Web Drugs: Anaesthetists Automated Scheduling System

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ABSTRACT
Web Drugs is an automated anaesthesia roster scheduling system, designed for the UCT Anaesthesia Department at Groote Schuur Hospital. The system consists of three parts, each which make up a part of the Web Drugs system. The system follows a strict set of Rational Unified Process software engineering methodology.

General Terms
Software Engineering, Scheduling, Design, Hospital, Roster

Keywords
Rational Unified Process, Human aided scheduling, Anaesthesia roster, hospitals

1. INTRODUCTION
Many hospitals in South Africa are under funded and ill equipped to contain computer resources to aid them in the scheduling of anaesthetists to daily and nightly rosters. Many of these hospitals currently perform these scheduling functions using a paper based system.

The development of this system (henceforth Web Drugs) was based on the UCT Anaesthetics Department at Groote Schuur Hospital, Cape Town. The department currently uses a paper based system which is manually created when the daily roster or nightly roster needs to be assigned.

This system requires considerable time and effort to maintain and manage. Since Groote Schuur (as with many South African hospitals) does not have the resources to hire dedicated staff to maintain this scheduling system, skilled doctors have to set aside valuable time for this difficult, tedious and time consuming task. This has led to doctors spending time maintaining the system when they could be teaching and operating.

The schedulers are also required to be aware of which doctors are available and which ones are on leave.

A mistake in the scheduling could result in an operation being performed without a scheduled anaesthetist.

As any program developed for an industry which has as critical processes and high risks, it is important the development follow sound software engineering principles.

The project consists of three distinct areas: the yearly planner (OX Matrix), the Daily Roster and the Night Call Roster which handle the scheduling and viewing of the respected system.

Software engineering is the development of software whose size and complexity warrants team(s) of engineers [1]. Software engineering involves the study of the software process, development principles, techniques and notation where the goal is the production of quality software, delivered on time, within budget, satisfying customers requirements and users needs [1].

2. BACKGROUND

The Rational Unified Process (RUP) is the most commonly used software engineering process in the industry [3]. It provides a disciplined approach to assigning tasks and responsibilities within a software development organization with its primary aim being to ensure the development of high-quality software that meets the needs of its end users while adhering to a set schedule and budget [4].

The RUP is not a rigid process but rather a flexible process framework consisting of an enormous number of activities designed to be tailored to a specific project s needs. The RUP consists of a large set of activities from which a specific project can select those that are applicable to its specific needs.

The software lifecycle of the RUP is divided into four sequential phases, each concluded by a phase milestone; each phase is essentially a slice of time between two major milestones [5]. An assessment is performed at the completion of a phase to determine whether the objectives of the phase have been met (the milestone). A successful assessment allows the project to move to the next phase.

RUP consists of four core iterative phases:

- Inception Phase,
- Elaboration Phase,
- Construction Phase, and
- Transition Phase

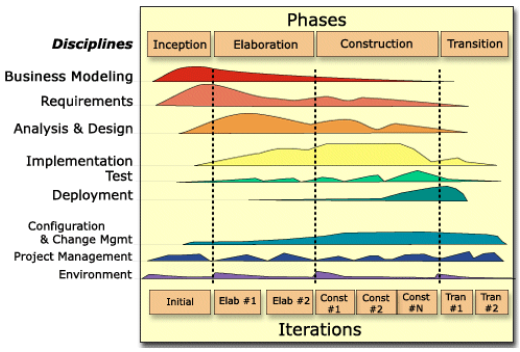

Figure 1: Overall architecture of the RUP [5]

Figure 1 gives an overview of the RUP architecture. The vertical axis represents disciplines that logically group activities (tasks) together. This axis represents the static aspect of the process as the process is implemented and consists of disciplines, activities, workflows, and roles.

The horizontal axis represents time and the lifecycle components of the process as it progresses. This axis represents the dynamic aspect of the process as it is implemented and consists of phases, iterations and milestones.

