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# PROCESS MODELING: A TEACHING APPROACH FOR DEVELOPING GENERIC SKILLS IN IT STUDENTS

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## Abstract

*This paper describes the rationale for a collaborative research project between academe and industry that was developing process models for clinical care pathways. The purpose of these process models were to inform the organization (a federally funded hospital) on actual practices, make recommendations for short term improvements, guide local systems development and provide input into the quality management program. The 'consultants' on this project were all post-graduate students who were completing a Masters degree in Information Technology. Lessons learnt from this interaction with the sponsoring organization include the need for senior management understanding and support, the involvement of line managers in the modeling exercise and validation exercise, and the need for modeling standards for system integration purposes.*

*The major outputs of the project include:*

- a) the development of a complete as-is process model of the hospital patient care system,*
- b) the rendering of this model into a web-based repository and*
- c) the appreciation of the power of process modeling for quality management, process improvement and guiding further systems development.*

## Introduction

The Information Systems-Centric Curriculum Document (1999) was the output of a collaborative review process held in the USA, with industry and academic participation. This curriculum committee sought to identify the skills required in developing and supporting large and complex systems in use within government, industry and defence. It recommends that students should undertake IT curriculum which has students experience and analyze real application systems from the beginning of their course (AMCIS Proceedings 1999: 204). This requires students to have exposure to a real and functioning application system. The ISCC committee identified the skills required for industry, and these are shown in Table 1.

The ISCC 99 curriculum document also recommends that an inverted curriculum model be used. In this approach, the student experiences the context of the information system, then master the details and finally returns to a systems view of the deployment of the technology in order to complete their experience.

In Stewart and Rosemann (2001) we describe how we formed a project to develop teaching cases based on SAP R/3 and Process Models using the ARIS methodology (Scheer, 2000). We formed partnerships with a state government enterprise working on a process improvement project (Rosemann, Sedera and Sedera 2000, Anderson Consulting 2000), and a federally funded hospital. This paper describes the evolution of a process model for the hospital, in which we were seeking

**Table 1. Skills of an Industry Ready IT Graduate (Information Systems Centric Curriculum)**

INDUSTRY-DEFINED ATTRIBUTES OF AN ISCC'99 GRADUATE		
Personal Skills	Systemic-thinking skills Problem-solving skills Critical-thinking skills Risk-taking skills	Personal-discipline skills Persistence Curiosity
Interpersonal Skills	Collaborative skills Conflict resolution skills	Communication skills (oral, written, listening, and group)
Technical Knowledge and Skills	Information abstraction, representation, and organization Enterprise computing architectures and delivery systems Concepts of information and systems distribution Human behavior and computer interaction	Dynamics of change Process management and systems development Information Systems domain knowledge Use of computing tools to apply knowledge

- to develop a complex process model depicting all aspects of the management of patients from arrival, admission, surgery, rehabilitation, clinical testing and discharge (the AS-IS model)
- analyze this model for suggested process improvements and guide further development the in-house developed Patient Administration System (PAS),
- develop a recommended model representing the clinical care pathways model at the hospital in order to ensure that further development of PAS were strategic, value-added, and would not duplicate the functionality of a new system wide Hospital Management System (HMS) to be introduced in mid-2001.

This projects aims to provide the participating students with exposure to real-world problems. The core objective is to comprehensively improve all skills that are required for IT-related consultancy. These projects are all placed in organizations that are involved in Enterprise Systems projects. Thus, we can make use of the comprehensive discussion of Enterprise Systems education at universities (Elam et al., 1999; Gable and Rosemann, 1999; Hawking and McCarthy, 2000; Lidtke and Stokes, 1999; Lederer-Antonucci 1999; Rosemann et al. 1999; Scott 1999; Victor et al., 1999; Watson and Noguera, 1999; Watson and Schneider, 1999).

We first describe the background to the project, then move on to describe the information systems in place at the hospital. We then discuss the process modeling strategy used, and close by discussing the issues in organizational support, advantages of the modeling process and outputs to the sponsoring organization, and advantages of the project for the graduate students.

## Background

The industry partner hospital (IPH) is a small hospital providing general medical services, limited surgery services and emergency medical care to a specialist population of some 15,000 personnel. It has some support services in the form of clinical services (pathology, x-ray, physiotherapy and psychological support services) and sub-contracts complex work to local clinical service providers. In addition, IPH will transfer patients to the larger, local hospitals for specialist support and long-term treatment of patients. This sub-contracting and outsourcing arrangement requires careful financial management, for which there are specific information systems support. The hospital structure is shown at Figure 1.

