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Impacts of process modifications

A case study at Volvo Cars Corporation

Master's Thesis in Software Engineering

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Göteborg, Sweden 2012

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Abstract

A process is commonly viewed as the series of actions carried out to bring out a result. Improving a process, or sub process, is of course very desirable for any kind of engineer. In this thesis, the author investigates whether a change to improve a sub process also could benefit other related sub processes indirectly. A case study is performed with a group of engineers at Volvo Cars Corporation to examine the impacts a small change to their data management process brings to their workflow. The effects of the changes are measured by gathering data using surveys and interviews. Using these opinions and thoughts that the group and their co-workers have, it is concluded that the sub process change was beneficial and has the potential of bringing additional improvements to other sub processes.

Keywords: *process change, data management, process improvement*

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Sebastian Andersson, Göteborg, May 2012

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VCC	Volvo Cars Corporation
CAE	Computer-Aided Engineering
CVS	Concurrent Version System
VCS	Version Control System

Chapter 1

Introduction

A process is commonly viewed as the series of actions carried out to bring out a result. For engineers, the process is a crucial part for all kinds of problem solving, since it is always important to consider in what way different actions are performed.

Improving a process, or sub process, is very desirable since it would for example mean reducing the amount of resources it would take to reach the same results, or to increase the quality of the results. However, making alterations to improve a process might also affect other adjacent activities. This means that it is not clear what actual benefit may be attained from the process change [2].

In order to confirm or deny this hypothesis, a case study at Volvo Cars Corporation (VCC) is performed. Some engineers at VCC are working with computer-aided engineering (CAE). Their tasks include analysing several different attributes of vehicle components. Thousands calculation and simulation files are used for this, which are managed using shared databases.

The data management sub process is part of the daily work for these CAE engineers, but the process itself is inefficient in its current state. An improvement is sought after, with the intention of reducing wasted resources. This change to the sub process could however also affect other activities, and actual improvement of the whole work process is uncertain.

1.1 Purpose

The purpose of this case study was to investigate how a change in a small part of the daily work process at Volvo Cars Corporation affected the overall workflow of the CAE attribute analysts.

1.2 Limitations

The case study was only focused on a single small development team at Volvo, and its processes.

Only a small part of the processes were changed, namely the sub process of data management. This process was chosen together with the attribute analyst team at Volvo, and the choice was based on what sub process they felt was unsatisfactory and in need of an improvement.

Evaluation of how every aspect of the process was changed was deemed too time-consuming and impractical to perform, and focus laid on the most noticeable changes.

Time and resources were also limitations. This case study was performed by a single student, which reduced the maximum amount of time that could be put in. The resources available at Volvo were also limited in the sense of time that they could afford to spend on this case study.

1.3 Method

The investigation begun with analyzing the current process. This included taking a closer look at the different activities, steps and flow that the attribute analysts were experiencing. Based on the observations and Volvo employees' suggestions, the sub process for improvement was found and identified.

A change in the process was introduced by extending and improving the data management software, which affected the process in some way. New helpful tools and functionality were implemented and added to the software. The focus of the implementation was simplicity, and a working end-product was more important than an aesthetically pleasing one.

The effects of the change were evaluated using data that was gathered from two separate questionnaires targeted at the attribute analysts at Volvo. The first was done before the software tool had been introduced. The second was performed a few weeks after the introduction, which left the attribute analysts some time to use it before evaluating. Interviews with individual attribute analysts were also be performed, although to a lesser degree.

Once all data had been collected, it was compiled and presented. The results were based on the collected data and the interviews.

1.4 Report layout

This report starts off with basic theory about processes in general, in Section 2. After that in Section 3, the situation at Volvo Cars Corporation is described and the problems they are facing are taken a closer look at. The practical activities that were performed during this case study are described in Section 4, Case study approach. Section 5 consists of the results of the study, followed by the conclusions that could be drawn from them in Section 6.

Chapter 2

Theory

2.1 Processes - What is a process?

A process can be defined in several ways. One very broad definition is given by the Oxford English Dictionary [12]:

> *"A continuous and regular action or succession of actions occurring or performed in a definite manner, and having a particular result or outcome; a sustained operation or series of operations."*

It basically applies to almost any activities that is performed in a certain way and gives a result.

The online dictionary Business Dictionary defines a process in a bit more specific way [11]:

> *"Sequence of interdependent and linked procedures which, at every stage, consume one or more resources (employee time, energy, machines, money) to convert inputs (data, material, parts, etc.) into outputs. These outputs then serve as inputs for the next stage until a known goal or end result is reached."*

This definition is also general, but limits itself to activities that has both inputs and outputs. In our case, this definition fits better. In figure 2.1, a example process is graphically presented.

$$\text{Input} \rightarrow (\qquad\qquad) \rightarrow \text{Output}$$

Figure 2.1: Example Process.

One analogy that applies to this could be *a person goes to the store to buy groceries.* If this simplified case is viewed as a process, the input would be time and money, and the output would be groceries.

