



Software Process Improvement Case Study



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Overview - *Advent* is a software development organisation involved in the development and support of publishing systems based around its 3B2 publishing software. The Advent Group has grown rapidly over the last five years and now includes Advent Publishing Systems Ltd and Advent Software Ltd in its portfolio of companies. In March 1998 Advent introduced the Personal Software Process (PSP) on a pilot basis in its Dublin office. The PSP is a scaled down version of the Capability Maturity Model (CMM) intended for use by individual developers or small teams.

Advent has found that its PSP trained software developers have improved their planning and estimation accuracy and are producing software with significantly fewer defects. It is planned to roll out the PSP throughout the organisation in the near future.



The Organisation and its Environment

Advent Software was formed as a result of a merger between Advent Publishing Systems of Swindon, UK and LaserType of Dublin. Advent Publishing Systems had as its core product a high-end typesetting and pagination software package - 3B2 - with a number of add-on's for use in other market domains e.g. scientific/technical publishing, legal, financial, etc.

Advent Software was established in Dublin to carry out the modifications to the core 3B2 product to address the needs of other market domains, e.g. workgroup/workflow solutions for the newspaper environment, an ODBC interface to 3B2 for use in database publishing systems, etc. The development work for the main product continues in Swindon.

Advent directly employs three software development staff in its Dublin office, with a further five based in Swindon. It is planned to expand the number of software development staff in the Dublin office over the next three years.

Starting Point

When Advent began its Process Improvement Experiment (PIE) in March 1998, no formal tracking of software development activities were being carried out. In most cases, development was carried out on a fixed-price contract basis, but as no measure was recorded of time spent on projects, it was not possible to accurately determine the profitability of individual jobs.

It follows from this that there were no metrics in place to record developer productivity or defect rates. However, an experiment in tracking the time of the three Dublin-based developers over a ten day period indicated that at least 20% of their time was spent on non-revenue generating, defect rework. In addition, the cost of distributing fixes to Advent's worldwide customer base ran to many thousands of pounds each time it was necessary to do so.

In these circumstances, Advent felt that a two-pronged approach to process improvement was needed. Firstly, a concerted effort was necessary to reduce the occurrence of defects and their associated costs, and secondly, a system of process metrics was instituted to gain an accurate understanding of the existing development process.

As Watts S. Humphrey, who developed the PSP, says "If you don't know where you are, a map won't help."

The principal goals of Advent's PIE, through piloting the use of the PSP in the Dublin office were:

- To implement a system of time and productivity tracking for the three Dublin developers.
- To analyse the data collected to accurately determine how and where developers' effort was being spent.
- To use this analysis to improve the accuracy of estimating and planning.
- To implement a formal system for defect tracking and control.

- To analyse the defect data collected, categorising defect types and causes and to propose further process improvements.

Based on our experiences in piloting the PSP in Dublin, to draw up a plan for its introduction into the Swindon office.

The Improvement Project

What is PSP?

The Personal Software Process was developed by the Software Engineering Institute (SEI) of Carnegie-Mellon University in the United States. The PSP consists of a group of seven well-defined processes that progressively introduce data collection and analysis techniques. It was developed by the SEI specifically to address the process improvement needs of small organisations and project teams and is based on the key process areas of their well-known Capability Maturity Model (CMM).

The PSP is a self-improvement process designed to help software engineers to control, manage and improve the way in which they work. It provides a structured framework of forms, guidelines and procedures for developing software. Properly used, the PSP provides the software engineer with historical data that is needed to make and meet commitments, making the routine elements of software engineering more predictable and therefore more efficient.

The PSP has a maturity framework similar to the CMM. It is introduced in seven levels, each successive level building upon the foundation laid by the previous one. The levels and their associated activities are shown in figure 1 below:

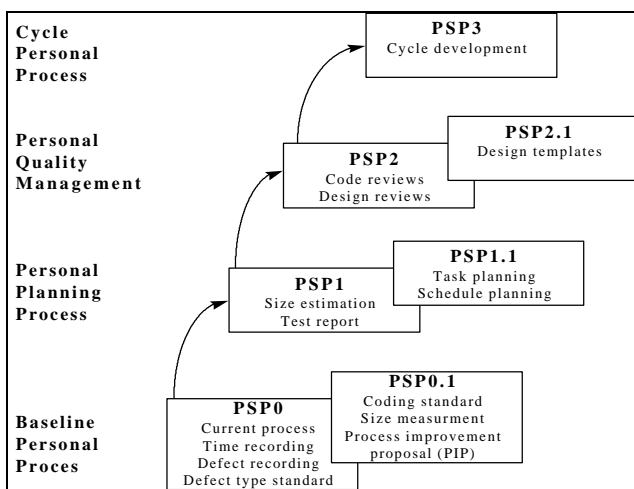
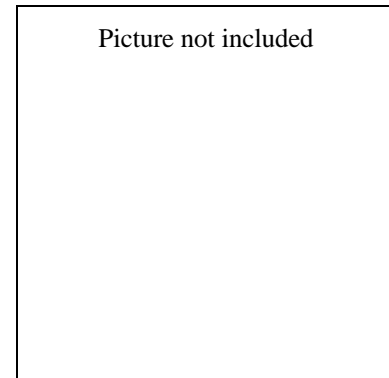