This project was fundamentally about the management of medical records needed for patient care. The metaphor used to describe the clinical care pathways approach was to imagine the patient moving through the hospital with a flag attached to the gurney. Information reports and request for additional services generated for each phase of treatment were to be attached to this flag. The accumulation of demands and reports (excluding the financial costs of services) represented the information flows for the clinical care pathway.

In March 2000 the senior management team decided that future development of the in-house Patient Administration System (PAS) should be guided by the principles found in the Clinical Care Pathways model, and NOT continue to be ad hoc development. In particular, it was seen to be important NOT to duplicate the functionality of a new corporate system (HMS) being adopted by the

federal agency in charge of the hospital. As at March 2001, the planned rollout of this HMS system has yet to occur, but is due in May 2001.

The focus of this process-modeling project was to ensure that any local systems development would a) NOT be supported by HMS, and b) be essential for implementing Clinical Care Pathways at IPH.

The project meeting of 17 July set the following project goal:

*To develop a comprehensive to-be model representing the Clinical Care Pathways approach to patient records management in order to guide future internal and external system development.*

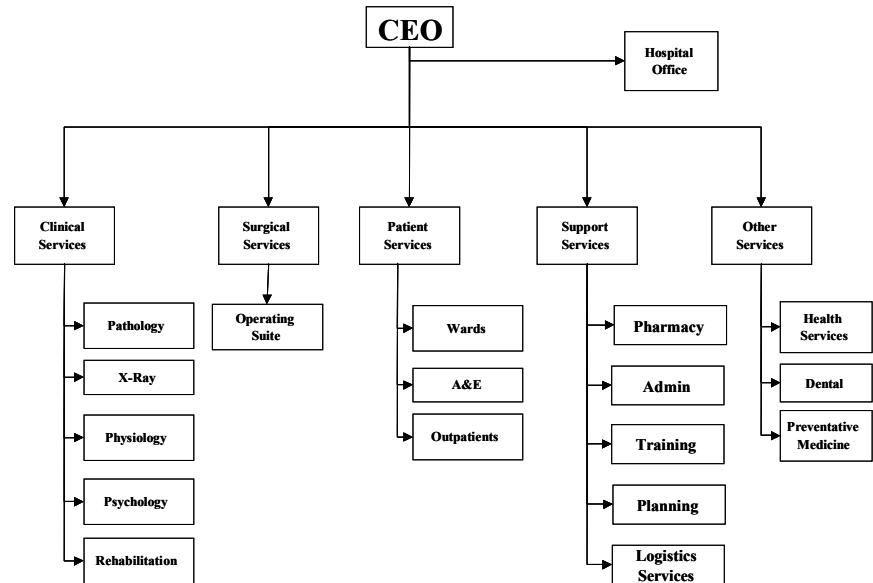


Figure 1. IPH Organizational Structure

For this goal, the following project objectives were adopted

- To model the existing processes within the hospital*
- To model the processes involved in the Clinical Care pathway model*
- To model the processes supported by commercial packages*
- To determine best practice processes for Clinical Care Pathways*
- To recommend system improvements to PAS consistent with Clinical Care Pathways*

Luttman (1999) defines a clinical care pathway is defined as

*An explicitly designed care process for a defined patient population.*

Luttman goes on to state that such pathways are used for

- a. for case management,
- b. costing services for pricing and contracting,
- c. quality improvement, d. documentation improvement, and
- e. developing support IS systems.

The pathway should include

- a. the clinical practice guideline upon which it is based;
- b. the ancillary and support activities which make the practice guideline a reality; and,
- c. the intermediate and end state outcomes the patients' are to achieve.

With the project charter agreed, a project team consisting of eight post-graduate students was raised. These students worked in conjunction with the team leader of PAS to coordinate modeling and facilitate access to key personnel.

## The Information Systems Base

The Patient Administration System (PAS) is a records management system that tracks patient details currently used in the Outpatients and Accident and Emergency Department. In addition, it stores member readiness data pertaining to a medical board status (classification and date) and data on vaccination currency.

The replacement system (HMS) is a Health Management System being adopted by the parent federal agency. HMS is designed for effective practice management. The functionality of HMS in its first phase of deployment includes: information for tasking including basic immunization and fitness

- |   |   |
|---|---|
| a. Sick Leave / Convalescence data including duty restriction by type | e. Medical Record Tracking                |
| b. Recall and Referral Monitoring                                     | f. Incident Reporting and Injury Tracking |
| c. Appointmenting   | g. Epidemiological Information            |
| d. Registration   | h. Resource Scheduling for large units    |

It has limited functionality supporting the management of patient care data within the hospital, though this is to be provided in later versions. Thus, there will be the ongoing need to support both PAS and HMS in this hospital for the medium term.