The above figure may give the impression that the RUP is akin to the waterfall model. This, however, is not the case. The RUP differs from the waterfall model in that in each phase a varying degree of emphasis is placed on each discipline. The entire set of disciplines is repeated for each iteration with only the amount of time spent on each discipline changing. For example, in the first phase the majority of time and effort is spent on the requirement discipline while in later phases more time is spent on the implementation discipline and less on the requirements discipline. This is in contrast to the waterfall model where 100% of the effort is focused on the current discipline and the current discipline is completed in its entirety before moving on to the next discipline.

2. SYSTEM DESIGN

The Web Drugs system will attempt to lessen the administration load, make the schedulers tasks quicker and easier, and reduce perceived unfairness of allocations. The system is designed to be web-centric, allowing privileged users to update and view scheduling information. Most importantly, it is intended to replace the inconvenience of sifting through large amounts of paperwork to find the availability of staff, with a system which will not allow the scheduler to enter the name of a doctor which is not available, and suggest names of people in such a way so that it maintains fairness.

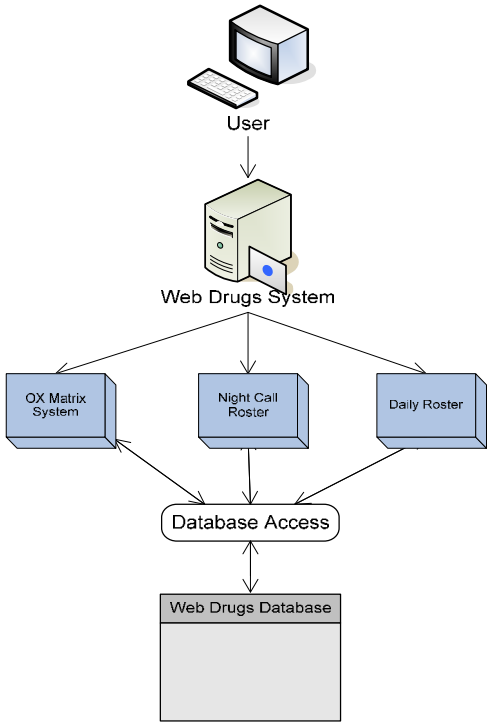

Figure 2: Web Drugs System Overview

The software engineering implementation of the Rational Unified Process (RUP) was implemented in its phases. The RUP system was engineered specifically for use for small products.

2.1 OX Matrix

The OX Matrix is a year planner that is prepared before the other two rosters (usually a semester in advance) and is maintained by one doctor. It has a row for each consultant and registrar, and a column for each day of the year. Entries in the matrix indicate any special activity that the individual has reserved for that day – e.g. on leave, doing admin, etc., and thus shows the days and shifts that the consultants and registrars are not able or available to work. It also records the allocation of registrars to blocks (e.g. cardiac, obstetrics, ENT, etc.)

The process to create, update and maintain the OX Matrix is a very tedious and laborious one. With the aid of this system, the OX Matrix operator will be able to perform this task easier, quicker and with no errors.

The OX Matrix system is considered critical, as it is this system that keeps track of who is on leave and who is unavailable for certain shifts (e.g. Doctor X plays chess on Monday nights). An error in this aspect of the project could result in operations without a scheduled anaesthetist.

With the OX Matrix, the Night-call Roster and the Daily Roster systems will be able to make use of this information and produce schedules with staff that are available, without needing the doctor in charge to remember who is on leave or unavailable. In addition, any user will be able to view their schedule over the Web at any point in time.

2.2 Night Call Roster

The Night Call Roster is prepared once every six weeks and is maintained by one doctor. The doctor looks at the OX Matrix in order to see who is available on each night and allocates shifts accordingly.

This arduous task takes the scheduler at least half a day to prepare, where the scheduling doctor is off duty from performing anaesthetics operations. The doctor needs to check each doctor s schedule to see whether or not he/she is unavailable, and a new doctor must be scheduled and rechecked again if the doctor is available.