2.2 Workflow

The term *workflow* is technically different from a process. As we have seen, a process is very generic. A workflow lies more towards daily work routines, which can be seen in this definition [14]:

> *"Progression of steps (tasks, events, interactions) that comprise a work process, involve two or more persons, and create or add value to the organization's activities.*

In a sequential workflow, each step is dependent on occurrence of the previous step; in a parallel workflow, two or more steps can occur concurrently."

2.3 Sub process

Each activity in the process or workflow can also be split into smaller parts called sub processes [6]. The relationship between a process and a sub process is shown in figure 2.2:

$$\text{Input} \rightarrow (\text{A} \rightarrow \text{B} \rightarrow \text{C}) \rightarrow \text{Output}$$

Figure 2.2: Process split into sub processes.

In the case of figure 2.2, our example process contains three smaller steps, A, B, C, which are considered sub processes. They need to be transversed sequentially in order to transform the input to the output successfully. Each of the sub processes could naturally be split into even smaller parts. This can be done until they consist of illogically small actions, similar to some of Zeno's paradoxes [10].

Our previous analogy, the grocery-shopping trip, could also be split into sub processes, as seen in figure 2.3. For example, the process could contain more, smaller steps: travel to the store, choose and pay for the groceries, and then travel home.

$$\text{Input} \rightarrow (\text{A} \rightarrow (\text{B1} \rightarrow \text{B2}) \rightarrow \text{C}) \rightarrow \text{Output}$$

Figure 2.3: Sub process split again.

In figure 2.3, the previous sub process of B actually contained two smaller activities. Our example process now consists of four steps, of various sizes, that are carried out in sequence to reach our output from the initial input.

In our shopping analogy, the activity of choosing and paying for groceries could be further split into first choosing and then paying. Now, our process is not just considered as inputs and outputs anymore, but instead as a sequence of more detailed activities, which helps us understand how the process really acts.

2.4 Change in processes

Process-change is interesting. There is a fair bit of uncertainty towards what the results of a change are [2] . The main question that is asked is *What happens if a process or sub process is changed?*. Naturally, the answer to this question is dependent on what actually is changed. In order to determine what to change and how, the true purpose and goals of the change needs to be determined.

2.4.1 Purpose of change

Why would you want to change a process? Let us take a closer look:

In our running shopping analogy, one of the sub processes were *travel to the store.* Let us be more descriptive and specify that as *walking to the store.* Now, if we decided to take the car instead of walking, we would change our process. What was the purpose of this change? One good reason might have been to save time, since taking the car to the store is most probably faster than walking. This means, that if we only take the time saving aspect into consideration, this would be an improvement to the process.

However, there are other things that are also affected by taking a vehicle instead of traveling by foot. One of those things is fuel consumption. The car runs on gasoline, which is arguably expensive, or at the very least more expensive, than walking. This means, that if we only take cost into consideration, this would be a negative process-change, since it would be more costly than previously.

With both cost and time considered, it becomes harder to determine which process is better. There are certainly more aspects in this change that also are interesting, but we cannot take all of them into account, which means that we have to be careful when we compare processes.

2.4.2 Comparing Processes

In order to determine whether a process is better than another, several aspects come into play. Our previous example showed that both time and cost reductions are interesting metrics when comparing processes, but there are several other metrics that can also be used for determining the performance of a process [3].

The metrics can target different aspects of the processes, such as reliability or learning, and can be grouped into three performance measurements [3]: Process Efficiency, Process Flexibility and Process Effectiveness.

- *Process Efficiency.* A process is considered efficient if it basically does not waste available resources. The most common metrics associated with efficiency are time and cost reduction.
- *Process Flexibility.* How adaptive and quick to respond to changes a process is, the more flexible it is. This performance is measured when taking cost of adaptation, time of adaptation and ease of adaptation into consideration.
- *Process Effectiveness.* The effectiveness of a process is observed from a customer's, or other external party's, perspective. Customer satisfaction and reliability are metrics that are used here.

When determining the performance of a process, all of these performance measurements should be taken into consideration. However, in some cases, some of the measurements do not make sense. For example, it might not be clear who the customer of a certain process is which makes measuring the effectiveness of the process difficult and hard to motivate. This means that the measurement that is most important to observe is dependant on the current subject process.

2.4.3 Outcome of change

Now that we have a grip of what the purpose of a process change could be, and we have some understanding to how to compare processes to each other, let us take a look at the different outcomes a change to a sub process can bring out.

In the following examples, a made-up process, *Process 1*, will be examined. *Process 1* consists of five sub processes, declared as letters A through E, as seen in figure 2.4.

$$\mathrm{A} \rightarrow \mathrm{B} \rightarrow \mathrm{C} \rightarrow \mathrm{D} \rightarrow \mathrm{E}$$

Figure 2.4: Process 1.

Now, let us consider that the sub process C does not have a satisfactory behavior in some performance aspect. A change from C into a new sub process X is wanted, where X is believed to have better performance than C. The desired final process is showed in figure 2.5.

$$\mathrm{A} \rightarrow \mathrm{B} \rightarrow \mathbf{X} \rightarrow \mathrm{D} \rightarrow \mathrm{E}$$

Figure 2.5: Desired Process.

