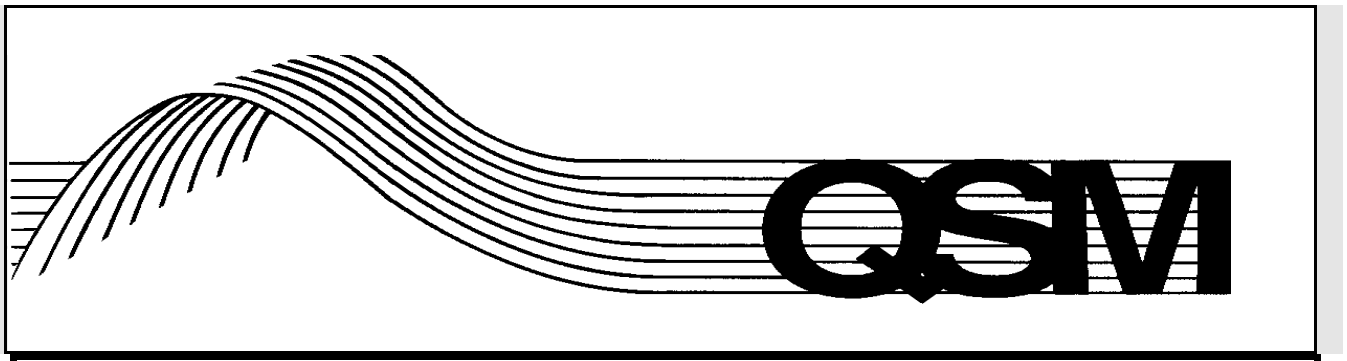

MEASURES FOR EXCELLENCE

Software Process Improvement:

Management

Commitment,

Measures

And Motivation

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Software Process Improvement: Management Commitment, Measures and Motivation

By J.W.E. Greene

"*Effective software process improvement will not start until management insists that product development work be planned and properly managed.*" (1) Initiatives to improve the software development process originate from the demands made by major purchasing organizations. Managers responsible for internal development groups, as well as system houses, now require similar improvement.

The U.S. Department of Defense (DoD) is the original sponsor of software process improvement. Through the DoD-funded Software Engineering Institute (SEI), five capability levels are defined to classify the maturity of a development organization. The SEI Capability Maturity Model, CMM, is used for assessment. Watts Humphrey, who led initial development of CMM, states, *"The original motivation for the CMM was thus to address DoD's problems with software acquisition." (1)*

Key Process Areas (KPA) are defined in detail within each level of the CMM. These are used to assess the capability maturity at each level within software projects, and in the organization as a whole.

Management factors characterize the KPAs. (2). It is significant that the maturity levels and KPAs are not based on using any specific technology; rather, maturity is judged on software management factors. The KPAs focus on the need for active and informed management permeating all aspects of the development process.

Software process improvement (SPI) initiatives are now under way worldwide in response to the demands of the SEI's CMM. These are frequently managed and driven by a software engineering process group (SEPG).

The role of the SEPG is to evaluate and improve the key process areas and hence the CMM level within the company. The goal is to reduce development time, cost, and risk, and improve the quality of the software.

Winning Commitment

It is vital to win commitment at all levels when starting an SEPG initiative. A fundamental commercial requirement is to measure the productivity of the development process to "benchmark" the current capability.

Figure 1 shows benchmarking as one of the first steps to support the commitment to software process improvement.

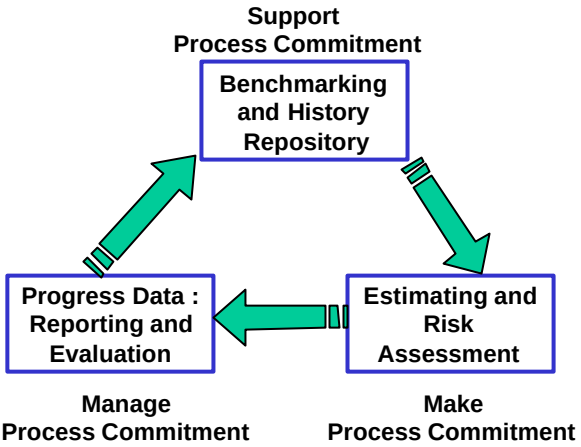

Figure 1 Commitment Measures

The anticipated benefits from process improvement are used to cost justify the investment in SEPG activities. The return on the investment (ROI) is calculated by forecasting the savings in effort and time in future developments.