The purpose of the Night Call Roster will be to automate much of this task for the scheduler, as well as offer suggestions as to who has worked the least on a particular night so that the scheduler may be guided in a direction to ensure affair and equal work schedule for all doctors. The doctor will no longer need to refer to the OX matrix to check if a doctor is unavailable. The unavailability list will be updated after a save to the system so that when the Daily Roster schedule takes place, those doctors who worked on a previous night will be noted as unavailable and unable to be scheduled.

2.3 Daily Roster

The Daily Roster is prepared every night for the following day, and is maintained by one doctor. The doctor looks at the OX Matrix and the Night Call Roster in order to determine who is available to work.

The ability to create templates frees the user from being limited to the initial foresight of the developer. The user can simply create additional templates when the need arises. The paper based Daily Roster allocation forms changed several times during the development cycle and reinforced the need for dynamic templates.

The allocate slots use case calls upon two other use cases to perform its function. The first use case it calls upon, the retrieve templates use case, retrieves all the templates that the user created when it initiated the create a template use case.

The view roster allocations use case functionality allows the user to view the registrar/consultant allocations that were made on a specific day. It collaborates with the retrieve allocations use case that retrieves the actual allocations that were made on the specific day.

3. METHOD

3.1 Implementation

The database of the Web Drugs system implemented a MySQL database, as it is a free Database Management System and compatible with JSP. It is a well supported open source management system, and thus minimum fear exists of discontinuation.

The Web Drugs system uses JSP Java Server Pages. JSP uses the Java language, which is a mature, powerful, and scalable programming language that provides many benefits over the Basic-based scripting languages (Jscript and VBScript). This means that all the features that accompany Java J2EE such as memory management and pointers as well as Java s robust error handling are included in JSP [2].

4. TESTING & RESULTS

This section outlines the various tests that will be conducted by the developers. It describes the Aim, why the test is conducted and what it is trying to achieve, the Problems and Limitations, what aspect this test cannot test and why, and Methodology, the method in which the test was conducted. These apply for each test that will be described.

4.1 Problems and Limitations

Due to the imposed time constraints, the Anaesthetics Department was unable to test the system thoroughly. They were only given a demonstration, and it is not known how well the system will perform under a highly stressed environment. In addition, the test results also depend on the processing power of the PC the test is being conducted on.

4.2 Good Practice

For more accurate results, the developer of the OX Matrix tested the other two systems, while the other developers tested the OX Matrix. In other words, the developers did not test their own systems.

4.3 Data and Database Integrity Testing

4.3.1 Aim

The aim of this test is to ensure that data is saved and read correctly, and with no errors, from the database. All in all, it ensures that mistakes will not be caused due to the fact that the system saved or read the data incorrectly, but because the user entered them incorrectly.

4.3.2 Methodology

To ensure data integrity, each and every function in the Web Drugs system that has to do with the database was executed, in order to ensure that the data is read and written correctly and with no errors.

4.3.3 Results

This test proved positive, as all data was written to and read from the database correctly and with no errors.

4.4 Correctness Testing

4.4.1 Aim

The aim of this test is to ensure that the Web Drugs system is correct. It is also intended to ensure that there are as few bugs as possible. All in all, it aims to ensure that the system does what it was supposed to do.

4.4.2 Methodology

In order to ensure correctness, as a first test, all hyperlinks were tested. This was possible due to the fact that the Web Drugs system did not contain many links, since the design goal had been to minimize these for user convenience.

Then, each feature was tested with strict comparison to the specification document, to ensure that all features were not only doing what they were designed to do, but also to ensure that it was designed to do the right thing.

4.3.3 Results

The Correctness Test results proved that the Web Drugs system met the requirements as set out in the specification documents. It was confirmed that the system correctly does what it was designed to do, and more importantly, it was designed to do what it was required to do. This can be confirmed by performing all the actions with the specification documents in hand.