## The Project Structure

The CEO of the hospital accepted the position of Project Sponsor and directed that all systems development efforts be towards identifying the additional functionality required to support the Clinical Care Pathways model. The hospital Quality Manager accepted the position of Project Champion, facilitating access to personnel, supporting workshops used in developing the material and communicating its interim results.

A team of four part-time analysts and programmers was assembled and the team of eight graduate students assigned as process modelers. The PAS team leader became the dedicated resource for integrating process modeling and PAS systems development. Student project teams were focused in the first part on specific hospital function, and were required to meet to develop an integrated process model. The function allocation was Accident and Emergency (2 students), Patient Services (3 students) and Clinical Services (3 students).

There was a division of labour between the part-time analysts and the graduate student team. The programming team was to complete the following tasks:

- Documentation of PAS (depicting the data model, the functional description, and the system design specifications) as this level of documentation had not been completed by the original development team,
- Enhancement of the reports from PAS,
- Development of additional PAS functionality as directed by the Quality Manager,
- Research the intended functionality and scope of HMS and
- Delay further significant development of PAS until the completion of the modeling exercise.

The students were tasked to model the existing processes using a Process Engineering methodology. This methodology has the following steps and the students were to complete the first three phases:

- |                                |                                   |
|--------------------------------|-----------------------------------|
| • Process identification       | • Process implementation          |
| • Process modeling (as-is)     | • Process execution               |
| • Process analysis             | • Process monitoring/controlling. |
| • Process optimization (to-be) |                                   |

It had been established that there would be four phases to this project:

- |          |  |
|----------|--|
| Phase 1: | Process identification and the development of an interim as-is model,  |
| Phase 2: | Completion of the as-is with a detailed process analysis leading to identification of system improvements, and |
| Phase 3: | The development of a To-Be model supporting the Clinical Care Pathways model.                                  |

We chose to adopt an integrated approach called the Architecture of Integrated Information Systems (ARIS) as

- the modeling technique is supported by a sophisticated modeling tool (ARIS-Toolset) that supports various purposes such as Enterprise Systems management, software development, reporting, simulation, Activity-based Costing, and publishing models on the Web,
- the resultant model would allow for the identification of future development of PAS that supports the clinical care pathways, and

- the resultant model would be useful for other development work of HMS.

In particular, this process model identifies on different levels of abstraction:

- The events leading to tasks and functions,
- The personnel involved in executing and managing tasks,
- The data required to furnish information for tasks (forms and databases),
- The data generated from completing tasks (reports and database inputs), and
- The mapping of existing information systems supporting the functions within each process.

Input to the student project teams was:

- Flow charts developed by IPH staff,
- Reports of functionality developed by part-time programming/analyst staff,
- Forms used in processing patients in and out of the hospital,
- Interviews with hospital staff of each area,
- Interviews with key project staff regarding the hospital environment and use of PAS
- Interviews with key staff regarding the structure and function of the hospital and medical systems within its support environment.

The operational staffs were most approachable, helpful and interested in participating in this project.

## Subject Assessment

Assessments are an integral part of the learning environment. They must be designed to measure the students understanding of the content in a valid, reliable and feasible manner. As Table 2 illustrates, there were three key assessments associated with this project. Identical copies of these management reports were handed in to both the course coordinator for assessment and to IPH for reporting purposes at each milestone event.

**Table 2. Associated Assessment**

Type of assessment	Marks allocated		Total
	Report	Presentation	
Initial investigation (as-is) report and presentation	20%	10%	30%
Interim report and presentation	20%	10%	30%
Final recommendation (to-be) report and presentation	25%	15%	40%

The as-is report and presentation was designed to enable the students to clearly identify the goals and scope of the individual processes, and to critically evaluate the current status of these. All teams modeled the “current situation” (as-is) of the sub-processes using the EPC (Event-driven Process Chain) methodology and the ARIS-Toolset. The weaknesses of the current processes were identified and possible solutions briefly introduced at this stage. Findings of each team were documented in an 'Initial investigation' report and presented to the supervisor and the relevant contact people from IPH. A team representative also presented the findings in a presentation that took place in front of IPH, SAP Australia and members of PricewaterhouseCoopers, addressing any issues that the audience put forward. The students were evaluated on a team basis, with both quantitative (for example, the syntactic correctness of the models) and qualitative (for example, the presentation style) factors assessed.