Fig1. The PSP Framework

The PSP does not rely on any special tools or aids. Standard applications such as spreadsheets and word processors are used for data gathering and analysis.

Implementation of PSP

To equip themselves with the knowledge required to carry out the process improvement experiment, two Analyst Programmers, Fintan Swanton and Kirill Chernyuk attended the PSP for Software Professionals training course at the Centre for Software Engineering.



Fintan Swanton

The course was run during March/April 1998 in two blocks of one week, with a three-week interval in between. Time on the course was divided equally between lectures and practical programming exercises, to gradually introduce participants to the concepts and techniques of the PSP.

To help ensure a smooth and effective implementation of the PSP, Gerry Coleman of the CSE was asked to provide post-training implementation consultancy. In addition, assistance was provided by Advent's SPIRE mentor, Patrick O'Beirne of Systems Modelling, a qualified PSP trainer who co-presented the course at the CSE. His knowledge and experience proved invaluable in this area.

Having trained the software developers in the PSP, Advent began to adapt the process to its particular needs. The PSP explicitly recognises that "one size does not fit all", and to be fully effective it must be tailored to suit those using it. It provides the concept of the Process Improvement Proposal to allow individual developers to document proposed adaptations to the process and to incorporate them into their personal process definition. The main changes made were to alter the standard time and defect recording forms, e.g. extending the time recording logs to include extra data relating to customers etc. One of the PSP's key process areas is a checklist based formal review of program designs and code – by analysing defect data from the first three months of the PSP's use it was possible

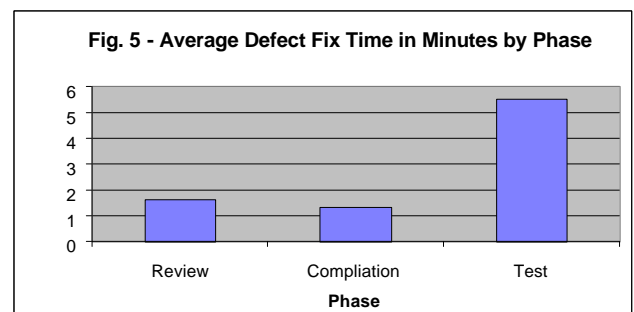
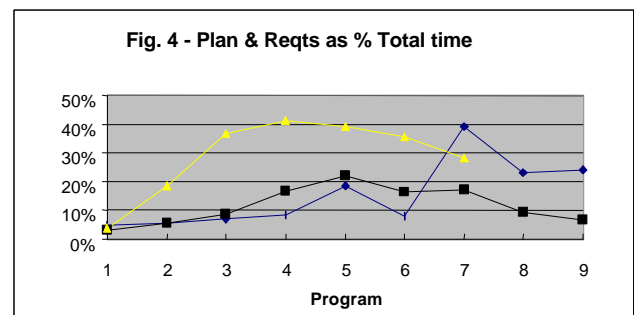
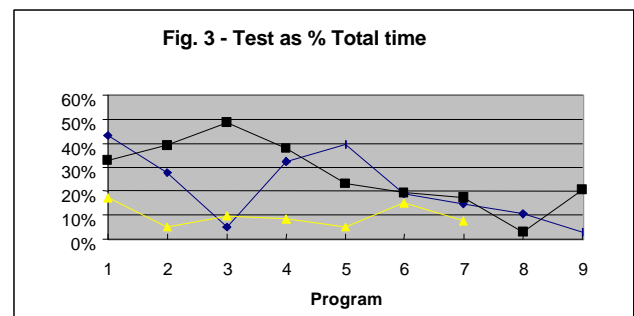
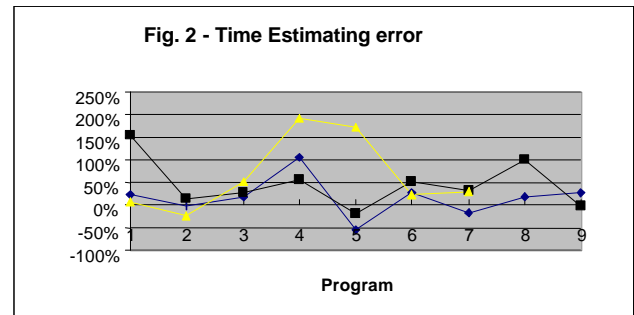
to revise these checklists to improve their usefulness in the detection of defects.

