Process Modelling and Simulation for Managing Clinical Care in the Community

STEPHEN KAY MSc PhD1, NICHOLAS R HARDIKER RGN MSc2, SIMON ALDRIDGE PhD2, BRIAN C WARBOYS MSc3, IAN ROBERTSON3, ANA MARTINEZ-GARCIA MSc3, MAX PENTREATH1, MARTIN PITT MSc1

1) Medical Informatics Group, Department of Computer Science, University of Manchester, Manchester M13 9PL, UK
2) Mancunian Community Health NHS Trust, Manchester M21 7RL, UK
3) Informatics Process Group, Department of Computer Science, University of Manchester.

ABSTRACT

'Care in the Community' is an easy catch phrase but a difficult goal. It is a phrase that addresses a current growth area within health care, and one that comes complete with an impressive array of political, economic and social factors that would seem to support the notion of a continuing trend. Technology, specifically information systems, however, has not been successfully cast in a supporting role. There are many reasons for this lack of success but a major one is the mismatch between the understanding of what is required to support the clinical care processes and the specifications of the current systems supplied [1].

Specifically the interest here is in the use and assessment of two computer science techniques, i.e. process modelling and simulation, as suitable means of capturing and communicating requirements so as to bridge the divide and power differential between users and developers of information systems.

INTRODUCTION

A project to Assist Process Performance and Utilisation through Simulation (the APPUS project) began in April 1996; its focus is to do with managing processes in community care. In particular, its emphasis is upon facilitating better communication between users, specifically managers (clinical and non-clinical), and analysts and developers of information systems for that setting. A case study approach introduced process modelling and simulation to non-computer scientists with the aim of understanding how and in what ways these techniques might help to elicit system requirements through dialogue.

The use of specific case studies was chosen as the appropriate approach for two reasons:

- to permit focus upon relevant examples which were readily accessible to the user;
- to permit description of more than one problem area in the two year project.

These constraints meant that the case study had to be sufficiently well circumscribed yet 'real', and generic, albeit only immediately applicable to a small number of users involved in the actual study.

This collaborative project is between the Mancunian Community Health NHS Trust and two distinct research groups (the Informatics Process Group, or IPG, and the Medical Informatics Group, or MIG) within the University of Manchester's Department of Computer Science. The former research group is an application independent group focusing upon business process. In this project the Medical Informatics Group have concentrated upon the application and use of simulation models within the healthcare setting.

The areas for the case studies were selected by the Trust as being 'problematic' with respect to the understanding of process issues. Although the outcome from the project is intended to produce generic results (after all misunderstanding of user requirements by developers is legend), others have shown that unless a simulation project in health care is targeted upon specifics it will not succeed [2]. A specific simulation project must enable users to see the immediate relevance of it to their work or else there is a poor level of co-operation with the consequence that the end result is less than satisfactory [3]. APPUS began therefore with the Trust's choice of an appropriate pilot case study, expecting the subsequent interaction to direct further work. Each case study was to be subject to an evaluation workshop, involving users and modellers, to assess value and to plot the next steps. The pilot case study was centred upon the role of Health Visitor and the paper presents the results from the associated workshop.

Community Health and the Health Visitor

Historically, Community Health in the UK can best be described as the bit between Primary and Secondary Care and has consequently suffered from being the poor relation to both. This is especially true with respect to information systems where Primary Care and Secondary Care systems attract the manufacturers and suppliers to the detriment of...
the Community. Rising costs, however, dictate a move away from expensive institution based care whilst there has been a number of politically sensitive issues related to the effectiveness and resourcing issues of community based care. The continual flux of Community Care agendas has given rise to organisation and re-organisation with the attendant impact upon business processes and roles. An approach capable of capturing, portraying and clarifying such issues, we suggest, will be of wider benefit and should itself be flexible enough to deal with the continual flux.

**Health Visitor.** The Health Visitor role is problematic even for the Community Care Trusts. Health Visitors are senior nursing staff who have a set of responsibilities which are different in scope to those of the 'district nurse'. Both are domiciliary oriented but the Health Visitor activity tends to be channelled towards caring for the new born and young within the context of the family unit. They are mainly autonomous in their work practice, responding to certain 'trigger' requests such as notification of a new birth. At this level, their job is similar to many other jobs of work that are triggered by a stochastic event, carrying out a pattern of activity to reach a goal. Organisationally they are ultimately responsible to the Trust for their management. Their case load is determined by a number of factors often through an attachment to a General Practitioner. They may informally report to the GP but are legally required to provide reports to the Trust through two administrative computer based information systems. Problems arise due to the geographical dispersion of patients, and the health visitor’s ‘invisibility’ in the community, they rarely work from one place or ‘clock in and out’. Their different way of doing things and their autonomy can be a source of confusion to the other professionals that they interact with, and Trust management in particular want to better understand the role that they play and the processes that they manage and interact with. The Health Visitors often feel the need to justify themselves and thus welcome an opportunity to document the work that they have to undertake, but which they feel often goes unrecognised.

