Experiences with the Practical Use of Care2x in Medical Informatics Education

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Abstract:

In this chapter the authors report about their experiences in education of both students of Health Care Engineering at Graz University of Applied Sciences, and students of Medicine at the Medical University Graz, gained during the winter term 2004. Care2x is an open source Web based Integrated Healthcare Environment (IHE). It allows the integration of data, information, functions and workflows in one environment. The system is currently consisting of four major components, which can also function independently: HIS – Hospital Information System, PM – Practice Management, a Central Data Server (CDS) and a Health Exchange Protocol (HXP). Although the components are under heavy development, the HIS has reached a degree of stability, where one can use it at least for educational purposes. Various groups also report the usage of enhanced versions of Care2x in real life settings. Our experiences in both – very different – students groups have been very promising. In both groups the acceptance was high and Care2x provided good insights into the principles of a Hospital Information System. The medical students learned the principal handling of a HIS, whereas the engineering students had the possibility to go deeper into technical details.

Keywords: Care2x, Integrated Healthcare Environment, Hospital Information System, Education in Medical Informatics

1. Introduction

It is a common open question how to prepare both medical and engineering students in the best possible way for their later work with modern Hospital Information Systems (HIS). Whereas students of engineering are rather enthusiastic of information technology (IT), students of medicine are skeptical in general of using IT. However, HIS are not widely accepted by health care professionals, i.e. barriers to the use of HIS are primarily sociological, cultural, and organizational, rather than technological [1].

It seems plausible to not only give students theoretical background about the structure, functions and common tasks of HIS, but instead let them work with a fully functional HIS during the lectures. This is essential particularly if students are required to be able to work with possibly any HIS in practice after only a short period of vocational adjustment. However, it depends on many different factors which HIS to choose. One of the most important is whether it is necessary to teach (with) a particular HIS of a certain vendor, e.g. if this system is deployed in a network of local hospitals. Another key factor – especially for non-commercial educational institutions – is the economic impact of the introduction of a commercial HIS at the university. Third, for the education of students of medical informatics it might also be reasonable to learn the process of developing (parts of) a bigger software engineering project. Hence, the need for an open-source system arises if one does not want to start-up the development of an own HIS. Although there are much more factors to consider in general, we chose Care2x as our primary educational HIS for these three reasons.

2. Care2x

Care2x[1] is a generic multi-language open-source project that implements a modern Hospital Information System. The project was started in May 2002 with the release of the first beta version of Care2x by a nurse who was dissatisfied with the HIS in the hospital where he was working. Until today the development team has grown to over 100 members from over 20 countries. Care2x is a web-based HIS that is built upon other open-source projects: the Apache web server from the Apache Foundation (http://www.apache.org/), the script language PHP (http://www.php.org/) and the relational database management system mySQL (http://www.mysql.com/). There exist several source code branches that try to integrate the option to choose from other RDBMS like Oracle and postgreSQL. The latter one is already supported in the current version at the time of writing: “deployment 2.1”. For our investigations we have chosen the most feature-rich version that was available from the Care2x webpage in early fall 2004. This release had the version number “pre-deployment 2.0.2”. Some minor deficiencies that we report later may already be fixed in the current version “deployment 2.1”.

Care2x is a very feature rich HIS, that is fully configurable for any clinical structure. It is built upon different modules which include e.g. in- and out-patient administration, admission, pharmacy, radiology (including DICOM image uploads), laboratories, ambulatories, nursing, medocs, DRG, etc. Online help is available for *some* clinical paths. See Figure 1 for an example.

