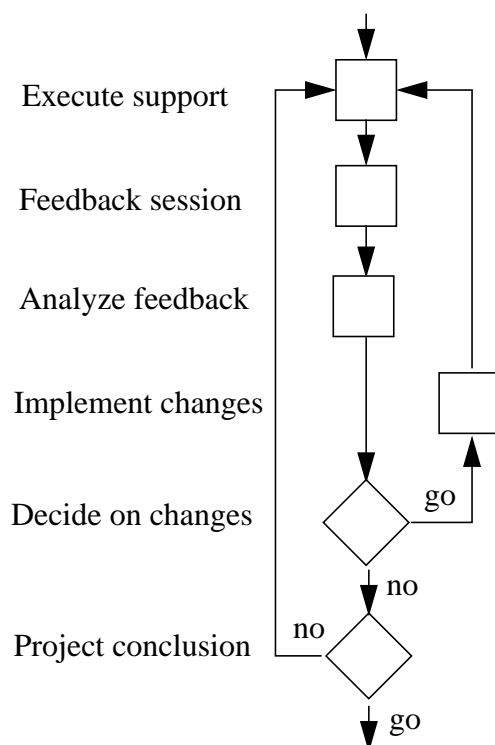
### Activities during Project Overture

This section describes the specific Process Model Support activities to perform during the Project Overture phase.

- (1) Characterize project. The purpose of this is to find factors that have or can have impact on the support activity. Interview the Project Manager to get an initial view of the project.
  - “Does the project team have experience of the software process model?”
  - “What kind of support do you think will be needed?”
- (2) Suggest Experience Package. Based on the characterization, a relevant Experience Package can be suggested to the project.
  - Search Experience Base for similar characterizations
- (3) Support project to tailor Experience Package. This is done to derive an Experience Package that can be used by the project.
  - Are all process steps applicable for this project?
  - Can the existing product model be used directly?

### Activities during Project Act

This section describes the specific Process Model Support activities to perform during the Project Act phase. Note the project specific feedback loop (figure 17).

**Figure 17: The project specific feedback loop****Execute support activities**

- (4) Make sure that the software process is understood by project members. This is done to check if training or information is needed. Interview project members about their work and how they believe the software process model is valid for their kind of activities.
  - “What do you think about the software process model?”
  - “Can you apply the software process model to your type of work?”
- (5) Motivate the use of the software process. This is done to make project members realize the need of the software process and make them committed to use it. One of the major reasons why many improvement programs fail is that project members are not committed to the software process.
  - Empower project members to be part of the goal setting and the problem-solving activities
  - Make it possible for project members to set their own personal goals for the project
  - Present experience from poorly performed projects and point out what the software process and project support could have done to avoid the failure
- (6) Perform training sessions when needed. The purpose of this is to increase the project members’ technical skills (process, techniques, tools). Make sure that enough training is conducted, otherwise project members will not feel encouraged and confident.
  - Use problem-based learning

- Perform training before activity kick-offs - “just in time training”
  - Make sure that everyone knows what has changed before project kick-off
- (7) Check if the software process is used by the project members. This is done to investigate if training or motivation is needed. The best way to investigate this is to interview project members about how they work in relation to the software process.
- “Do you feel that you lack support somewhere?”
  - “What kind of support would you like to better take advantage of the software process model?”
  - “What process steps have you done differently/better and why?”
- (8) When needed, give expert knowledge concerning the software process. This is done to support project members with expert knowledge about the use of the software process when problems or questions occur during the project. Due to the nature of the problem, many different methods can be used like coaching and counselling.

### **Feedback Session**

- (9) Monitor adherence to the software process model. The purpose of this is to monitor how well the software process model is used by project members. Get the project members’ opinion about how well the analyses relate to reality.
- Present a diagram that shows “level of process adherence”
  - “Do we support you with what you need?”
  - “Do our analyses show a correct picture of process adherence or do you have a different opinion?”
- (10) Investigate deviations from the software process. The purpose of this is to detect and identify which deviations from the software process have occurred during the project. Interview project members about what deviations they can recognize and point out.
- “Where did you lack support?”
  - “What have you done differently/better?”
  - “Why did you do it differently?”