The measures are then used to:

- make commitment in estimates and planning for product developments; and
- manage commitment by following progress, confirming productivity, and evaluating process benefits.

These commitments address many significant key process areas, including: informed estimating, risk assessment, defects, reliability, progress control, and feedback from the ongoing projects.

Measures for Process Improvement

The concept of measures when related to process improvement has two meanings:

1. quantitative benchmark measures of the software development process (see Figure 1), and
2. management actions to implement practices that address key process areas (see Figure 2).

These two aspects are closely related and this article describes how:

- Readily available project data is used to benchmark process productivity,
- These measures provide management insight in to Key Process Areas,
- The measures are the basis for the implementation of a software control office function that fulfils essential Key Process Areas, and
- The return on investment (ROI) is calculated as a result of measured process productivity improvement.

Background to the Measures

In the 1980s, prior to the SEI's CMM, we at Quantitative Software Management (QSM) provided a Software Engineering Assessment Service (SEAS). SEAS evaluates the software management practices in a company, and links these to measures of the company's process productivity.

The first SEAS evaluations were performed in Europe; evaluations were later extended to companies in the U.S. They provide insights into the most significant factors that impact process productivity. QSM's findings agree with the SEI's CMM, namely, that management factors dominate the development process and productivity.

QSM found that, in the absence of any meaningful measure, senior managers had no way of understanding that they themselves controlled the most important development process factors. These factors relate to management policy and methods, not technical factors.

Details and results from applying SEAS in one company over the period from 1980 to 1990 are set out in reference 3. This describes how SEAS was applied every three years to benchmark process productivity, and to identify areas for improvement. The ROI was found to be 70 percent.

More recently, QSM's research has shown a similar link between measures of process productivity and CMM levels. (4)

Management Measures

Metrics are useful insofar as they provide added value to management. Equally important is to introduce management functions that make use of metrics. However, many companies are faced with a chicken-and-egg situation of what to do first.

A company can overcome this roadblock by quickly benchmarking productivity to show its current position against industry reference measures, as well as the potential commercial benefits from improvement. At the same time, the company can put the functions in place to exploit the measures

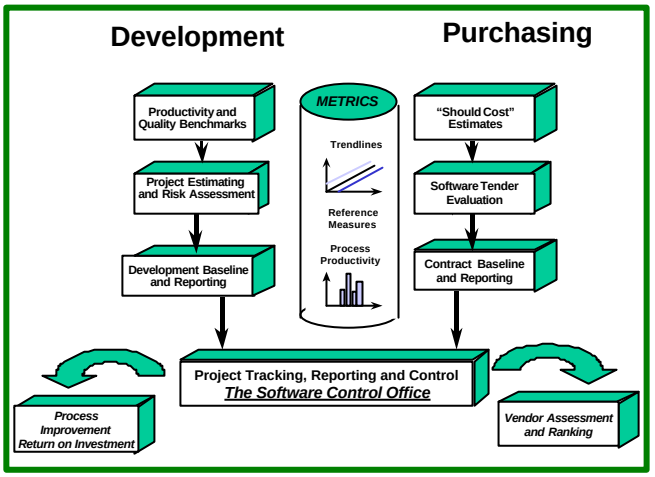

Figure 2 Management Functions

Figure 2 sets out the essential functions in managing software from both development and purchasing perspectives. These management functions, using metrics, are almost identical. Development is concerned with reducing the life cycle time and costs. Purchasing seeks value for money and confidence in delivery.

The Software Control Office

The Control Office, shown in Figure 2, lies at the heart of successfully managing the development and purchasing of software (5).

For a development group, the principal Control Office objectives are to support software projects by:

- productivity and quality benchmarking,
- estimating and risk assessment, and
- tracking, reporting progress, and quantifying process improvement.

I highlight below how the Control Office ensures that many of the development KPAs are met within CMM.

Figure 2 shows similar functions introduced by purchasing managers. Here the high-level measures are applied to assess proposals and then track and forecast each contracted development.