[1] The webpage of Care2x is located at http://www.care2x.org/

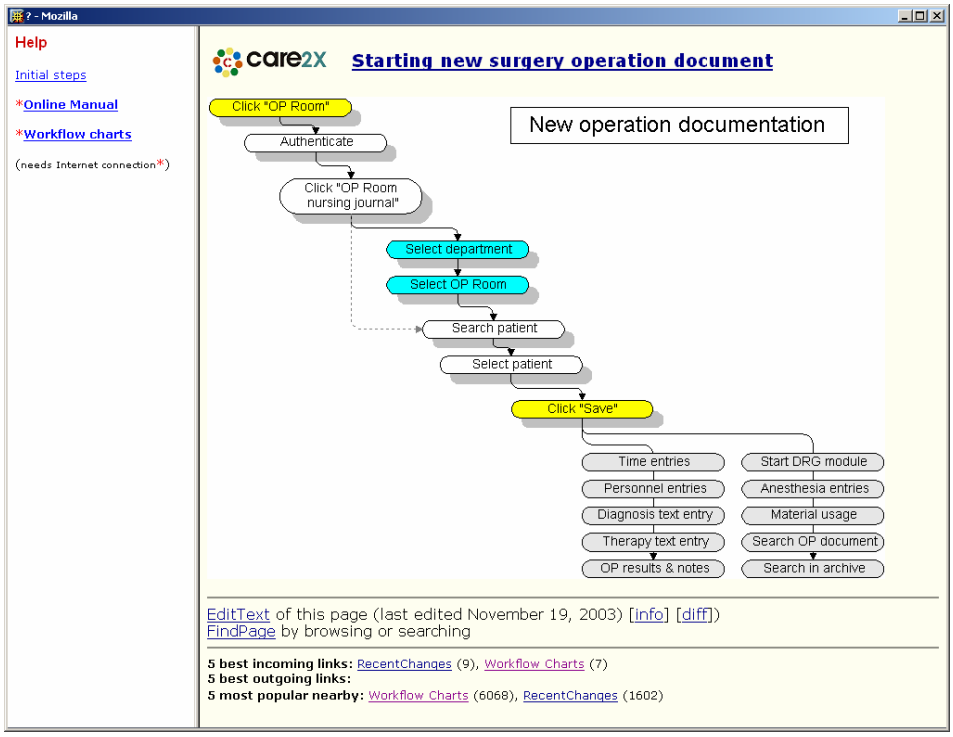

Figure 1: Help page describing the clinical path for starting a new surgery operation document

3. Reverse Engineering

Reverse engineering of existing complex software packages starting at the source code level has a higher value for practical education than a new development. [2] argue that groups of students will rarely be able to develop a project further than to a prototype stage during a single lecture. Access to the source code is not available for most commercial HIS, which is another advantage of using Care2x as an educational system. In our first lecture the students of HCE were asked to test all functions and paths of Care2x. They had to set up a small virtual clinic, employ doctors, nurses and technical stuff. Finally, patients had to be admitted, attended and dismissed again at all stations. In a second lecture in the upcoming semester, our students have the assignment to analyze a fully functional HIS at the source code level. Since Care2x is built upon a modular structure, small teams of programmers have tasks like finding and fixing bugs in the current version, add simple modules for special functions not included in the official version or implement interfaces to other existing information systems or medical equipment. In the spirit of open source projects, reasonable additions and modifications can and should be published to the Care2x community again.

4. Lessons Learned

Approximately 100 students participated at the MUG and approximately 25 at HCE (figure 2).