### **Analysis**

- (11) Analyze software process adherence and deviations. This purpose of this is to understand what factors impact and how they impact on software process adherence.
- Use some benchmarking method to compare the captured process with the software process model.
  - Derive dependency graphs to understand what kind of impacting factors we have and how they impact
  - Make a qualitative estimation of the probability of derived dependency graphs

- (12) Suggest improvements of the software process and the support activities. This is done to optimize the project's use of both the software process and the support activities. Interview project members to get suggestions that directly affect their work.

- "How can the software process model be enhanced?"
- "What kind of support would you rather have had?"

### **Decide on changes**

- (13) Decide whether to implement changes or not. The purpose of this is to decide if it is possible to implement desirable changes to either the software process model or the support activity during the execution of the project. The decision is made by the Project Manager in cooperation with the Project Supporter.

- Use Impact Analysis to determine the impact of changes

### **Implement changes (optional)**

- (14) Implement changes. The purpose of this is to implement changes and to insert them into the software process or the support activity.

- Document changes to the process model carefully

- (15) Commit project members to accept changes. This is done to make project members realize the need of changes to the software process and make them committed to use it.

- Coach to build commitment

- (16) Perform training sessions as needed. The purpose of this is to increase the team members' technical skills (process, techniques, tools). Make sure that enough training is conducted, otherwise team members will not feel encouraged and confident.

- Use problem-based learning
- Perform training before activity kick-offs - "just in time training"
- Make sure that everyone knows what has changed before project kick-off

- (17) Check that project members understand the changes. This is done to investigate if training or information is needed. Interview project members about how they feel the changes will affect their work.

- "How do you think these changes will affect your work?"
- "During what activities will you infuse the changes?"

- (18) Make sure that the changes are used by project members. This is done to investigate if training or motivation is needed. The best way to investigate this is to interview project members about how the changes have affected their work.

- "Do you feel that you would have needed more support when infusing changes?"
- "What kind of support would you like to better take advantage of the change?"
- "What have you done differently/better and why?"

**Activities during Project Finale**

This section describes the Process Model Support activities to perform during the Project Finale phase.

- (19) Make a post-mortem analysis. This is done to make an overall analysis of the software process adherence and the support activity.
  - Use feedback reports and analysis made during the project to get an overview of the project
- (20) Suggest improvements of the software process and the support activity. The purpose of this is to suggest improvements in order to optimize the project's use of the software process and the support activity.
  - Summarize and set priorities to improvements which were suggested during the project
- (21) Package experience in the Experience Base. This is done to document experiences, analyses and suggested improvements of the software process and the support activity in order to support reuse and organizational learning.

## 10.16 Process Control Support (PCS)



The Purpose has been presented previously. See 5.9.2 on page 36.

### Goals:

- Identify the factors that have significant impact on the project
- Analyse and understand how these factors actually impact the project's performance
- Identify arising problems and risks for the project and its results based on the measurements
- To support project in establishing and executing a project measurement program

### Fundamental for performing:

- The organization has an infrastructure for collecting, validating and storing measurements.

### Activities during Project Overture

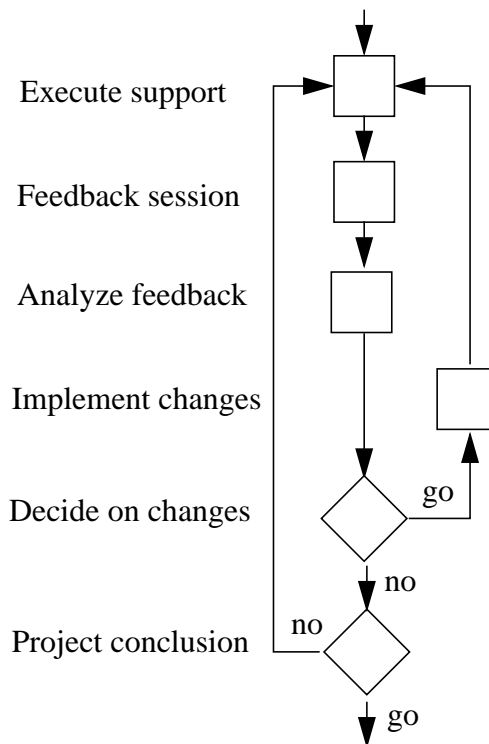
This section describes the specific Process Control Support activities to perform during the Project Overture phase.