4.5 Usability Testing

4.4.1 Aim

The aim of the Demonstration (usability) is to ensure that the Web Drugs system meets all the requirements that were set out at the beginning of the project. It is also intended to ensure that the Anaesthetics Department is happy with the quality of the final product.

4.4.2 Methodology

A demonstration of the Web Drugs system will be conducted at the Anaesthetics Department on one of the developer s laptop.

The relevant stakeholders will be told what the Web Druga system is able to do and will be walked through the whole system. Then, they will be asked to use the system, performing an action that they would normally do, and by asking questions, in order to determine its user friendliness.

4.3.3 Results

The reactions from all the relevant personnel was one of amazement and gladness to see a fully functional, user friendly system that does what took them hours to do in a matter of minutes. Comments like This is amazing or I can t believe it works! I never thought that you would have finished it by now. reinforce the fact that the system does what it was required to do.

4.6 Performance Testing

4.4.1 Aim

The aim of this test is to ensure that the Web Drugs system performs adequately in terms of response time. It is intended to ensure that pages do not take unacceptably long to load, and that it does not crash. In addition, the performance test must take place after the correctness test, as there is no point in testing if the system performs well if it is not doing what it is supposed to do.

4.4.2 Methodology

The loading of pages was timed so that their performance can be tested. They were timed after various actions (e.g. update user, add slot, create daily roster, etc.) in order to see how long the action will take to execute.

4.3.3 Results

The Performance Test results proved that the Web Drugs system met the performance requirements as set out by the developing team.

4.7 Security and Access Control Testing

4.4.1 Aim

The aim of this test is to ensure that no unauthorized consultants and registrars can access the Web Drugs system.

4.4.2 Methodology

This test was performed by trying to access every web page without logging on. Then, different users were logged on to the system, and tried to access pages they were allowed to and pages they were not. This way the developers were able to test if users were able to access pages that they were not allowed to, and not able to access pages that they were allowed to.

4.3.3 Results

When a user tried to access any page of the Web Drugs without having logged on, the system would correctly display the error message You are not authorised to view this page. Please log on. In addition, all users were able to access pages that they were allowed to access, and were given the message You are not authorised to view this page! when they tried to view a page they were not allowed to.

5. CONCLUSIONS

The Web Drugs system has the potential of greatly reducing the scheduling time and effort required for constructing the Daily and Night Rosters for each day. Currently, the paper based roster administration effort takes 1 ½ hours per day per day for the Daily Roster, and an entire day for the Night Call Roster which is scheduled for six weeks in advance. This time can be reduced significantly when the web-based Web Drugs system is employed.

The testing performed on the Web Drugs system has proven that the system is both functionally correct and that the system performs efficiently

The Web Drugs system conforms to the RUP principles, following on the RUP best-practices.

6. FUTURE WORK

The Future Work section is intended to contain ideas that could improve the project.

6.1 Requests by Users

The first request was that they wanted the users of the Web Drugs system to be able to send requests for days they want leave, shifts they want off, or shifts they prefer to work. Due to the fact that it was agreed between the Anaesthetics Department and the Honours group that this could be done via e-mail, this feature was given a low priority. In addition, due to the time constraints of the Honours project, this feature was not implemented.

6.2 SMS/Email Notification

The second request was that the consultants and registrars could be notified about their upcoming shifts via sms. In the event that that would not be possible, they would ve liked the notification to take place via e-mail. This extension to the project was regarded as of low priority, and was, thus, scheduled to take place only if time permitted. Due to the time constraints of the Honours project, this feature was not added, and can be regarded as future work for the Web Drugs system.

6.3 Tutorials

The Anaesthesia Department requested during the implementation phase of the project that a similar tutorial scheduling system to be implemented. The work that would be required to implement such a system is out of the scope of this project; however it may be a useful addition for future implementations.

6.4 Reports

The Anaesthesia Department specified that they would like to see a report out after each scheduling shift was completed to give an overview of the assignment decisions that

were made. Due to time constraints this was not implemented.

7. REFERENCES

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