While this looks good, it is not the guaranteed outcome of the change. Other sub processes might also be affected by the change. For example, sub process X might have its input and outputs slightly changed which affects the activities before and after X. The indirect changes to X's adjacent sub processes might have a negative effect to B and D, and change them. In figure 2.6, these possible outcomes are shown with the new sub processes, Y and Z, which have worse performance than B and D respectively.

$$\begin{array}{ccccccccc} \mathrm{A} & \rightarrow & \mathrm{B} & \rightarrow & \mathbf{X} & \rightarrow & \mathbf{Z} & \rightarrow & \mathrm{E} \\ \mathrm{A} & \rightarrow & \mathbf{Y} & \rightarrow & \mathbf{X} & \rightarrow & \mathrm{D} & \rightarrow & \mathrm{E} \\ \mathrm{A} & \rightarrow & \mathbf{Y} & \rightarrow & \mathbf{X} & \rightarrow & \mathbf{Z} & \rightarrow & \mathrm{E} \end{array}$$

Figure 2.6: Possible outcomes.

It is important to note that it is hard to determine what actually happens to the other sub processes. How flexible and strongly related the sub processes are to each other are also factors that are hard to determine and play a part in the outcome. The indirect change might even be a performance increase in other sub processes, or making them obsolete and removing them all together. The performance of the entire process is what is ultimately the most important, which is why the effects of a sub process change are interesting to examine more closely.

Chapter 3

Processes at Volvo

In this case study, we will examine how a group of engineers work at Volvo Cars Corporation (VCC). The group consists of 15-20 people that are computer-aided engineering (CAE) engineers.

3.1 CAE engineers

The CAE engineers at VCC work with simulations and calculations on different vehicle-components. Some of the CAE engineers are considered to be attribute analysts. The attribute analysts work more closely with the actual characteristics of certain components, such as solidity and durability, or noise and vibrations. Many of them are considered to be in different departments, in different parts of the office building, that work on different parts of the vehicle. However, most of the vehicle parts are dependent on each other which means they work somewhat together.

In their work, they are heavily dependent on computers. Model and calculation-files are shared between the engineers and they collectively make changes to them. In order to keep track of which engineer that has done which changes, they use a version control system.

3.2 The attribute analyst process

The attribute analysts use version control systems (VCS) extensively in their daily work, which there are many benefits to [5]. The version control systems allows the engineers to utilize a shared database, called repository, where the definitive versions of the files reside. From the repository it is possible to retrieve certain versions of files to the local computer, via checkouts or updates. After changes has been made to a file locally it is possible to upload it, or *commit* it, to the repository as a new version, which allows other users to see and benefit from the change. Since they are many distributed CAE engineers working on the same files, the VCS helps the engineers to keep track of the files in their daily work.

A common workflow scenario that the CAE engineers experience can be seen in figure 3.1:

Retrieval/Update of files → Work/Computations → Commit files

Figure 3.1: Attribute analyst workflow scenario.

In our scenario, a attribute analyst need to do some work using a certain set of files. First, an update-call from the version control system, targeted at the desired files, ensures that the files are of the most recent revision. After this, the analyst performs the calculations and simulations, along with changes to the files, that are required to complete the work task. Lastly, a commit-call done through the VCS, with contributing comments regarding what changes that had been made, uploads the files to the shared database for other CAE engineers to work with.

3.3 Problem area

Finding right files for retrieval, or specifically the first activity in figure 3.1, among the thousand of files has become a problem for the CAE Engineers. Searching and filtering by filename alone has proved to not be sufficient, since most files have very similar names which does not differentiate the content well enough. The engineers feel that the simple process of finding the correct files is tedious, takes too much unnecessary time, and could be improved. If they could filter by more specific criteria, such as when a file was changed or by whom it was changed, it would be much easier to find what was sought after.

Chapter 4

Case study approach

This case study had been divided into seven activities that were carried out in sequence in order to investigate how a change in a small part of the daily work process at Volvo Cars affects the overall workflow of the attribute analysts, as mentioned in Chapter 1.

The methodological steps of this case study are:

1. Analysis of current process.
2. Discussion of which subject to change.
3. Development of tool.
4. Assessment: Current work situation.
5. Trigger change, introducing tool improvements.
6. Assessment: Updated work situation.
7. Analysis of questionnaire-data and reach results.

4.1 Analysis of current process

The attribute analysts group members of this case study had their current processes analysed. They work a lot with calculation and simulation tools during their workday, which we have mentioned in the previous chapter. A number of models and other files are being worked on throughout the day, which are located in a database on a shared server. Several different analyst groups at Volvo Cars work with the shared files in their projects, and the files are used between groups. These files were handled by their version control system.

4.2 Discussion of which subject to change

Informal interviews revealed a problem area they had in these computer-aided engineering (CAE) attribute analyst groups, as we have seen in the Problem Area section of the previous chapter.

The employees felt that the process of retrieval of files was difficult and that it was not intuitive to find certain files in their database. Searching for the files by filename was possible, but not sufficient. According to the engineers, searching and filtering by more criteria was highly sought after since that functionality was not available in their current version control system (VCS).

Based upon the attribute analysts' experience with the sub-par sub process of utilizing the version control system, a decision was made that this was the area to be changed.

This sub process was something that they felt was in need of an improvement and changing something else, that perhaps were not as poor, did not make sense. Even though any change would be interesting to investigate, a change that is not wanted or needed by the end of the study would not be beneficial for the employees at all.