A report examining the software purchasing practices within the U.S. Federal Aviation Authority (FAA; 6) discloses how vulnerable this organization is due to the lack of quantified information related to software. The following summary on the FAA's position is based on SEI CMM criteria:

- Corporate memory *No*
- Sizing and reuse *No*
- Extrapolation using actual performance *No*
- Audit trails *Partial*
- Integrity within dictated limits *No*
- Data collection and feedback on actual performance *No*

All these weaknesses can be addressed and resolved by adopting the management measures shown in Figure 2.

Fast Start: The Development Control Office

Simple high-level data is used to introduce and operate the development control office function in a development group.

Benchmarking is done within three to four weeks to provide measures of current process productivity from recently completed projects. The minimum data required consists of three numbers:

1. the time in months to build and test the software,
2. the corresponding effort, and
3. the size of the software

These inputs provide measures of development productivity to determine the current position against industry reference measures. (3) Armed with this data, the company can calculate potential commercial benefits from improved process productivity.

The company then checks existing developments against the local measures to ensure that their process assumptions are consistent. It makes realistic high-level estimates for proposed developments, to quantify risk against the management constraints of time, effort, cost, and reliability. The rapid evaluation of alternative estimates that reflect time pressure leads to agreement on the high-level baseline estimates for all proposed developments.

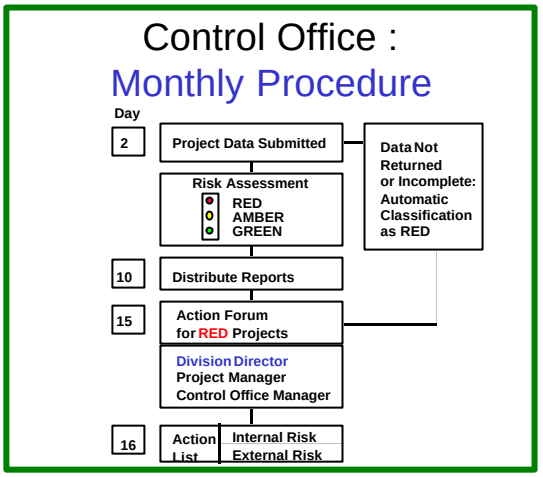

Figure 3 Monthly Control Office Procedure

The high-level baseline is then used to track and report progress. The procedure shown in Figure 3 operates to drive the Control Office (5).

Progress data is mandatory. Each month every development is risk assessed and reported using "traffic lights," whereby a red light means that development is at risk. The most senior vice-president is responsible for reviewing all red projects and taking actions to reduce risk.

Change requests are dealt with by examining the potential impact on the agreed baseline. Completion requires that the history from the project is delivered to update the in-house metrics repository and to evaluate process improvement.

Every six months benchmarking is repeated to determine productivity improvements. The return on investment from improvement is calculated to show the commercial benefits from SEPG activities.

Fast Start: The Purchasing Control Office

Rapid implementation of the purchasing control function often begins with

current developments. Frequently this involves “runaway” projects, where dates are continuously slipping and costs are soaring. The company has immediate motivation to get such projects under control. Again, this is practical to do using simple data (7).

The organization compares the implied process productivity from the current “runaway” plan estimate against industry reference measures. This detects unrealistic assumptions. The organization determines actual process productivity so far using the high-level progress data to date.

The organization makes a forecast for completion using the current process productivity. This forecast becomes the basis for future tracking. The organization then introduces a monthly (or weekly) procedure as shown in Figure 3.

The purchase of software-based systems involves preparing and issuing an Invitation To Tender (ITT; 8.) A generic questionnaire is used with each ITT; this quantifies the proposed software development plan. An essential metric is the size of the proposed software (6).

Basic data on completed projects is requested as part of the ITT. This allows the organization to make informed comparisons between the process productivity assumed in the proposal, and the track record achieved by the vendor.

By using the questionnaire, the purchasing organization rapidly collects historic data on the capabilities of suppliers. This adds to the organization’s ability to prepare “should cost” estimates before issuing the ITT.

It is a contract condition that the winning supplier must provide high-level reporting data with which to detect any variance against the agreed baseline plan and size. As shown in Figure 3, the Control Office here functions exactly as it would for a development group, with the purchasing vice-president deciding which actions are necessary on the red-lighted projects.