- (1) Characterize project. The purpose of this is to find factors that have or can have impact on the support activity. Interview the Project Manager to get an initial view of the project.
  - “Does the project team have experience of a measurement program?”
  - “Are you committed to an improvement program?”
  - “What kind of support do you think will be needed?”
- (2) Suggest Experience Package. Based on the characterization, a relevant Experience Package can be suggested to the project.
  - Search Experience Base for similar characterizations
- (3) Support project to tailor Experience Package. This is done to derive an Experience Package that can be used by the project.
  - What kind of measurements will be collected?
  - How does the Improvement Program affect?

### Activities during Project Act

This section describes the specific Process Control Support activities to perform during the Project Act phase. Note the project specific feedback loop figure 18).



**Figure 18: The project specific feedback loop****Execute support activities**

- (4) Support projects to derive relevant measurements and process control models. The purpose of this is to generate relevant measurements and process control models in order to monitor and analyze results related to project goals, improvement goals and software process performance. Measurements and process control models are required for management activities and to increase understanding of the software process.
  - Use GQM to derive measurements
  - Beginners in the area of measurements can find interesting examples in the Software Measurement Guidebook [NASA94]
  - Remember to start small and don't collect too much data. Why don't start with the Eight Key Metrics according to [NASA90]?
  - Look in your Experience Base and search for Experience Packages used by similar projects
- (5) Support projects to derive measurement plans. This is done to establish a plan that defines measurements to collect, when to collect them, who is responsible and how to visualize and analyze them.
  - Use GQM to derive measurement plans
  - Reuse measurement plans from previous projects
  - The project is responsible to collect measurements
- (6) Motivate the use of a measurement program. The purpose of this is to make project members understand that measurements are essential to manage, con-

trol and analyze projects. It is important that team members are committed to the measurement plan.

- Coach to build commitment
  - Empower project members to be part of the goal setting activity
  - Project members should not feel controlled by metrics
- (7) Check if project members collect measurements according to the measurement plan. The purpose of this is to confirm that the measurement plan is followed and that collected measurements are valid. Interview project members about how they collect metrics in relation to the plan.
- Investigate measurement collection forms
  - “Do you feel you lack support?”
  - “What kind of support would you like instead?”
- (8) Continuously analyze and monitor measurements. This is done to visualize project progress and to increase understanding of project performance in order to aid project management activities. The analyses are related to goals, plan, process and improvements.
- Present diagrams of management measurements
  - Derive dependency graphs to understand what kind of impacting factors we have and how they impact
  - Make a qualitative estimation of the probability of derived dependency graphs

### **Feedback Session**

- (9) Monitor adherence to measurement plan and get feed-back on analyses. The purpose of this is to visualize how well the collection of measurements is performed and to get feed-back on made analyses. Get the project members’ opinion about how well the analyses relate to reality and why these results occurred (impacting factors).
- Present a diagram that shows “% of collected data that is valid”
  - “Are we giving the right support?”
  - “Do our analyses show a correct picture or do you have a different opinion?”
  - “Do you have any ideas why this happened?”
- (10) Investigate deviations from the measurement plan. The purpose of this is to detect and identify which deviations from the measurement plan have occurred during the project. Interview project members about what deviation they can recognize and point out.
- “Where did you lack support?”
  - “What was the reason for collecting this data?”
  - “What would make you collect this data?”