An improvement to the version control system was sought after by the CAE engineers in order to address this problem. The goal of the improvement was to reduce the time-consuming activities related to the VCS usage, such as finding the correct files, and to improve the workflow for the CAE engineers. It was agreed that the VCS would be extended with additional tools that would help reaching this goal, and this is described in more detail in the following section.

Since this change would affect a software program that the users are familiar with, and would act similar to a software update, the introduction would be smooth. Introducing a whole new software system to fill the utility gap of TortoiseCVS would be much more resource consuming transition than just evolving the current system that the users know how to use.

4.3 Development of tool

The version control system the CAE engineers use is called Concurrent Versions Systems (CVS) [1].

4.3.1 CVS

CVS is a free software that keeps track of changes and versions of files. It is a client-server system that lets its users checkout a file to work on locally and then commit the changes to a shared repository as a new version, called *revision*. When committing a revision, the user can add comments that helps explain what has been changed to other users. The revision can also be tagged with a specific text-tag that helps users differentiate between versions of files. A revision also contains other data, such as when it was committed and by whom. All the data that a revision contains can be called *meta-data*, which is stored in the repository. Originally, CVS was only used in a command-line context, but the CAE engineers utilize TortoiseCVS to make it more user-friendly.

4.3.2 TortoiseCVS

TortoiseCVS is a open-source graphical tool that makes using CVS much easier [7]. It is a utility-tool that the CAE engineers use on a regular basis. TortoiseCVS allows Windows users to easily checkout and commit files directly from their regular Explorer-window. It reduces the hassle that the normal command-line CVS usage can be. It also provides graphical help using for instance colored icons and context menu interactivity [9]. An example screenshot from the graphical user-interface of TortoiseCVS can be seen in the figure 4.1 below.

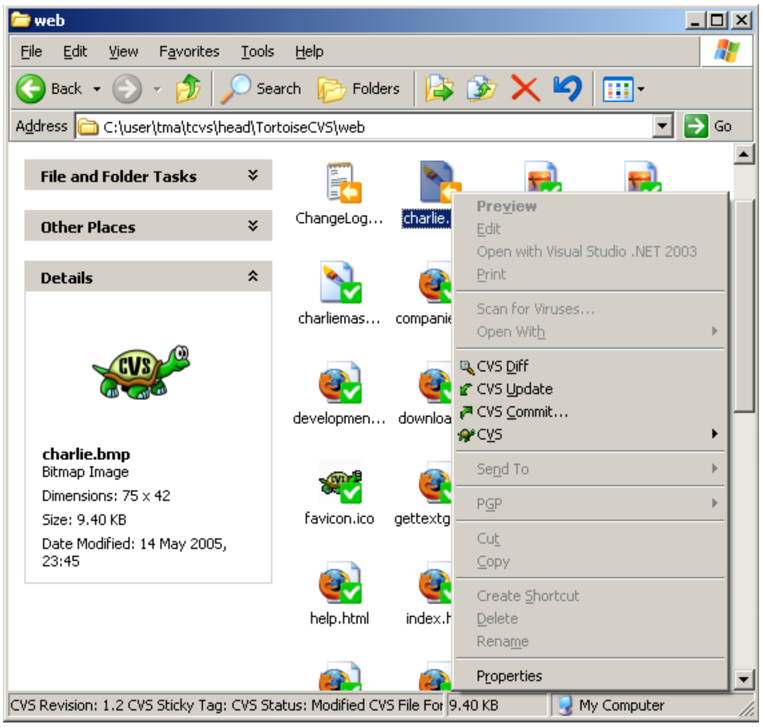

Figure 4.1: The original graphical user-interface of TortoiseCVS [8].

It is the attribute analysts intent to make changes to TortoiseCVS and extend its functionality. The requirements and purpose of the changes are described in more detail in the next section below.

4.3.3 Tool Requirements

The purpose of the change to TortoiseCVS was to easier find files based on information that was available in the repository, which we called meta-data. This is to address the targeted problem area and to improve the sub process of CVS-usage.

The requirements of the proposed tool improvement were elicited through several informal interviews with the attribute analysts, both before and during the development. This close end-user relation was very helpful in finding out the true needs of the tool had to fill. They agreed that the basic requirements included the ability to search with meta-data criteria and that it should be easy to do. A more complete list of requirements are available in Appendix D.

4.3.4 Implementation overview

In order to make changes to the open-sourced TortoiseCVS, the C++ source-code was retrieved from SourceForge [9]. The source-code was altered to reach the proposed requirements.

In order to get the functionality available, the development of the tool was the focus of the project for ten to twelve weeks. After that, weekly iterations with new releases were provided with changes based on a close feedback loop with a few of the attribute analysts. This was done with the intention of making the finding of bugs more efficient, increasing the quality, and to reach as close to optimal results as possible for the CAE engineers.