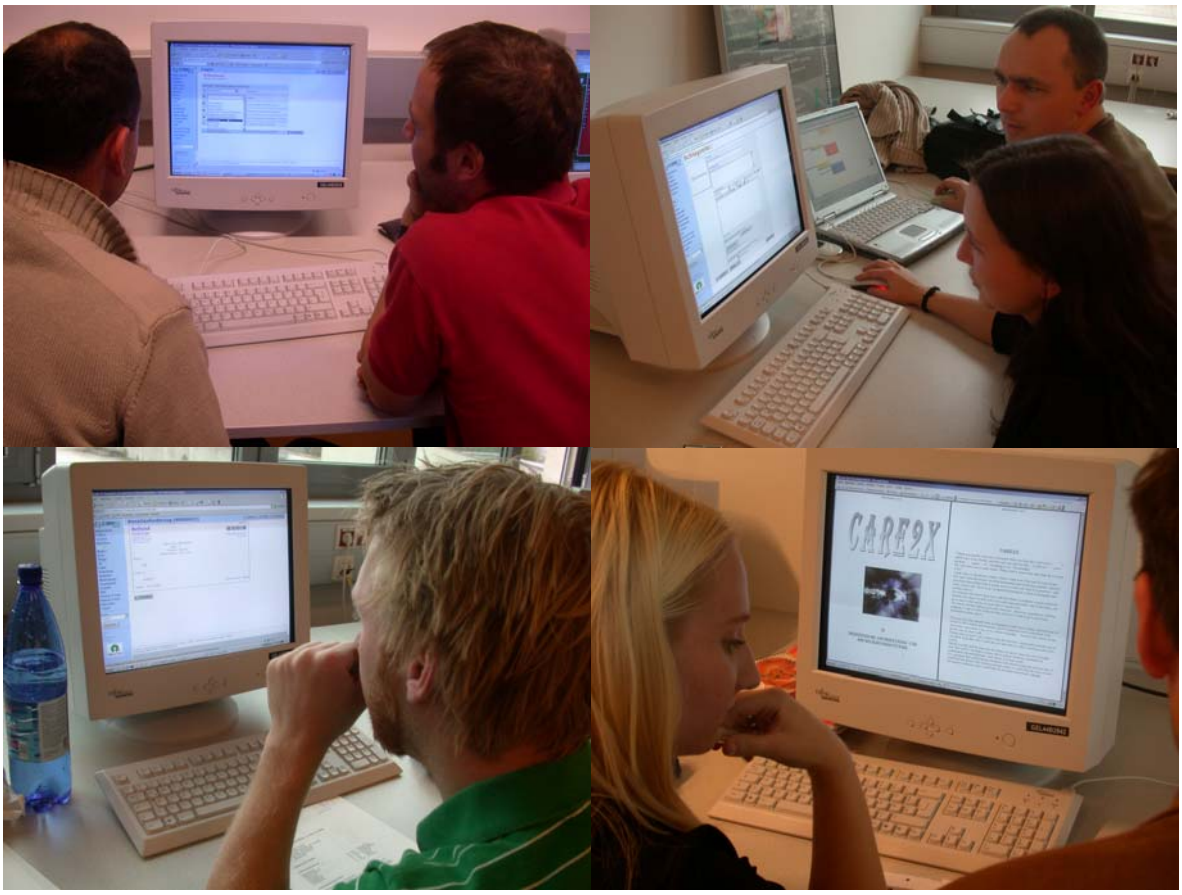

Figure 2: Students at work with Care2X: we assigned groups of 2-3 students with different tasks related to the administration of a virtual hospital

The whole lecture was build in the following order

1) Theoretical Foundations of HIS in traditional lectures
2) Principles of Care2x explained (HCE group: more technology orientated)
3) Familiarization with Care2x in practical sessions
4) Practical Work: Specific Workflows
5) Applying Reverse Engineering (HCE group only in the second part of the lecture)
5) Examination (both theoretical and practical)

During the education the students were faced with the following strengths and weaknesses of Care2x:

+ everybody can make his own tools
+ work has not to be done in a strict order
+ very flexible
+ easy to handle
+ a continuing design and development
+ open source
+ a lot of different languages
+ a big community which takes care of Care2X
+ easy to select the different departments and stations

- no real standard between the modules
- documentation is only rudimentary
- a few tools are not really easy to interpret
- lack of security measures
- not a state-of-the-art user interface
- there is no global list of patients where you can select one

