Software Project Management: Analysis of Engineering and Management Processes by Simulation of Stochastic System of Graphical Printing Industry Production

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Abstract: Proper and effective Software Project Management is usually the most important factor in the outcome of a project for many companies in modern graphical printing industry production and their project engineers and managers [2]. Article opens new analytical directions for proper management of the software project in modern graphical printing industry production, which can be one of the important reasons for success. By using effective project management techniques a project manager can improve the chances of success in graphical printing production. Problem is how to analytically combine these techniques into a practical and best effective workable process? For effective solution one need a balanced process that covers the management and production of the entire project from inception to completion.

Key-Words: Software Project Management, Stochastic Simulation, Graphical Printing Production

1 Introduction

As Warren Buffett said: “It is better to be approximately right than precisely wrong”, but is that enough to say for specific problems of nowadays “modern graphical printing industry production” (MGPIP)? Let us see. From literature [2] it is well known that proper and effective “Software Project Management” (SPM) is usually the most important factor in the outcome of a project for many companies in MGPIP and their project engineers and managers. Also, effective SPM is mainly based on the models similar to SPM model of the Infosys Technologies Ltd., which has been assessed at level 5 (the highest level) of the widely adopted Capability Maturity Model® (CMM®), and whose project managers have successfully executed hundreds of projects.

The CMM for software is a framework that was originally developed by the Software Engineering Institute (SEI) at Carnegie Mellon University by observing the best practices. The CMM mainly reflects the collective process experience and expectations of many companies and it specifies desired characteristics of processes without precisely prescribing specific processes. Consequently, it can be used to evaluate the software process of an organization or company in MGPIP and to identify deficiencies. Like the CMM is one of the most popular frameworks for software process improvement in MGPIP and the other commonly used framework is ISO 9001 [2]. As main objective of the CMM for SPM in MGPIP is to distinguish mature processes from (ad hoc or) immature software processes, which imply that projects are executed without many guidelines and the outcome of a project depends largely on the capability of the team and the project leader in MGPIP.

2 Environment

2.1 Problem

Question is, why then does so many specific software projects in MGPIP fail? Improper management of the software project in MGPIP can be one of the important reasons for failure. By using effective project management techniques a project manager can improve the chances of success in MGPIP business. Usually each proposed SPM technique solves the problem it is designed to solve. But what are these effective SPM techniques in MGPIP? Usually, problem is how to combine these techniques into a practical and best effective workable process? For effective SPM in MGPIP we need a balanced process that covers the management and production of the entire project from inception to completion.

Today there are no so many published and scientific approaches illustrating how to integrate techniques in this way. Another fact is that the worldwide, approximately more than a million project managers execute about few million software projects each year, producing software worth more than $1000 billion. Many of these projects in MGPIP fail to fulfil customers' quality expectations or fail to deliver the software within budget and on schedule. One analysis suggests that about one-third of similar projects have cost and schedule overruns of more than 125% [2].

2.1.1 CMM Levels of SPM in MGPIP

With mature processes, a project is executed by well defined processes and the outcome of the project is less dependent on people and more on the processes. Consequently, the more mature the processes, the more predictable the results and the more well controlled the projects in MGPIP. The CMM framework describes the key elements of software processes at different levels of maturity, and it also specifies the path which includes five maturity levels (Fig.1), that a software process follows in moving from immature processes to highly mature processes. The path to higher maturity includes some well-defined plateaus referred to as maturity levels by the CMM.