**Mancunian Community Health NHS Trust.** The Trust provides an annual budget of £40 million, of which approximately £11 million is spent on the delivery of services to children and young people. Much of the Trust’s work with children is focused towards health promotion and healthy development of the individual child in the family unit. Of special importance in delivering this service is the role of the Health Visitor.

**BACKGROUND**

**The Process Models**

A process model can help explain how organisation goals can be met by the invocation of processes. The organisation achieves its objectives when individuals do work, and their behaviour can be usefully described in terms of roles, activities and interactions [4]. A single role in fact describes a simple process that is undertaken by a single agent; these become interesting when we bring them together with other roles with whom they need to communicate to achieve specific organisational objectives [5]. A diagram representing this is called a Role Activity Diagram (RAD). This technique can also be used to map to discrete event simulations [6]. The process model of the Health Visitor Information Processes was presented as a booklet of 23 pages, one RAD to a page (see Figure 1).

![Figure 1. Role Activity Diagram to show a specific process (birth notification)](image)

**The Simulation**

The APPUS project arose from experience with an earlier initiative that sought to present General Practitioners with a requirements specification for system procurement [7]. It was found that while much could be done with static text explanations, the dynamic nature of the systems was not expressed adequately, particularly for the user unfamiliar with new functional areas. This led to a recommendation to use a discrete event simulator to assist users by visually depicting the processes involved.

In APPUS the purpose was to understand how effective the interactive visualisation was as a means of checking requirements. In particular we wished to compare the effectiveness of this form of visualisation with paper-based models of process. Figure 2 shows a simple visualisation
including the process described in Figure 1. WITNESS is the sophisticated discrete event simulation product that is being used by APPUS. It was already being used by MIG to model planning developments for a new acute hospital [8], in part to consider the number of beds required and the interdependence with the resourcing of community care.

APPUS is only using the dynamic, visualisation aspects of WITNESS. The main purpose was to clarify responsibilities and interactions between entities using an overview of the processes rather than describe their behaviour in fine detail.

First of all it had to provide feedback to the Trust, reassuring them that the collaboration was being productive and that continuation had value for them. It had the task of informing those who had not yet been involved about what was going on, and for giving the first 'results' to those who had been involved directly in IPG's analysis. For the design team, the workshop had to not only deliver critiques of the techniques used but also provide some indication as to what case studies to pursue next.

Structure. The process modelling exercise was completed first. This involved members of IPG interviewing and discussing the area of 'birth notification' with the Health Visitors. From this a set of role activity diagrams was produced and presented as a book. IPG were expected to glean their understanding of the domain exclusively from the interviews and to produce process models independently of MIG. The result was a set of process models that reflected what an analyst new to community health care might produce. The MIG simulation exercise took part of those same process models and provided a representation corresponding to the Birth Notification process, handling the discharge letter and the Health Visitor's part in these processes. The purpose of the simulation was to present aspects of the same model but in a different, visually dynamic way.

Figure 2. Visualisation of health visiting information process

It was possible to use only a sub-set of the WITNESS product in the research, thus using the product in a way that is not strictly intended. In APPUS the interest is in the behaviour of individual entities rather than in aggregations. The visualisation of interactive processes is possible without a wealth of data under-pinning it. We will consider the advisability of doing this in the concluding discussion.

METHODS

The Workshop of the Pilot Case Study

Purpose. The purpose of the workshop was to show the developed models and presentations of the Health Visitor Case Study and to obtain critical comment. With that in mind, the workshop had a number of objectives to satisfy.
The main aim of the workshop was to present the two representations to stakeholders and to evaluate what they made of them. The 'small scale case study' approach limited the number of active participants and meant that only qualitative data was expected. The advantage was that those present were all key stakeholders who knew the Trust both at senior managerial levels (e.g. Director of Business Development) and at the clinical practice level (e.g. Health Visitor, District Nurse). After a brief introduction, the 11 participants divided into two groups, one group being shown the RAD book before the simulation and vice versa with the other group. As Figure 1 shows, a single RAD is much more attractive on paper whereas the screen-shot does not do justice to the dynamic visualisation. Although more sophisticated visualisations are possible at a cost, it becomes a trade-off situation as to what is justified as part of a requirement elicitation process. We chose to go for a 'quick and dirty', unsophisticated visualisation.