4.3.5 Basic functionality

In the improved tool, the search is performed in a local folder that is handled by CVS, and is accessed through a new menu item in the TortoiseCVS context menu through Windows Explorer, as seen in figure 4.2. This item, called *"Search ..."*, opens up the Search dialog which allows the user to input the meta-data criteria that are desired to search by, seen in figure 4.3. In the graphical interface, the current folder structure is available as well the local files. When the search is performed, the tool conducts a retrieval of meta-data from the repository. The results are filtered based upon the search criteria and presented in a new dialog window, which is presented in figure 4.4. The user is then allowed to interact with the results in different ways, including accessing the file from Windows Explorer as well as exporting the results to a txt-file. Then, the user either performs a new search or exits the program.

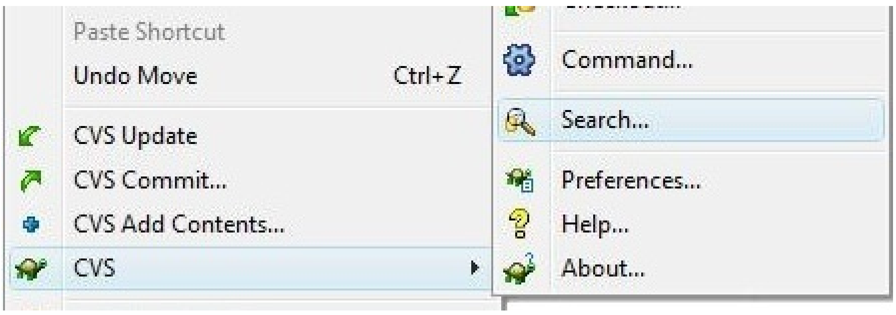

Figure 4.2: The Search-menu option, accessed from Windows Explorer.

4.4 Assessment: Current work situation

In order to assess our work situation, including what the effects and impacts of the changes and the improvements to TortoiseCVS brought, data needed to be gathered. The opinions and thoughts about the changes that the CAE engineers experienced were what was important, and that information needed to be collected.

The data-collection methods that were chosen consisted of surveys, in the form of questionnaires, with the addition of interviews. A questionnaire takes very little time for the participants to perform, compared to other data-collection methods such as interviews, which is why it was chosen to be the primary data source [13].

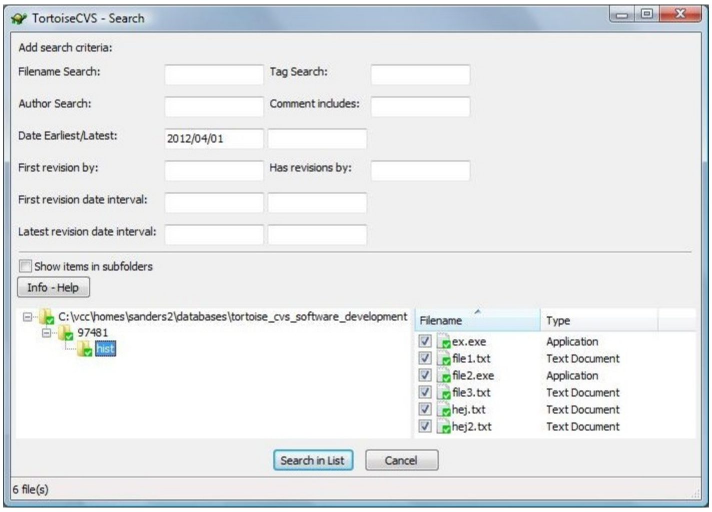

Figure 4.3: The graphical user interface for TortoiseCVS-Search.

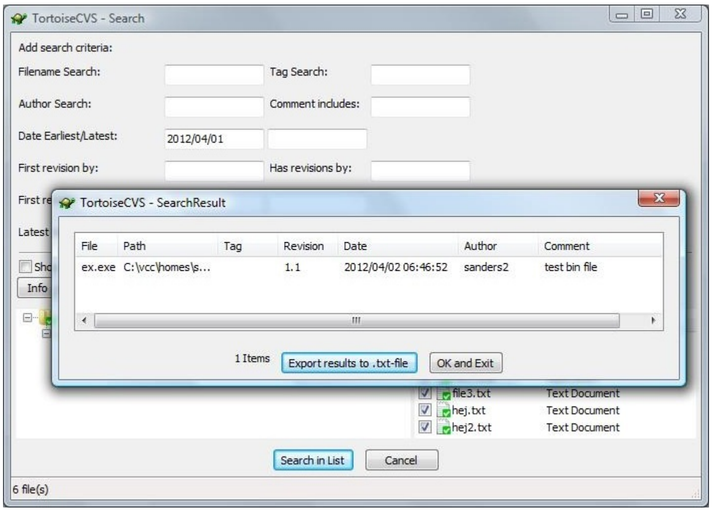

Figure 4.4: The interface presentation of the search results.

4.4.1 The first questionnaire

There are several steps that should be taken to create a questionnaire, which include defining the research question, study population, question formulation and response formulation [13].

The questionnaire research question is the subject that the questionnaire is investigating, and is not the same as the research question of our whole case study. The purpose of the questionnaire is assessing the current situation. This is to establish a reference point to be able to compare the situation after the tool was introduced. Therefore the question that both the first and the second questionnaire should answer is: *What is the current situation like?*

The study population is easier to figure out and it is the recipients of the questionnaire. In our case, the recipients are the ones that assess the current situation, the CAE engineers.