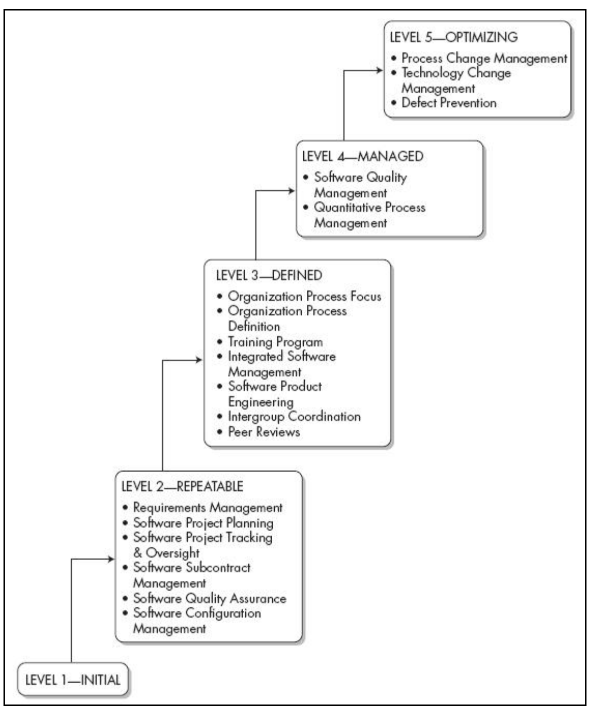

Fig.1 Maturity levels in the CMM [2]

Each maturity level specifies certain characteristics for processes, with higher maturity levels having more advanced characteristics that are found in more mature software processes of SPM in MGPIP. The range of results in MGPIP that can be expected in a project when it is executed using a process is its process capability and its process performance (the process performance depends on the process capability). To consistently improve process performance on projects in MGPIP, one must enhance the process capability and the process itself must become more mature. Maintaining processes at higher levels of maturity is a challenging task requiring commitment from the company and a proper work culture. Of the 900 assessments conducted between 1996 and June 2000 whose assessment results were provided to the SEI, only 3% of the companies were at level 5, and another 5% were at level 4. The rest were at level 3 or below, with 38% at level 2 and 18% at level 3 [2].

Each maturity level (except level 1) is characterized by “key process areas” (KPAs), which specify the areas on which the companies in MGPIP should focus. For a company in MGPIP to achieve a maturity level, it must satisfy all the KPAs at that maturity level as well as the KPAs at all lower maturity levels. In level 1, the initial level, a project is executed in a manner that the team and project manager see fit. The repeatable level (level 2) applies when established project management practices are employed, although organization-wide processes may not exist. Six KPAs at the level 2 focus is almost exclusively on SPM in MGPIP (one creates and documents a project plan, evaluate the ongoing project performance against the plan, and take actions when the actual performance significantly deviates from the plan). Requirements are properly documented, and changes to requirements are properly managed. All work products are controlled, and changes to products are properly managed through a planned configuration management plan. Reviews and audits are performed to ensure that planned processes and standards are being followed. If some parts of the project are subcontracted to other vendors, the subcontracted work is also monitored properly. At the defined level (level 3), company-wide processes have been defined and are regularly followed. Seven KPAs at the level 3 focus to company uses a tailored version of the standard process and reuses assets, data, and experience from past projects for planning. The various groups that contribute to the project cooperate smoothly through well-defined interfaces and mechanisms. Reviews are properly carried out to identify defects in work products, and sufficient support for conducting reviews and follow-up activities is provided, and the rest KPAs focus on organizational and process management issues of

SPM in MGPIP. At the managed level (level 4), quantitative understanding of the process capability makes it possible to quantitatively predict and control the process performance on a project. For two KPAs at level 4, the capability of the company's process is understood in quantitative terms. The process capability is used to set quantitative goals for a project. A key aspect of level 4 is the use of statistical process control techniques on an ongoing basis so that each activity can be evaluated and corrective action taken if needed. At the optimizing level (level 5), the process capability is improved in a controlled manner and the improvement is evaluated quantitatively. The three KPAs at level 5 focus on improving the capability of the process. Of the three KPAs, the Defect Prevention KPA is the one that most directly affects project management. This KPA requires that defects be prevented proactively by systematically analyzing the causes of defects and then eliminating those causes. If defects can be prevented from entering the software, the effort spent in removing them can be reduced, thereby improving quality and productivity [2].