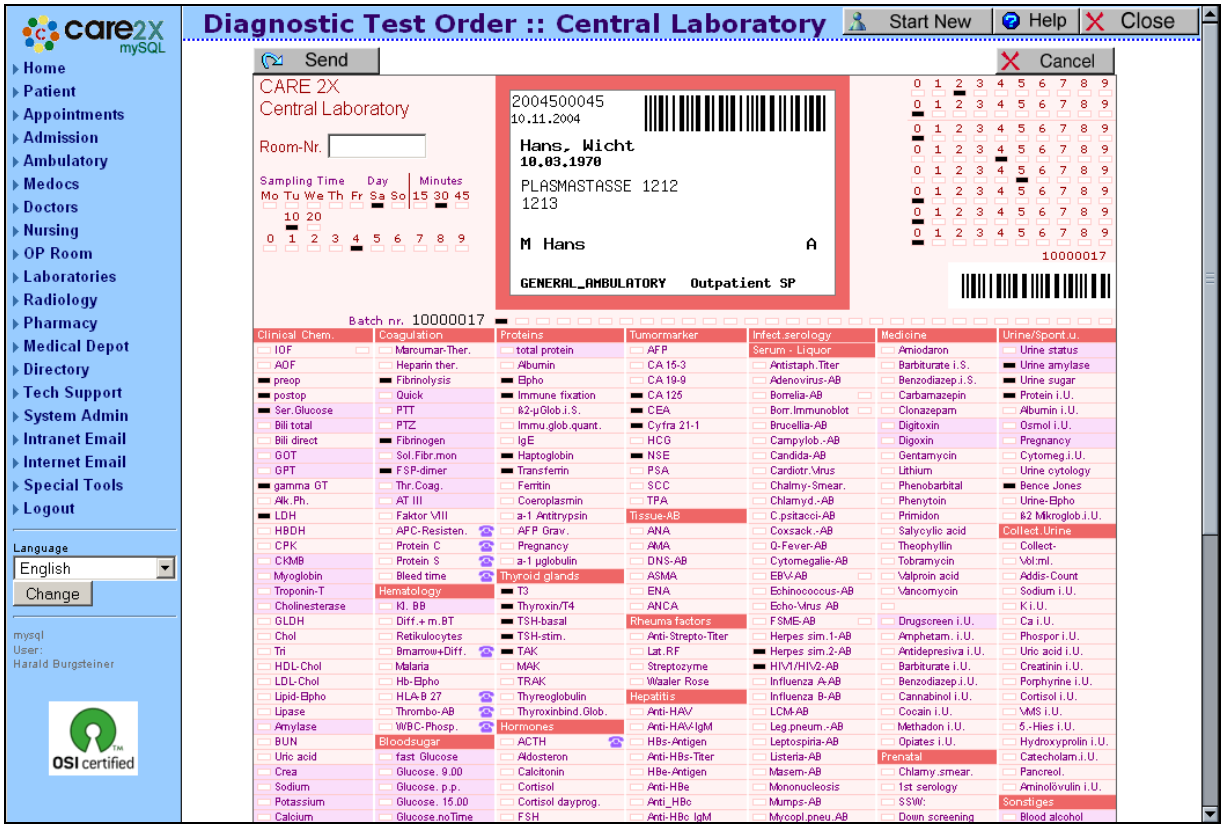

Figure 3: Example of a complex graphically embedded form: diagnostic test order

5. Obstacles identified

During our lectures and trainings there emerged several problems whilst using Care2x. There are a lot of smaller bugs, which caused troubles. The biggest problem was that sometimes the browser responded that there was an “inactivity error” and the session has timed out. But most of the times this error message was shown, the last click had not been even one single minute ago. The next problem with the handling was that sometimes the back Button on the web browser would lead into nowhere because Care2x does not manage this. Much later we found out that the back button of the Browser is unnecessary because the program has included this function. But that didn’t solve the problem completely, every now and then the integrated back button of Care2x lead into nowhere too. In addition some pages didn’t include the Care2x back button (inconsistency) resulting in a blank page. This immediately caused restart at the very beginning and clicking through all menus once again, which was felt boring by the students.

