Modelling surgical pavilions and a unit of anaesthesia on a Chilean hospital using Specification and Description Language

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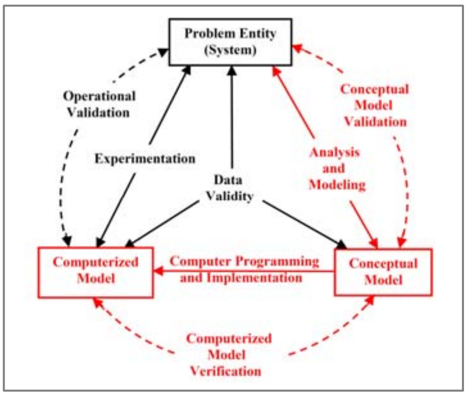
Abstract

This work addresses the problem of performing a formal modelling of the processes related to the surgical pavilions and an anaesthesia unit on a Chilean hospital. To perform this modelling we used Specification and Description Language (SDL). The model was very successful in order to document and to understand the tacit knowledge of the unit and facilitates the simulation.

Keywords: Modelling language, SDL, Surgical pavilions.

1. Introduction

The high cost of operation, complexity, scarce resources and high demand of the anaesthesia units and surgical pavilions (or larger structures such as hospitals or full health systems), permanently pose challenges to improve them. Their optimization requires the specification and documentation of each of the processes. The best way is modelling. Models are increasingly used to solve real life problems. They can describe the functioning of processes, facilitating the understanding of the system. Respect to the stages of modelling, a simplified version of the model development process is presented in Figure 1. The problem is the system (actual or proposed), the conceptual model is the logic-mathematical representation of the system and computerized model is the conceptual model implemented using a computer application (Sargent 2007).



In this paper we focus in the definition of the model (formal definition) that helps to solve some of the aforementioned problems reinforcing the idea that a model by itself is a product (Brade 2000). This formal definition allows quasi-automatic translation into several computerized simulation systems. A simulation of a part of the model is presented to evaluate the process of the model validation, as shown in Figure 1. The study was developed in the Hospital Dr. Gustavo Fricke (Chile), a highly complex operative (Chile Ministry of Health 2009). Its anaesthesia unit and surgical pavilions (UAPQ) play an strategic role and do not have an adequate description of its operation model.

2. Methods

With the participation and supervision of UAPQ hospital staff, the components of the system were studied. modelling was performed using the Specification and Description Language (SDL), using Microsoft Visio® to represent the diagrams. Simulation was conducted over the SDLPS simulation engine.

3. Modelling the UAPQ

The designed model has the following agents: the system, 10 blocks and 50 processes. The environment of the UAPQ has 3 components: (i) The clinical services, (ii) the emergency units and (iii) the support units. Communication between these entities is done through 102 channels using 126 different signal types. Since SDL allows a modular specification of the system, and due to the problem complexity and the importance of each activity, we decided to start specifying and simulating the process related to the surgical interventions, as shown in Figure 2. The state diagram and the simulation results of the Process 74 “Surgical intervention” is show in Figure 3. 476 time units (t.u.) were simulated, generating 1010 events and a total of 30 cycles of the process. 73.9% of time, the process was in state "Wait74" (i.e., waiting for signals), 23.1% in state "Sending signals" (i.e., performing only one operation and then sending signals to processes 71, 72 and 73) and 2.9% in state

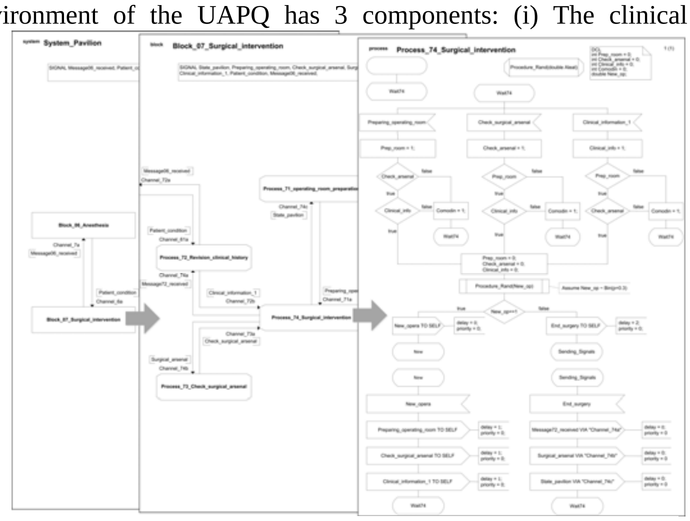


Figure 2. System, block 7 and process 74 of reduced model.

"New" (i.e., there was more than one active operation and signals were sent internally). The average times to move from one state to another were: 13t.u. to transition from Wait74 to Sending_signals and 5t.u. to Sending_signals to Wait74, while 9.6t.u. for the transition Wait74 to New and 2t.u. from New to Wait74.

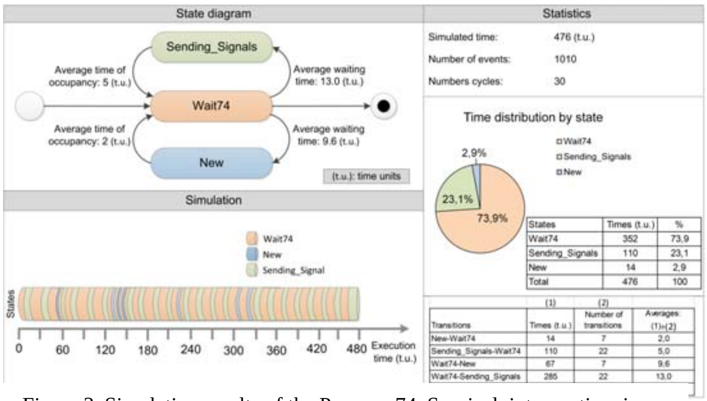


Figure 3. Simulation results of the Process_74_Surgical_intervention in the reduced model

4. Data validation

The next step is to feed the model with validated data. In order to do this we collected information of the last 5 years from the UAPQ database. We performed a validation process of the existing records. They were tested also for goodness of fit. These will be used for future simulations

5. Discussion

The study allowed the creation of an unambiguous documentation and a full understanding of the UAPQ processes by clinical and administrative staff. The information channels, the signals, the directionality and hierarchy between different processes have been defined. This complete definition of the system features and the modular structure of the language allows a clear identification of relations between different system elements. The modular model definition allows continuing different research lines, such as continue simulating the UAPQ processes or studying the optimization of some of their processes.

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