## **Analysis**

- (11) Analyze measurement plan adherence and deviations. The purpose of this is to understand what factors impact and how they impact on measurement plan adherence.
  - Use Impact Analysis to determine the impact of different factors
  - Derive dependency graphs to understand what kind of impacting factors we have and how they impact
  - Make a qualitative estimation of the probability of derived dependency graphs
- (12) Suggest improvements of the measurement plan and the support activities. This is done to optimize the project's use of both the measurement plan and the support activities. Interview project members to get suggestions that directly affect their work.
  - “How can the measurement program be enhanced?”
  - “What kind of support would you rather have had?”

## **Decide on changes**

- (13) Decide whether to implement changes or not. The purpose of this is to decide if it is possible to implement desirable changes to either the measurement plan or the support activity during the execution of the project. The decision is made by the Project Manager in cooperation with the Project Supporter
  - Use Impact Analysis c to determine the impact of changes.

## **Implement changes (optional)**

- (14) Implement changes. The purpose of this is to implement changes and to insert them into the measurement program or the support activity.
  - Document changes to the measurement program carefully
- (15) Commit project members to accept changes. This is done to make project members realize the need of changes to the measurement program and make them committed to use it.
  - Coach to build commitment
- (16) Perform training sessions as needed. The purpose of this is to increase the team members' technical skills (process, techniques, tools). Make sure that enough training is conducted, otherwise team members will not feel encouraged and confident.
  - Use problem-based learning
  - Perform training before activity kick-offs - “just in time training”
  - Make sure that everyone knows what has changed before project kick-off
- (17) Check that project members understand the changes. This is done to investigate if training or information is needed. Interview project members about how they feel the changes will affect their work.
  - “How do you think these changes will affect you when you collect your

measurements?”

- “When will you collect measurements according to the changes?”
- (18) Make sure that the changes are used by project members. This is done to investigate if training or motivation is needed. The best way to investigate this is to interview project members about how the changes have affected their work.
- Investigate measurement collection forms
  - “Do you feel that you would have needed more support when infusing changes?”
  - “What kind of support would you like to better take advantage of the change?”
  - “What have you done differently/better and why?”

### **Activities during Project Finale**

This section describes the Process Control Support activities to perform during the Project Finale phase.

- (19) Make a post-mortem analysis. This is done to make an overall analysis of the measurement plan adherence and the support activity.
- Use feedback reports and analysis made during the project to get an overview of the project
- (20) Suggest improvements of the measurement program and the support activity. The purpose of this is to suggest improvements in order to optimize the project’s use of the measurement program and the support activity.
- Summarize and set priorities to improvements which were suggested during the project
- (21) Package experience in the Experience Base. This is done to document experiences, analyses and suggested improvements of the measurement program and the support activity in order to support reuse and organizational learning.

## 10.17 Process Experience Support (PES)



The Purpose has been presented previously. See 5.9.3 on page 37.

### Goals:

- Make predictions of the project's performance and its results based on experience
- Support the execution and management of the project by identifying and presenting relevant experience

### Fundamental for performing:

- The project takes active part in interpreting the experience provided and uses it in their project to predict and monitor progress

### Activities during Project Overture

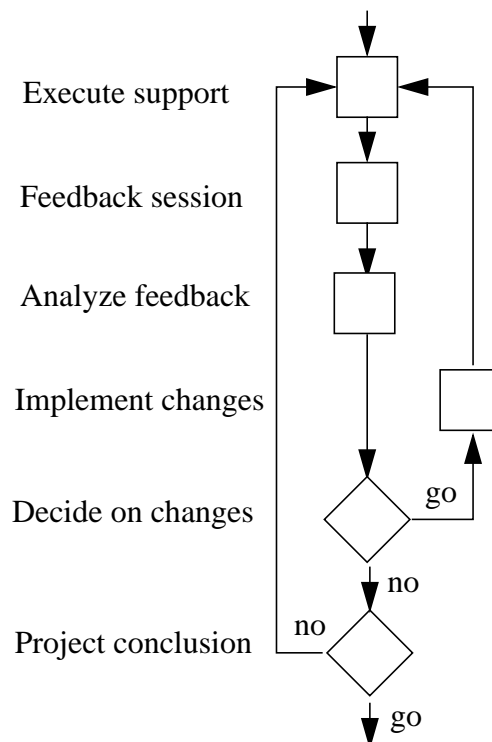
This section describes the specific Process Experience Support activities to perform during the Project Overture phase.