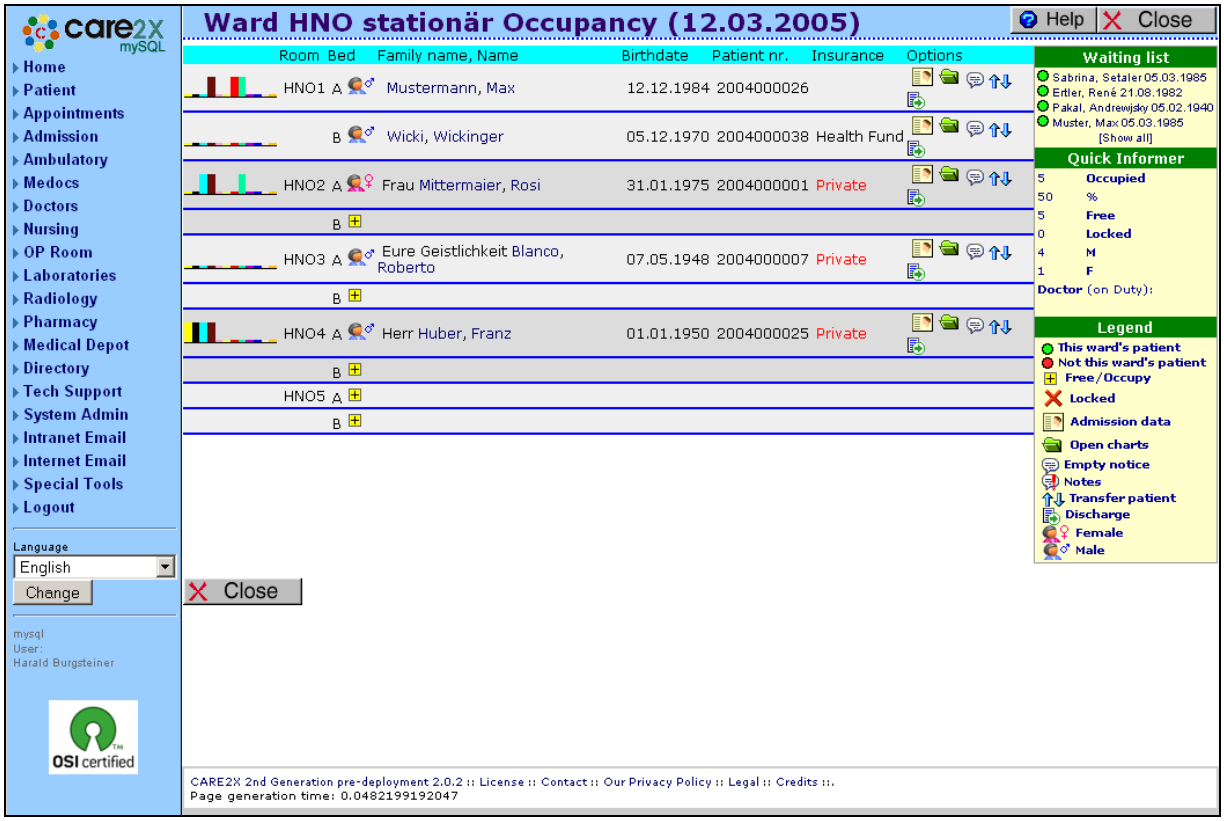

Figure 4: Nursing information about stationary occupancy of one of our virtual wards

But the general software problems that did not concern the running process were not severe. It just is a serious problem when it’s possible to admit a patient to more than one station, or when it’s possible to alter the patient record of a patient after his death.

A severe problem that has to be solved is that patients have to be discharged and then hospitalized again if they just should be transferred from ambulatory to a station.

There are some translation errors and missing notes. For example if a new patient record is being applied, there are red stars above some properties. Although this is an obvious sign for experienced users it is noticed nowhere *why* these stars appear. The students found out that these stars show the minimum amount of data that is required to create a patient record, but how should the students of medicine with little experience in IT know this fact.

And it's sometimes really annoying that bits of information are hidden behind a link. For example if you want to hospitalize a patient you have to remember the social insurance number because it is not shown on the place needed. This is due to the fact that Care2x works with only one window. Sometimes there might just be to little space to provide all the information needed and then the user has more than ever to write this information down or remember it, and this cannot be the aim of a HIS.

6. Conclusion

Care2x is a flexible open source software. Although there are some bugs it has the potential to become a functional software to support workflows within a (real) hospital. We think the biggest problems are the documentation and the deduction of the treatments. Working with Care2x as beginner is not very comfortable or intuitive. But if one trains with Care2x the workflows get clearer and more logical. The online help of Care2x should be better and more comprehensive. Working with the software was very funny, because you really can play with a virtual hospital. Care2x is a very good possibility for training with workflows in a hospital. Further improvement of the Care2x will open new areas to work with this software.

7. References

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8. Terms and Definitions

HIS: Abbreviation of Hospital Information System. It is the central medical information system in most hospitals where most health care related data (e.g. personnel, stations, patients and their medical history etc.) is stored.

Reverse Engineering: Taking apart an existing system to analyze smaller or single parts. The reduced complexity simplifies the process of enhancing or understanding its functions.

Open Source: The idea of sharing the source code of applications or tools for free. Other people are invited to elaborate on future extensions and improvements. Most open source projects are committed to one of the “Gnu Public Licences” (see http://www.gnu.org/licenses/licenses.html).

Care2x: An open source HIS available from http://www.care2x.org/. Care2x is a quite mature and stable product that can be used at least for educational purposes for both, students of medicine and medical informatics. Some groups report the deployment of enhanced and adopted versions in real hospitals.

Medical Informatics: The rapidly developing scientific field that deals with biomedical information, data, and knowledge - their storage, retrieval, and optimal use for problem solving and decision making. The emergence of this new discipline has been attributed to "advances in computing and communications technology, to an increasing awareness that the knowledge base of medicine is essentially unmanageable by traditional paper-based methods, and to a growing conviction that the process of informed decision making is as important to modern biomedicine as is the collection of facts on which clinical decisions or research plans are made." [Edward Shortliffe, M.D., Ph.D. What is medical informatics? Stanford University, 1995.]

DICOM: Digital Imaging and Communications in Medicine. The DICOM image format is commonly used for transfer and storage of medical images. Visit Chris Rorden's Dicom page for information about the format and free software to view and manipulate it.

RDBMS: Relational Database Management System, a software package which manages a relational database, optimized for rapid and flexible retrieval of data; also called a database engine.

DRG: Diagnosis Related Group. The DRG system is an inpatient classification system based on several factors: principal diagnosis; secondary diagnosis; surgical factors; age; sex; and discharge status. Under the Medicare prospective payment system, hospitals are paid a set fee for treating patients in a single DRG category, regardless of the actual cost of care for the individual.