3 Problem and Solution

Usually in practice of SPM in MGPIP we have small and larger projects. A small project with a team of one or two persons working for a few weeks can be executed almost "informally", where the project plan specifies the delivery date with a few intermediate milestones by e-mail, and requirements might be communicated in a note or verbally, and intermediate work products, such as design documents, might be scribbles on personal note pads. To successfully execute larger projects in MGPIP, "formality" and rigor along dimensions tasks and personnel must increase.

Usual situation for most commercial software larger projects is that many people may work for many months, where each engineering task must be done carefully by following well-tried methodologies, and the work products must be properly documented so that others (managers, etc.) can review them. In fact the project tasks are carefully planned and allocated to project personnel and then tracked as the project executes. Also, briefly discussing the role of processes of SPM in MGPIP one must know that a larger software project has two main activity dimensions: engineering and project management. The engineering dimension deals with building the system and focuses on design, test, code, and similar issues. The project management dimension deals with properly planning and controlling the engineering activities to meet cost, schedule, and quality project goals of SPM in MGPIP. Formality requires that the outcome becomes more dependent on the capability of the well-defined processes that are used for performing the various tasks. Formality is further enhanced if quantitative approaches are employed in the processes through the use of suitable metrics.

Technically, a process for a task comprises a sequence of steps that should be followed to execute the task. For a company, the processes it recommends for use by its engineers and project managers are much more because they encapsulate what the engineers and project managers have learned about successfully executing projects. The benefits of experience are conferred to everyone and these processes help managers and engineers emulate past successes that avoid the pitfalls that lead to failures. For a project, the engineering processes generally specify how to perform engineering activities such as requirement specification, design, testing, and so on. The project management processes, on the other hand, specify how to set milestones, organize personnel, manage risks, and monitor progress, and so on. This article focuses on the new analysis of the some project management process data of SPM in MGPIP.

This work proposes that only few simulation models (and stochastic simulations) can analytically (and on scientific research basis) solve specific management and engineering organisational, controlling and monitoring problems of SPM in MGPIP. Mentioned simulation models are bases for simulations of components of whole graphical production process, from digital records arrivals to finished printing plate. Why to simulate components of whole graphical production process, from digital records arrivals to finished printing plate? Possible important answer is that nowadays MGPIP is in a time of big changing of (especially "mass printing") production technology in a way of to integration traditional printing with digital printing, and moving in the space of digital printing for internet, intranet and for wide web systems usage [1].

Also, modelling of main production components of whole graphical production flow, with description of main activities involved by specific printing production were done, as needed. Time activities are from real printing production cycle, so that simulation results clearly show the "bottle necks" of printing production and to conclusion how to organise better planning of printing production. With simulation results of whole graphical production, with components that are modelled and tested, and which include number of stochastic variables, the reached level of SPM in MGPIP and management of printing production is much higher and modern oriented. Also, future improvements are promising. Simulation model working example includes parts of digital exposure of printing plates in MGPIP. Focus of research was one segment of daily news production. Fig.2 presents basic model for experimental testing. Note that in desktop publishing RIP is abbreviation of Raster Image Processing. Raster image processing (verb) or raster image processor (noun) is the process and the means of turning vector digital information such as a PostScript file into a high-resolution raster image. That is, the RIP takes the digital information about fonts and graphics that describes the appearance of your file and translates it into an image composed of individual dots that the imaging device (such as your desktop printer or an image setter) can output. In the Computer-to-Plate or CTP process the image of the page from a digital file is recorded directly from the file to the printing plate instead of creating film and making the plate from the film. Although CTP is a printing process, in order to insure the best possible output it is important that the designer discuss CTP with their printer. The printer's familiarity with the process, their equipment, the type of plates, and file format and preparation all play a role in the success of the CTP process.

