Introduction to Modelling

Version 4

Available online at: http://www.robin-beaumont.co.uk/virtualclassroom/contents.htm

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Contents

1. Learning Outcomes

The aim of this chapter is to enable you to achieve the following learning outcomes and after you have worked through it you should come back and see how much you have learnt.

Learning outcome	Tick box
Be able to describe the terms Domain Expert / subject matter expert (SME)	❑
Be able to describe the terms Modeller / Analyst	❑
Be able to list the basic characteristics of any system	❑
Be able to describe what the term 'output based specification' means	❑
Be able to list the five aspects that should be considered for input, processes and outputs of any system	❑
Be able to provide a basic (two sentence) description of the Zachman framework	❑
Be able to provide examples of models	❑
Be able to describe a number of purposes a model may have	❑
Be able to describe the concept of granularity	❑

2. Introduction - the Domain Experts/SME role in modelling

This chapter introduces the idea of the Domain expert also called the subject matter expert (SME) along with the concept of systems and modelling, often called simply "systems modelling".

The 'domain expert' is, basically a person who acts as an intermediary between the end user and the 'techies' who needs not only to understand systems modelling and all the jargon that comes with it, but also have a in depth knowledge of the domain (sometimes called the application area) that is being investigated. Does this sound familiar?

You will have realised that this is basically the role that you will probably play after working through these chapters. Empirical research has demonstrated that It is vitally important for the success of the modelling process that domain experts are not only acknowledged but included as core roles in the process.

I will discuss in greater depth the skills required of the SME in several other chapters, notable the beginning of the first chapter concerning UML class diagrams and also that concerned with getting users involved in systems development/evaluation. All these chapters on modelling and systems development/evaluation have been designed to support those planning on taking on this role in the Health domain.

In later chapters I will introduce specific modelling techniques such as Entity Relationship Diagramming (ERD's) - and in more depth the Uniform Modelling Language (UML) along with the modelling jargon of the techies because, in terms of importance it is of far greater consequence that you learn these techniques and the language rather than some particular programming language such as JavaScript or C++. It is very important to realise that it is the modelling language that describes what is to be built or modified not the programming language. If you don't heed my advice there is the danger that you will become an amateur programmer (sometimes called fiddlers in the trade) instead of informatics professionals.

eHealth insider a free popular UK health informatics paper in July 2011 highlighted the CCIO campaign, reading the abstract below you will realise that one of the prime functions of the CCIO is to act as a domain expert/SME.

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Email not displaying correctly? View in **your browser.**

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Highlights

- EHI CCIO Campaign website launched
- Registration open for EHI Live 2011
- Vodafone launches mHealth package

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Welcome robin **Issue 11,** 14 July 2011

Editorial

The EHI CCIO Campaign, which is calling on every NHS provider organisation to consider appointing a chief clinical information officer to lead on IT projects and the use of information to improve patient care, has gathered support from some major IT suppliers.

It has been backed by Cerner and BT, who have provided much appreciated investment and logistic support, and endorsed by a number of other companies including Accenture, INPS, iSoft, JAC and McKesson. The EHI CCIO Campaign has also **launched a website** on which EHI readers can leave messages of support.

Clinical leadership is one way to make sure that good ideas and technological innovation is taken up by the NHS. The Department of Health has just launched another innovation review to look for others, to which industry is invited to contribute.

Innovation in healthcare IT will be on show at EHI Live 2011 in Birmingham in November. Registration for the **conference and exhibition has just opened**. Suppliers are also **invited to send in ideas** for the Best Practice Showcase; a popular part of the free exhibition that highlights great work going on around the country.