Formulating the questions clearly is important. In this first questionnaire, the questions should be aimed towards the current situation and its problems. A example question from the first questionnaire can be seen in figure 4.5.

How often do you use the version control system TortoiseCVS in your daily work?

Figure 4.5: Example question from the first questionnaire.

The responses of the questions are also important to formulate correctly. They should be unbiased and clear. Because one of the focuses of the questionnaire is to save the participants' time, the questions consist of defined multiple-choice responses, called closed questions [13]. The example question from figure 4.5 together with the closed responses can be seen in figure 4.6 below.

How often do you use the version control system TortoiseCVS in your daily work?

- Very often (several times per day).
- Often (few times per day).
- Moderate (once per day, a few times per week).
- Seldom (a few times over some weeks or less).
- Never.

Figure 4.6: Example question with closed answers.

A online survey was finally created, with the full list of chosen questions found in Appendix A, and distributed via email to the attribute analysts group.

4.5 Trigger change, introducing tool improvements

The change was induced by introducing the improved TortoiseCVS. The tool was presented at a group meeting and the installation file for the program was distributed via email together with instructions.

Since this change would affect a software program that the users are familiar with, and would act similar to a software update, the introduction would be smooth. Introducing a whole new software system to fill the utility gap of TortoiseCVS would be much more resource consuming transition than just evolving the current system that the users know how to use.

4.6 Assessment: Updated work situation

To make a comparison with the situation before the introduction, data needed after the introduction of the tool as well. Two weeks were given to all of the attribute analysts to test the software and to evaluate the change in their daily workflow. The assessment was done by performing another separate surveys in addition to interviews.

4.6.1 The second questionnaire

The second questionnaire was similar to the first one, but was targeted more towards the changes that has happened since the introduction of the new tool and thus had slightly different questions. Similarities existed since it would be easier to compare the survey data if the resulting data of the two questionnaires were in a similar structure.
An example question from the second questionnaire, with the question responses, can be seen in figure 4.7 below.

Has this introduction made more time available for you in your daily work?

- Yes, a lot.
- Somewhat.
- No.

Figure 4.7: Example question from the second questionnaire.

The questionnaire was once again created online and distributed via email to the same survey participants as the first questionnaire. The survey questions of this questionnaire are presented in Appendix B.

4.6.2 The interviews

In order to fully cover the assessment, interviews, that generate a bit more in depth information, were performed. The structure and questions of the interviews were similar to the questionnaires, but focused on more on qualitative, open, feedback.

The most important parts of conducting the interviews are starting from a point that is well known and moving towards more uncertain things, as well as keeping a level of formality that makes the interviewees feel that what they have to say is important [4].

As mentioned, the quality of the responses in the interviews is what is important. That is why only a few, broad, questions are asked with the purpose of generating in depth answers. The interviews were conducted with a group of three attribute analysts in the same sitting, which enabled discussions to naturally emerge. One of the questions that were asked in the interviews can be seen in figure 4.8 below.

How has the new TortoiseCVS functionality changed the CVS sub process?

Figure 4.8: Example interview question.

All the interview questions can be found in Appendix C.

4.7 Analysis of questionnaire-data and reach results

The questionnaire-data was gathered and compiled together with the interview data. The results are presented in the next chapter.

Chapter 5
Results

Here are the results from the questionnaires and interviews presented.

5.1 First questionnaire

Responserate: 4 responses of 15 participants.

Questions:

1. Are you generally satisfied with the workflow of your current day-to-day activities?

Very satisfied.	75%
Could be better.	25%
Not at all.	0%

2. Is there a presence of interruptions in your current daily workflow?

Yes, lots of interruptions.	0%
Yes, some interruptions.	25%
No, none.	75%

3. How often do you use the version control system TortoiseCVS in your daily work?

Very often (several times per day).	25%
Often (few times per day).	25%
Moderate (once per day, a few times per week).	50%
Seldom (a few times over some weeks or less).	0%
Never.	0%

4. How important is TortoiseCVS for your daily work?

Very important (a must have).	25%
Important (very beneficial).	75%
Somewhat important (helpful).	0%
Not important at all.	0%

5. Is there a presence of interruptions in your daily work caused by TortoiseCVS?

Yes, lots of interruptions.	0%
Yes, some interruptions.	25%
No, none.	75%

6. Could introducing more user-friendly functionality to TortoiseCVS reduce the amount of interruptions it causes?

Yes definitely.	75%
Perhaps it can.	25%
No.	0%

7. Could a more user-friendly TortoiseCVS improve overall day-to-day workflow?

Yes definitely.	75%
Perhaps it can.	25%
No.	0%

8. Additional comments

No comments.	100%

5.2 Second questionnaire

Responserate: 4 responses of 15 participants.