The PSP is now being used for all software development in Advent's Dublin office. In addition, use is being made of the time tracking and management elements of the PSP to plan and schedule non-development related activities.

The Results

The PSP has only been in fully in use in Advent for three months at the time of writing, so available data is limited. Nevertheless, some interesting conclusions can be drawn from what is available:

- (1) Figure 2 shows the trends in estimation accuracy by developer over the course of the PSP training and in the first few real life programming projects. 0% indicates complete accuracy. While there are considerable fluctuations, by program 7 or 8, all three developers seem to be converging on an accuracy level of around plus or minus 50%. This is still not perfect, but a great deal better than many in the industry achieve – including ourselves, up to now!
- (2) Figures 3 and 4 contrast trends for the same set of programs for test effort and planning & requirements effort as percentages of total development time. For two developers the test effort shows a steady decline from around 40% to around 15% - the development effort of the third developer was always at this level. On the other hand, all three show a steady increase in effort devoted to project planning and requirements validation. In other words, the PSP encourages the developer to spend time getting things right early on, rather than trying to test quality into products late in the development cycle.
- (3) Data on 151 defects were logged, including the development phase in which they were introduced and detected, and the time taken to fix each one. The average fix times are shown in Figure 5 - it was on average 3.4 times faster to fix defects detected in review than those detected in test. Defects found in compilation were the quickest to fix - 4.2 times faster than in test - however the types of defects which compilers can find are limited. Compilers cannot, for example, detect that program code does not fully cover the corresponding design.





Lessons Learned

The three developers who have been using the PSP remain very positive about it. In particular, they believe that the focusing of greater emphasis on planning and requirements has proved very beneficial in improving both the quality of their work and their planning and scheduling techniques. In addition, as a result of this project, the company showed an improvement in the SPICE ratings in 9 out of the 19 process areas assessed. Advent intends to introduce the PSP into its UK development team in the near future.

The PSP involves quite a high level of paper work - filling in forms and following process scripts. Some may object that such a detailed process definition acts as a straitjacket, stifling creativity. On the contrary, we have found that it makes the routine and repetitive aspects of a task easier, helping to ensure that nothing is overlooked and allowing the developer to concentrate on the truly creative aspects. Other benefits include improved planning and tracking of work, guidance in the performance of work (particularly when new staff are being introduced), and help in evaluating and improving the way in which work is done. Some problem areas became apparent as we gained experience with the PSP:

- (1) The PSP is designed around a rigid waterfall life cycle, and does not lend itself easily to an incremental style of development.
- (2) There is little or no tool support available for the PSP. Tools could be very useful, particularly in the areas of time and defect recording.
- (3) Availability of training is still very limited. Advent was fortunate that the SPIRE time scale coincided with the PSP training course held at the Centre for Software Engineering. While we would hope to be able to run a formal course in-house for our UK development team, there remains the problem of training for new recruits on an ongoing basis, if the PSP is adopted as a company standard process.

- (4) Training also requires considerable effort – approximately 120 hours for each participant. This can prove difficult to schedule.

Plans for the Future

It is planned to continue using the PSP in Dublin and extend its use to the Swindon office.

We have been very encouraged by the results of the formal reviews that form one of the PSP's key process areas. (See Figure 5.) However, these reviews are carried out by the author of a work product on his or her own work. We believe it would be very worthwhile to introduce formal peer reviews, both to provide developers with an alternative viewpoint on their work, and to improve technical communication within the development team.

The improved process definition brought about by the PSP could provide a very good starting point if we were to seek ISO 9000 or similar certification for our development process. In the United States, where Advent is developing its business, many firms now are requiring certification under the Capability Maturity Model (CMM) from vendors. While we believe the CMM is probably inappropriate for a firm of Advent's size, use of the PSP, based as it is on the CMM, could well improve our credibility when pitching for business in this market.

Finally, the Software Engineering Institute (SEI) who developed both the CMM and the PSP are currently working on an intermediate process model, the Team Software Process (TSP), intended for use in small project teams. Very little has been published on the TSP to date, but we will be monitoring developments closely to see how relevant they are to our situation.

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