The regular collection of progress data and progress reporting provides a complete history of what happened during the development. This data is assembled in the vendor reference data base built by the purchasing organization to rank its suppliers.

Meeting the Key Process Areas

“The maturity-level framework and related evaluation system help organizations understand their capabilities. They can then compare their current practices with the CMM model and see what activities they need to add or improve (1).”

CMM Level	Key Process Areas	Key Actions
5 Optimising	• Statistical Evidence of Process Effectiveness • Continuous Process Improvement Focus • Rigorous Defect Causal Analysis and Defect Prevention	Software Control Office Measure Process Change Defect Prevention
4 Managed	• Productivity and Quality are Measured • Process Operates within Acceptable Limits • Predictable Process and Product Quality	Software Control Office Defect Management Process Measurement/Analysis
3 Defined	• Documented Managerial/Engineering Process • Organisational Software Process Focus • Project Activities Under Control, Quality Tracked	Software Control Office Integrated S/W Management Inter-group Co-ordination Education Program
2 Repeatable	• Disciplined Management Control Process • Project Management Policies/Procedures • Project Activities Under Control, Quality Tracked	Software Control Office Project Estimating/Control Subcontractor Management Tender Evaluation/Control Education Program
1 Initial	• Absence of Sound Management Practices • Software Process is Ad Hoc, Unstable • Software Development Results are Unpredictable	Education Program Process Measurement Project Control/Planning

Figure 4: Key Process Areas and Key Actions

Figure 4 maps the main CMM levels to show how the measures described in this article, both management and metrics, enable many KPAs to be met. The Control Office ensures that key process areas are continuously addressed. QSM has found that education is essential at all levels, especially related to understanding measures of process productivity and their commercial implications.

Yes, It Does Work!

The methods and metrics outlined here are now used extensively in Europe and the United States. Many development and purchasing organizations have introduced the Control Office concept on both continents.

Each year QSM holds a user conference where companies using these methods and measures present their results. Some of their findings are discussed below.

European Control Office Experience

The information systems director of Royal Dutch Telecom (KPN) discussed his organization’s experience in introducing the control office function in 1995 (9). He said that the objectives achieved included:

- Benchmarking and process improvement,
- Reliable software project planning,

- Keeping project progress and risks under control,
- Educating and training key personnel,
- Keeping management aware, and
- Helping improve customer relations!

This presentation proved to be of great interest to U.S. companies. Two years later, in 1997, U.S. companies reported on their experiences (see below).

KPN also introduced the software purchasing management functions. Their logistics department now has more than five years of experience in operating a control office. Some of the reported benefits include the ability to:

- Measure process productivity,
- Compare with industry averages,
- Build a data base with completed projects for future reference,
- Compare and evaluate plans against the software life cycle model, and
- Track and analyze project progress. (10)

U.S. Control Office Experience

Among the U.S. users is Rockwell Collins, which develops highly complex, real-time software for avionics systems. At the 1997 QSM conference a spokesman commented:

- It's not easy!
- High-level estimating and control works
- Get started ASAP
- Keep it simple!
- Get and use success stories

BellSouth is a major IS shop employing around 3,000 developers. Its experience in implementing a control office in support of its SPI initiatives is set out in a paper entitled "The top 10: A prioritized approach for implementing software process improvement and QSM Tools." (11)

At the QSM user conference, Jim Mayes, SEPG estimating specialist there, reported that:

- Traffic lights are appearing on many senior management status reports;
- High-level estimating and control techniques are accepted;
- The techniques have been used on more than 15 major projects for estimates, tracking (vendor and internal), or defect analysis;
- The top BellSouth Telecommunication projects or programs (minimum 10 in 1996; 36 in 1997), are expected to implement the techniques
- Accelerated process improvement (ASPI) and metrics are being implemented across IT (consisting of 3,000 people).

Measures and Motivation

The combination of high-level process productivity numbers, when coupled with effective management practices, yields significant commercial benefit. QSM finds that the more senior the management level, the stronger is the commercial motivation to use these processes and practices.

Motivating top executives means introducing and actively following good management practices based on practical metrics that result in significant savings. Winning the commitment at the highest level depends on quantifying the commercial benefits of process improvement.

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