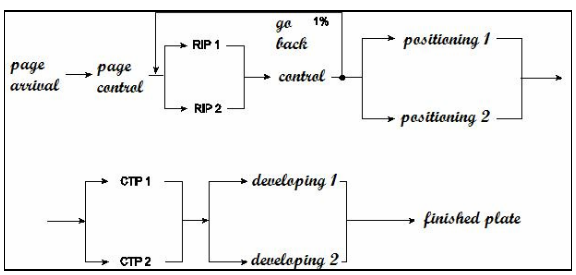

Fig.2 Basic model for experimental testing

Simulation starts with digital records (pages) arrivals from the redaction space for highlighting and ends with finished plate for printing. Digital records (pages) arrivals are generating from the redaction space of daily news edition. Depending of necessity they are generating in "ps" or "pdf" format. First point of model input is activity of controlling of digital records in arrival. Model was constructed with: 2 RIP places for digital records in arrival, 2 places for positioning of final assemble for highlighting, 2 CTP devices for highlighting of printing plates, and 2 places for developing of highlighted plates. Through few really different experiments testing was done with additional third RIP, with main idea to accelerate the whole system for plates highlighting. Also, different experiments testing were done with different times for page generating. All experiment was done with precisely specified data. Research work objective was to detect the "bottle necks" of printing production processes, to enable their numerical computation, to improve present model, and to make conclusion how to organise better planning and monitoring of printing production. Analysis and defining the space of accumulation in the production part of preparing of graphical production was research objective. Researches done before were fragmented, and consequently the goal was to develop the integral model. Focus of research was on digital system for highlighting of printing plates.

Activities were: digital records (pages) arrivals for printing, controlling of digital records (pages) in arrival, RIP process, positioning (of final assemble for highlighting) on ending printing sheet, highlighting of printing plate and its development. From real process of (daily news) productions was adopted information that 1% of RIP pages were incorrect and have to go back to RIP process. Workloads were measured on these working positions (Fig.2): controlling of digital pages in arrival - "page control" (PageContr); controlling of RIP pages - "control" (RIPPageContr); work of RIP processing - "RIP 1" or "RIP 2" (RIP); controlling of working place for positioning (of final assemble for highlighting) on ending printing sheet - "positioning" (Position); work of CTP system processing - "CTP 1" or "CTP 2" (CTP); controlling of working position of system for development of printing plates - "finished plate" (Develop).

3.1 Experimental simulation results

Table 1 GPSS Simulation testing results of main model

	E1	E2	E3	E4	E5	E6	E7
PageContr	0.403	0.427	0.424	0.527	0.461	0.569	0.579
RIPPageContr	0.125	0.120	0.122	0.133	0.115	0.126	0.129
RIP	0.983	0.983	0.982	0.980	0.982	0.979	0.979
Position	0.187	0.190	0.187	0.194	0.187	0.185	0.187
CTP	0.548	0.555	0.550	0.531	0.547	0.543	0.534
Develop	0.894	0.892	0.891	0.858	0.878	0.841	0.828

Testing with main model (Table 1) was done with varying in time of digital pages arrival (in seconds) from redaction system, and 7 experiments were one (from E1 to E7) with changing in arrival of digital pages in system of digital highlighting: E1=60,20; E2=60,30; E3=60,10; E4=50,20; E5=55,20; E6=45,20; E7=40,20. Conclusion is that workload of RIP working is constantly (from 0.979 to 0.983). RIP page controlling and page positioning were much closed in very closed interval. Resulting data significantly varies by acceleration and workload at place of "PageContr" from lowest (40.3%) in E1 to highest (57.9%) in E7. Opposite is at place of "Develop", because there is highest workload at E1 (89.4%) when it is lowest acceleration of page arrival, and lowest workload at E7 (82.8%) when it is highest acceleration of page arrival.

Then testing of expanded main model by addition of active RIP was done, but without past data changing because of future computations (Table 2). With additional active RIP largest difference in workload change is at position CTP, average higher about 26.6%. Position PageContr significantly varies, but Position is with average higher improvement about 9.2%, RIPPageContr is with average higher improvement 6.6%.