- (1) Support project to tailor Experience Package. Experience from previous tailorings are presented.
  - Present templates and examples

### Activities during Project Act

This section describes the specific Process Experience Support activities to perform during the Project Act phase. Note the project specific feedback loop (figure 19).

**Figure 19: The project specific feedback loop**



### **Execute support activities**

- (2) Identify and present relevant experience of software process performance. The purpose of this is to support software projects with experiences of the software process to increase understanding and to facilitate use of the software process. The Experience Packages should contain:
  - Projects with similar characteristics
  - Experience of used software process
  - Experience of introduced changes
  - Experience of improvement suggestions and their impact
- (3) Derive and present predictions of process performance. This is done to facilitate the Project Manager's actions and decisions during the project. Interesting predictions are:
  - Staffing profiles
  - Code growth rates
  - Error rates
  - Productivity, Quality and Time to market
- (4) Identify and present relevant experience from previous projects. The purpose of this is to facilitate the Project Manager's actions and decisions and to support him to avoid mistakes made in earlier projects.
  - Warning limits for predictions
  - Qualitative experience
- (5) Suggest corrective actions based on experience. This is done to support the Project Manager to take corrective actions based on experience. If former projects have detected and solved/failed to solve problems, experience from their actions and their results can be found in the Experience Base. If a similar problem occurs, this information and suggestions of actions should be presented to the Project Manager. This can be automatized like the SME-tool from [NASA92].

### **Feedback Session**

- (6) Investigate use of presented experience. This is done to determine whether presented experience and corrective actions are used within the project. Interviews with the Project Manager can give a view of the usefulness of presented experience. If turns out that presented experience is not used or applicable to the project, the causes for this must be detected in order to be able to improve the support and present usable experience.
  - "How have you used presented experience?"
  - "What problems did you encounter?"
  - "How did you use your experience to avoid problems or to be warned about problems?"
  - "What kind of experience would you think be usable for your project?"

- (7) Investigate deviations from previous experiences. The purpose of this is to detect if project performance deviates from previous experience and investigate the reasons why it deviates. Interview project members about what deviations they can recognize and their ideas about how they occurred.
- “In what way has the project performance deviated from our experience?”
  - “What do you think the deviations depend on?”

### **Analysis**

- (8) Analyze use of presented experience. The purpose of this is to analyze what kind of experience is usable or not for a project and the reasons for that.
- Derive dependency graphs to understand what kind of impacting factors we have and how they impact
  - Make a qualitative estimation of the probability of derived dependency graphs
  - Can we make any connections to the characterization?
- (9) Analyze actual project performance versus predicted project performance. This is done to understand what factors impact and how they impact on project performance.
- Derive dependency graphs to understand what kind of impacting factors we have and how they impact
  - Make a qualitative estimation of the probability of derived dependency graphs
  - Can we make any connections to the characterization?

### **Decide on changes**

- (10) Decide whether to implement changes or not. The purpose of this is to decide if it is possible to implement desirable changes to either the Experience Package or the support activity during the execution of the project.
- Use Impact Analysis to determine the impact of changes

### **Implement changes (optional)**

- (11) Implement changes. The purpose of this is to implement changes and to insert them into the Experience Package or the support activity.
- Document changes to the Experience Package carefully

### **Activities during Project Finale**

This section describes the Process Experience Support activities to perform during the Project Finale phase.

- (12) Make a post-mortem analysis. This is done to make an overall analysis of the use and correctness of presented experience.
- Use feedback reports and analysis made during the project to get an overview of the project
- (13) Suggest improvements of the Experience Packages and the support activity.

The purpose of this is to suggest improvements in order to optimize the project's use of the Experience Packages and the support activity.

- Summarize and set priorities to improvements which were suggested during the project
- (14) Package experience in the Experience Base. This is done to document experiences, analyses and suggested improvements of the Experience Packages and the support activity in order to support reuse and organizational learning.