Questions:

1. Are you generally satisfied with the workflow of your current day-to-day activities?

Very satisfied.	25%
Could be better.	75%
Not at all.	0%

2. Is there a presence of interruptions in your current daily workflow?

Yes, lots of interruptions.	0%
Yes, some interruptions.	75%
No, none.	25%

3. Do you find the new TortoiseCVS functionality useful?

Yes, very.	75%
Somewhat.	25%
No.	0%

4. Has the new functionality reduced the amount of TortoiseCVS-caused interruptions?

Yes, a lot.	0%
Somewhat.	75%
No.	25%

5. Has the new functionality increased the amount of TortoiseCVS-caused interruptions?

Yes, a lot.	0%
Somewhat.	0%
No.	100%

6. Has this introduction made more time available for you in your daily work?

Yes, a lot.	0%
Somewhat.	75%
No.	25%

7. Has this introduction affected other activities in your daily work?

Yes, many activities.	0%
A few activities.	75%
No, none.	25%

8. Has this introduction created new activities that takes up time in your daily work?

Yes, many activities.	0%
A few activities.	0%
No, none.	100%

9. Has this introduction improved transitions/flow between activities?

Yes, a lot.	0%
Somewhat.	50%
No.	50%

10. Has the new TortoiseCVS functionality reduced amount of workflow interruptions?

Yes, a lot.	0%
Somewhat.	75%
No.	25%

11. Has the new TortoiseCVS functionality improved the overall daily workflow?

Yes, a lot.	25%
Somewhat.	75%
No.	0%

12. Additional comments
”So far, I have not had the opportunity to test the new CVS thoroughly, only for a

few minor tasks. Thus, it is a little early to conclude exactly how well it performs in our IT environment setting."

5.3 Interviews

1. How has the new TortoiseCVS functionality changed the CVS sub process?

   The added functionality gives a positive sub process change. Introduction resource cost is low, easy to install in most cases. The targeted process for improvement is said to have a performance increase, based on current observations. However, hard to determine because of limited evaluation. More usage will make the actual changes clearer. According to prognosis, the changes seems to be almost entirely positive to this sub process.

2. How has the new functionality affected the transitions between activities?

   It has not affected activity transitions very much. Small hindrances could potentially occur, but nothing clear yet. Overall fine. No clear change in transitions seen.

3. Has the change in the TortoiseCVS sub process affected other work processes?

   Potentially yes but no real concrete evidence yet. This would be clearer after more usage and evaluation when the users are more comfortable with the software.

   (a) Could you give an example of a scenario where the sub process change positively affects a different work process?

   Some model-file needs to be created. Using a similar existing model-file would reduce the amount of work needed to create the new one. However, if one is unable to locate the existing file then reuse would not be possible which forces unnecessary extra work. If it would be easier to find the file, a lot of potential extra work could be avoided. The new tool could potentially improve the performance of this scenario.

4. How has it affected the whole work process?

   Very hard to determine at the current stage of evaluation. Better question would be: How **will** *the process be affected? Since the usage of TortoiseCVS is not the core part of the work process, but instead considered as a utility used a couple of times each day, the impact size would probably be small. Even though a small impact, it is considered a good impact. Improved utility could also improve the whole CVS-usage as well as reduce the risk of faults.*

Chapter 6

Conclusions

The purpose of this case study was to investigate how a change in a small part of the daily work process affected the overall workflow for a group of engineers. In order to draw conclusions, a closer look upon the questionnaire and interview answers is taken.

6.1 First questionnaire

The question that the first questionnaire wanted to answer was *What is the current situation like?*. However since the response rate was quite low, 4 responses out of 15 handouts, solid conclusions of what the original situation looked like cannot be drawn. Higher response rate would help a lot, but it is worth mentioning as a reference point that, in postal surveys, a 75% response rate is considered extremely good [13]. Reminders of the questionnaire was sent out, which usually increases the responses, but that failed in this case [13].

From the data that is available, one can argue that the original situation was not perfect. Improvements to the Concurrent Versions System (CVS) process could prove to be beneficial, as was discussed in the pre-study informal interviews, which also was why this process was chosen in the first place. As mentioned above, the low response rate makes it difficult to make definite conclusions.

6.2 Second questionnaire

The second questionnaire targeted the opinions of the changed situation after the sub process change, specifically the introduction of the new TortoiseCVS functionality. This questionnaire had the same low response rate as the first one, 4 responses out of 15 participants, which also makes this data somewhat unreliable.

The answers from the second questionnaire hint that the new functionality that the TortoiseCVS improvement brings is useful. The overall workflow seems to have received a positive change. One comment describes the situation as not fully tested and explored, which is likely to be the general situation for the users since two weeks might not be enough to fully get a feel for the software. As with the first questionnaire, the low response rate makes it difficult to be certain that this is the general consensus of the changes.

6.3 Interviews

The interviews, that were conducted about three weeks after the introduction, were meant to complement the questionnaire answers. However, since the response rates were quite low, the interviews carry more weight in the conclusions.

In the interviews, it was made clear that the new functionality was indeed beneficial. It was stated that the sub process was changed for the better. It was repeatedly pointed out that more testing would be beneficial for a better evaluation, since the tool was said to be something that is used only a couple of times each day in a normal situation. Based on the current level of observations, the sub process change does not affect other processes very much, but it is mentioned that the *potential* benefit is great. The interviewees thought that, in the future, the new TortoiseCVS functionality would be a very beneficial asset once the users got acquainted with it.

6.4 Discussion

6.4.1 Our case

Since the response rates of the questionnaires were low, the most part of our conclusions are mainly based on the interviews.