Table 2 GPSS Simulation testing results of expanded main model by addition of active RIP

	E1	E2	E3	E4	E5	E6	E7
PageContr	0.443	0.431	0.414	0.495	0.468	0.516	0.601
RIPPageContr	0.192	0.196	0.193	0.189	0.192	0.184	0.183
RIP	0.978	0.979	0.977	0.978	0.977	0.976	0.974
Position	0.278	0.276	0.293	0.272	0.278	0.285	0.276
CTP	0.825	0.803	0.824	0.793	0.833	0.797	0.793
Develop	0.890	0.891	0.890	0.871	0.877	0.852	0.825

Then testing of third model (Table 3) was done with 2 active RIP, but with same and constant page arrivals from redaction, defined from first test and first experiment E1. Variable element was time for RIP work, which was defined under discrete function: E1=3.300/6.320/1.290; E2=3.290/6.310/1.280; E3=3.280/6.300/1.270; E4=3.265/6.285/1.255; E5=3.220/6.240/1.230; E6=3.145/6.170/1.180; E7=3.120/6.140/1.150.

Table 3 GPSS Simulation testing results of third model with 2 active RIP

	E1	E2	E3	E4	E5	E6	E7
PageContr	0.403	0.422	0.424	0.400	0.417	0.429	0.424
RIPPageContr	0.125	0.128	0.134	0.142	0.174	0.231	0.284
RIP	0.983	0.982	0.982	0.983	0.983	0.982	0.981
Position	0.187	0.193	0.214	0.214	0.247	0.357	0.410
CTP	0.548	0.576	0.599	0.612	0.730	0.945	0.949
Develop	0.894	0.892	0.894	0.900	0.905	0.915	0.920

With 2 active RIP (Table 3) larger difference in workload change is at position RIPPageContr, average higher about 12.5% to 28.4%. Position PageContr was constantly with big workload about 40% to 42.9%, Position is without influence and in bigger interval, from 18.7% to 41%, but RIPPageContr is with average higher improvement 6.6%. The largest difference in workload change is at position highlighting of printing plates in E4, E5, and E6, and CTP was changed from 61.2% to 73% and at the end 94.5%. Conclusion is that in third experiment the largest difference in workload change is at position digital highlighting of printing plates.

Then testing of fourth model but now with 3 active RIP was done (Table 4), and with exact same data from last (third) experiment.

Table 4 GPSS Simulation testing results of fourth model with 3 active RIP

	E1	E2	E3	E4	E5	E6	E7
PageContr	0.443	0.412	0.426	0.414	0.410	0.430	0.432
RIPPageContr	0.192	0.206	0.207	0.214	0.246	0.330	0.322
RIP	0.978	0.978	0.979	0.978	0.979	0.933	0.756
Position	0.278	0.288	0.304	0.316	0.365	0.489	0.493
CTP	0.825	0.848	0.897	0.917	0.933	0.945	0.949
Develop	0.890	0.892	0.894	0.896	0.905	0.916	0.920

With additional and now 3 active RIP (Table 4) largest difference from last experiment was in workload change at place of page positioning, with higher improvement about 10.2%. Position PageContr has not significantly changes, but RIPPageContr is with constant improvement higher in average 7.7% then before, from 19.2% in E1 to 33% in E6. Now with 3 active RIP largest difference from last experiment was in workload change at place of CTP, with higher improvement average about 22.6%, from E1 to E6.

4 Conclusion

This research solve some practical problems of MGPIP in accordance with the stated before, and this paper shows the result of a scientific comparison of the existing practical systems that function in different ways in MGPIP of famous Croatian printing house "Vjesnik" Zagreb and largest Croatian (daily news) publishing house EPH ("Europapress Holding") Zagreb, but whose main aim is offering solution contents, knowledge, information, etc., and to reach as many users as possible by means of this and similar solutions. This research was part of main Scientific research named "Analytical Model for Monitoring of New Education Technologies for Long Life Learning" conducted by Ministry of Science, Education and Sports of the Republic of Croatia (Registered Number 227-2271694-1699). Now with these experiments it is clear that method of simulation (with appropriate ICT software package usage, like it is GPSS, or Vensim®, etc.) open significantly new approach in managerial and engineering problem solving during the SPM in MGPIP, where the big projects depends largely on the capability of the team and the project leader. With developed results of stochastic simulations of SPM in MGPIP wide range of open questions arises, and new directions in researching of SPM in MGPIP.

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