Each attendee participated in a full session containing both parts; brief questionnaires were given after the completion of each part, requiring the attendee to complete two questionnaires. The second one not only covered the second technique but also invited comment on the two together. Both sessions were also observed and monitored by 'silent' members of the design team. During the second session some members of the design team reviewed the completed questionnaires to provide input to a combined plenary session; the facilitator used the input to encourage discussion of the two representations and to explicitly draw out the similarities and differences between the two. Note that, the earlier modelling activity of IPG necessarily involved some present at the workshop. Contamination, therefore, reflecting attendee’s previous exposure to these specific models was inevitable (2 out of the 11 had been exposed to process modelling via APPUS); two others had previous experience of simulation from outside of APPUS.

**FINDINGS**

**Findings from the workshop**

After seeing both techniques, most of the participants said they found simulation easier to understand but felt that the process models were more accurate. It was inconclusive as to which was the more effective at communicating but 10 of the 11 respondents felt that the approaches complemented each other. In Figure 3 we present a summary, in chart form, of the initial responses to the process models and to the simulation respectively.

**Observations and discussion**

One major difference between the Process Models and the Simulation was the familiarisation time required to understand what was being shown. The process modellers had to give a brief tutorial on the concepts and conventions used in the RADs before the application area and its issues were addressed. There was very little feedback during the presentation and it was evident that those who had not encountered RADs before needed more time to appreciate their purpose and use in modelling. The groups had difficulty in appreciating the nature of a "Role" within an organisational and individual context. This meant that users critically analysed the terminology and detail of the diagrams (e.g. "This box/role is labelled incorrectly"), without evaluating the overall suitability and usefulness of RADs as a modelling tool.

By contrast, the groups immediately engaged with the simulation, ignoring the mechanics, discussing the application issues, noting the omissions, and accepting the overall story presented to them. For example, it was clear that omissions were quickly noticed with the simulation, whereas the process models needed more investigation. There was some initial questioning as to what the simulation was trying to model - was it trying to capture a clinical or administrative procedure? The dynamic nature of the simulations aided their understanding of the models, but not necessarily the purpose behind them; there was some misunderstanding as to what the purpose of the simulations were at first: Why were we trying to show them what they did? - they already knew! Some thought that the simulations only provided a simplistic overview, whereas there was some feeling that the RADs were a useful tool with which to describe the detailed procedures and that they captured the full complexity of processes. There was the feeling that both the RADs and the simulations were useful modelling tools, but in different contexts. The simulations were perceived as a useful tool in providing an overview of the process - perhaps in a managerial context, whereas the RADs were more suited to simulating the internal working detail and of the process - more useful at an individual, professional level. This may well be due to the difference in the medium in which the two techniques were presented. Another reason might be because the simulation was not based upon detailed analysis of time, activity and motion; the visualisation was content-free in these terms, focusing more on the interactions between entities. The users did not seem to be aware of this, however, and seemed to believe what they saw, a fact that raises a cautionary alarm and places an ethical requirement upon the use of simulation as 'solution'.

What was bizarre, was that whilst the users generally felt the techniques to be complementary, none realised that the simulation was directly generated from the process model. When asked to compare the methods of process modelling and simulation the users had difficulty in "relating the complexity of the RADs to the simplicity of the simulations". Generally they saw the simulation models as providing an easily understandable overview of the process,
while the RADs were far more detailed and complex. Therefore the common perception that Process modelling was the more accurate was illusory rather than real. It may be that the dynamic simulation may seem to trivialise processes; one person alluded to 'Theme Hospital', a PC game. If one identifies oneself with the entities moving across the screen, then it may be that it is an uncomfortable experience and quite different from reading a static paper description of the same processes.

A last observation concerns the perceived differences between the management of caseload and clinical effectiveness. It was hotly debated as to whether the models were for administrative or clinical use. The models were of the information processes, and as such were not directly related to clinical interaction between the health visitor and the client. It was argued by some that gaining better control of their caseload would improve the quality of their interactions with clients. It was this area of controversy that provided the design team with the next step, studying different patterns of care for typical patients.

Generally there was the realisation of the difficulty of capturing the whole complexity of the health visiting process in a model, but a positive attitude towards reaching this goal - the recognition that modelling such processes is of key importance. The participants from the Trust were all very keen that further work should be done. The design team achieved all of its objectives from the workshop.

APPUS did not set out to push one technique at the expense of the other. Rather its concern was to understand the value of the techniques for articulating and communicating requirements between lay and technical stakeholders. The pilot case study has provided a good start.

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