The 'Interim' and 'Final recommendation' (to-be) assessments were designed in a similar manner. The interim assessment was designed as a quality control mechanism to enable the students to clarify and confirm the key areas and concepts that the organization wished to address. The 'Final recommendation' assessment was designed as the overall outcome of the project. The proposed reengineering solution was to be addressed in detail, depicting its flow with Event-driven Process Chains together with statistical information (for instance, from benchmarking, process simulations and reports) on the solution's feasibility and appropriateness. Organizational constraints such as governmental regulations and availability of resources were also carefully considered when developing these solutions.

## Outputs

Student teams have completed the as-is study generating detailed process maps for:

- A&E, Operating Theatre and Day Surgery
- Ward, Outpatient Department and Discharge.
- Clinical Services including Pathology, Imaging and Rehabilitation.

They then spent significant time ensuring that the disparate process models from each function were standardized and integrated. Common object definitions were developed, common interfaces defined, and a common layout was defined. This standardization took over five weeks of work. The standardization of the models involved:

- The development of one model describing the existing processes,
- a syntactical check (ensuring that standard symbols are used throughout), and
- a semantic check (standardizing the meaning for the objects within the model).

Finally, the students were able to publish the resultant models on the internal Intranet. These models are used by staff to orient new staff to actual hospital information management procedures.

The original intent of the study was to identify best practice and benchmark data, but the complexity of the environment has led to this element being excluded from the project scope. Students had developed 54 process models, taking over 1800 hours of work. The extension of the project to examine best practice was undertaken and completed over the summer semester by another project team. These results have yet to be communicated to hospital staff, as there has been significant staff turnover, not due for completion until April 2001.

## Organizational Issues

During the conduct of this project, there was some concern that the methodology of undertaking a process engineering approach to the analysis and design of refinement to PAS was a) inappropriate, b) not adding value to the knowledge base, c). tied to one tool (the ARIS Toolset) and d) clouded by other agendas.

The organization was using a variety of flowcharting tools to trap both the administrative procedures governing the hospital, as well as the medical procedures to invoke in time of emergency. The conceptual load of another modeling tool was significant. Not only were new concepts of Event-Driven Process Chains being used, but also the resultant models looked unfamiliar and complex. Indeed, the complexity of models occurred precisely because of the actual complexities found in the hospital that used a paper driven system, which required subsequent data entry into corporate management systems

To address this concern, we had to continue to 'sell' the advantages of process modeling. We pointed out that this method was used in Enterprise Systems, quality programs and business process improvement programs. This real world 'noise' in the process modeling activity made it a difficult task for the students, but they were able to apply their skills in an actual organization that had competing priorities. The student team learnt that the strengths of a modeling approach are rarely appreciated by business unless the activity and resultant model directly addresses a business priority. In addition, they learnt that their efforts had to lead to increased value for the business partners in terms of greater understanding of their internal processes, recognition of system improvements, with clear short-term gains.

This experience led to the students appreciating that the process of systems analysis is very complex. They could relate to Brooks' (1986) observation that

*The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical requirements, including all interfaces to people, to machines and to other software systems. No other part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later.*

## Conclusion

This project was embarked on to ensure that the correct systems development target was selected for future PAS development. This was done in the context of having a partial solution in PAS, a potential solution in HMS and other functionality offered in SAP R/3 powered financial systems and Peoplesoft powered Human Resource systems. We needed to complete a detailed analysis of the existing processes within the hospital. This was beyond the time availability of the part-time analyst support team and external resources were required and provided through the graduate student teams.

Graduates found the experience demanding, but rewarding. In terms of the ISCC curriculum objectives, the student have gained skills in the following areas:

**Table. 3 Skills Gained During the Project**

INDUSTRY-DEFINED ATTRIBUTES OF AN ISCC'99 GRADUATE		
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Interpersonal Skills	Collaborative skills Conflict resolution skills	Communication skills (oral, written, listening, and group)
Technical Knowledge and Skills	Information abstraction, representation, and organization Enterprise computing architectures and delivery systems Concepts of information and systems distribution Human behavior and computer interaction	Dynamics of change Process management and systems development Information Systems domain knowledge Use of computing tools to apply knowledge

These skills are directly translated into job opportunities, with two graduates being employed as Enterprise Systems consultants because of their demonstrated competencies above. (Note that other students are completing their study, and two additional graduates are being now considered for appointment as consultants).

The hospital is reassessing its position to extending the project this semester, due to personnel changes and the impeding rollout of HMS. The part-time analyst team has found the resultant models to be useful, as have the line managers in each of the hospital units. We are continuing to give ARIS support to the web-based model. We will be meeting the new CEO in April to show how to use the model for process improvement, and determine their interest in extending the project.

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