As we have seen from both the questionnaires and interviews, the change to our case study group's daily work at Volvo Cars Corporation is small but positive. We see that the negative effect on other processes is low or neglectable. There is no clear positive effect on other sub processes yet, but according to the interviews there is a potential for it in the future.

With the above considered, it is concluded that this change resulted in a performance increase and a improvement in workflow. In addition, we conclude that in this case there exist a potential benefit to the overall process which is greater than the actual improvement to the sub process. The modifications to the CVS process did in our case positively affect the overall process.

When everything regarding our case is taken into account, we can say that we reached and fulfilled the purpose of this project and answered the question of how a change in a small part of the daily work process affected the overall workflow for this group.

6.4.2 The general case

While it is easier to draw conclusions at the case level, it is more difficult in the general case. Even though the actual concrete thing that was changed in our case was not the most important part of this study, which should makes it somewhat transferable between groups, it is impossible to be certain of the effects in a different case. With this said, the author believes that other groups, at other companies or projects, that are in a similar situation could potentially also have a performance increase with a comparable sub process change. This means that a different sub process, that has a similar resource wastage, could be altered in a potentially exclusively performance increasing way as we saw in our case. However, this is absolutely not definite as there are many hidden factors that come into play which might be case-specific which makes the general case uncertain.

6.5 Future work

Improvements to processes are very interesting to engineers. However, as we have seen in this case study, it is not always easy to predict what actually happens when a process is changed for the presumed better. In the future, more studies in this area could be useful. Perhaps some better tools for measuring small scale process changes could be beneficial to fully investigate the effects of a change.

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Appendix A

Questionnaire 1: Before introduction

1. Are you generally satisfied with the workflow of your current day-to-day activities?
    - Very satisfied.
    - Could be better.
    - Not at all.
2. Is there a presence of interruptions in your current daily workflow?
    - Yes, lots of interruptions.
    - Yes, some interruptions.
    - No, none.
3. How often do you use the version control system TortoiseCVS in your daily work?
    - Very often (several times per day).
    - Often (few times per day).
    - Moderate (once per day, a few times per week).
    - Seldom (a few times over some weeks or less).
    - Never.
4. How important is TortoiseCVS for your daily work?
    - Very important (a must have).
    - Important (very beneficial).
    - Somewhat important (helpful).
    - Not important at all.
5. Is there a presence of interruptions in your daily work caused by TortoiseCVS?
    - Yes, lots of interruptions.
    - Yes, some interruptions.
    - No, none.
6. Could introducing more user-friendly functionality to TortoiseCVS reduce the amount of interruptions it causes?
    - Yes definitely.
    - Perhaps it can.

- No.

7. Could a more user-friendly TortoiseCVS improve overall day-to-day workflow?
    - Yes definitely.
    - Perhaps it can.
    - No.
8. Additional comments

Appendix B

Questionnaire 2: After introduction

1. Are you generally satisfied with the workflow of your current day-to-day activities?
   - Very satisfied.
   - Could be better.
   - Not at all.
2. Is there a presence of interruptions in your current daily workflow?
   - Yes, lots of interruptions.
   - Yes, some interruptions.
   - No, none.
3. Do you find the new TortoiseCVS functionality useful?
   - Yes, very.
   - Somewhat.
   - No.
4. Has the new functionality reduced the amount of TortoiseCVS-caused interruptions?
   - Yes, a lot.
   - Somewhat.
   - No.
5. Has the new functionality increased the amount of TortoiseCVS-caused interruptions?
   - Yes, a lot.
   - Somewhat.
   - No.
6. Has this introduction made more time available for you in your daily work?
   - Yes, a lot.
   - Somewhat.
   - No.
7. Has this introduction affected other activities in your daily work?

- Yes, many activities.
- A few activities.
- No, none.

8. Has this introduction created new activities that takes up time in your daily work?
   - Yes, many activities.
   - A few activities.
   - No, none.
9. Has this introduction improved transitions/flow between activities?
   - Yes, a lot.
   - Somewhat.
   - No.
10. Has the new TortoiseCVS functionality reduced amount of workflow interruptions?
    - Yes, a lot.
    - Somewhat.
    - No.
11. Has the new TortoiseCVS functionality improved the overall daily workflow?
    - Yes, a lot.
    - Somewhat.
    - No.
12. Additional comments

Appendix C

Interview structure

1. How has the new TortoiseCVS functionality changed the CVS sub process?

   Positive/Negative changes.
   Finding and retrieval of files.
   Resource waste?

2. How has the new functionality affected the transitions between activities?

   Better/Worse transitions?
   New transition activity emerged?

3. Has the change in the TortoiseCVS sub process affected other work processes?

   How?
   Positively or negatively.
   Not at all?

4. How has it affected the whole work process?

   Overall improvement?
   Size of impact?

Appendix D

List of requirements

Functional requirements:

1. User should be able to find files by search for meta-data in the repository, such as author of revision, tag, dates and comments.
2. User should be able to select where the search will be performed.
3. User should be able to export search results in either .txt or .xls format.

Non-functional requirements:

1. The software should be easy to use.
2. The software should be easy to understand
3. The software should be easy to install and distribute.