News **Industry view**

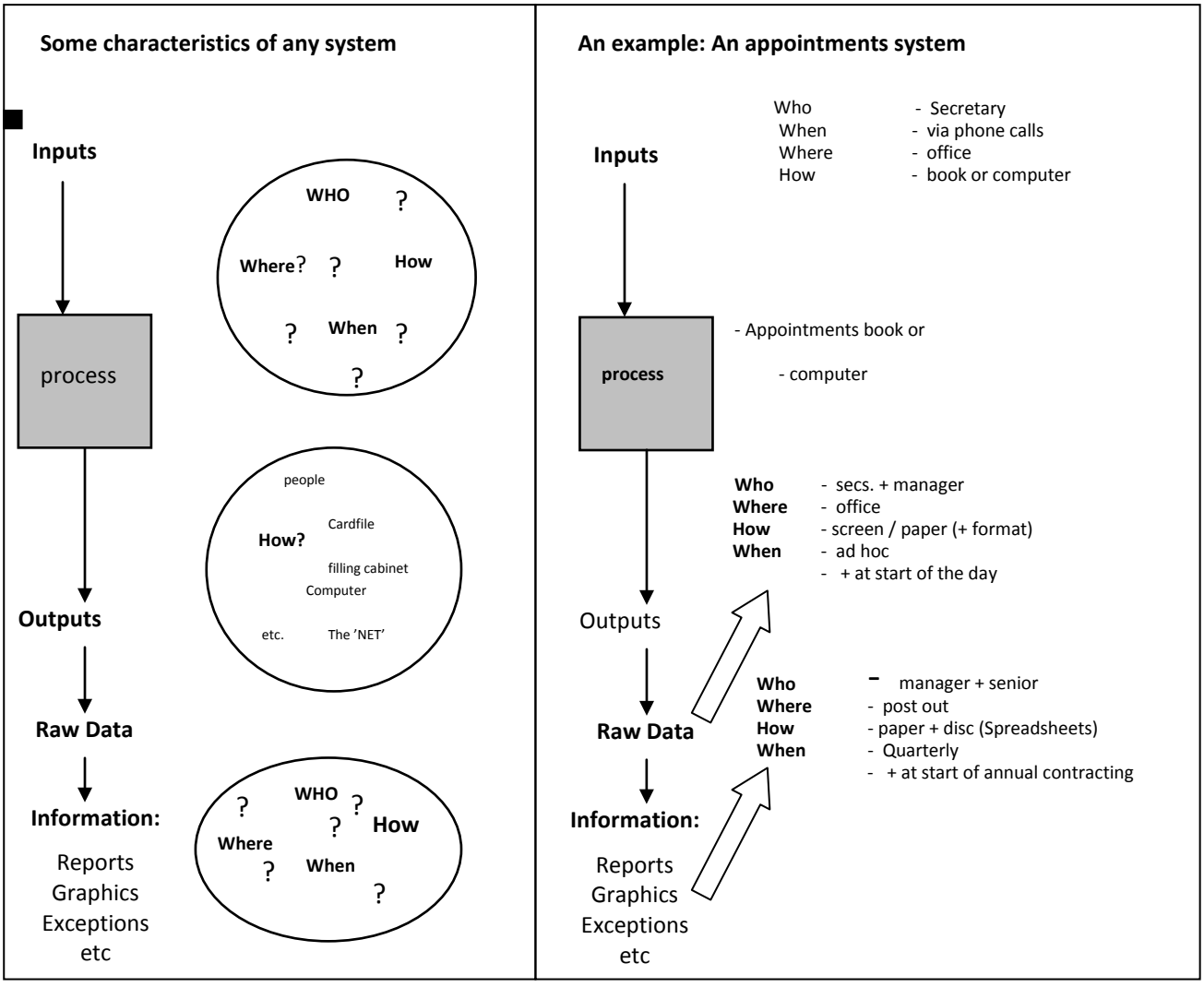
3. What is a System?

The purpose of modelling is to provide a description of a system of some type.

A **system** can be a human body, an organisation (such as a hospital) or, frequently something that is computer based, such as a database. A model of a system is a description of it with a particular purpose in mind. Developing such models is the principle role of analysts/modellers with assistance from domain experts and the 'description' is technical in the sense that it provides the necessary information in the relevant format to allow the system to be analysed/mimicked or possibly supported in some way, possibly by a computer.

The 'systems view' of the world has developed over the past century. The concept provides a framework which allows a large number of seemingly disparate things to be analysed using a common framework. Those who accept the systems view believe that everything can be described by considering input, processes and output. The 'boundary' concept is also important along with some other characteristics which will be discussed in the document concerned with the theories underlying modelling (http://www.robin-beaumont.co.uk/virtualclassroom/chap11/s4/sa1.pdf).

A system receives data (**input**) which is then possibly **process**ed in some way before producing some type of **output**. The human body is possibly the most beautiful and complex example of a system there is. The processing aspect may (but not always) also contain memory and monitoring functions. In Informatics the idea of a system is often applied to a wide range of things. For example the hospital, the nurse bank and the mortuary are all systems. Each of these systems has a clearly defined **boundary**. For example, we know that the local shoe shop is not part of the hospital system. The two diagrams below provide both a general overview of the characteristics of a system along with an example. [Please note that they are incomplete].



From the above diagrams it appears that there is a great deal to consider for any system. Depending upon your viewpoint you may focus on either the input, processes or output. It is often felt that certain models of systems consider in too great depth the input aspects to the detriment of other aspects such as the processes and more importantly the output. Because of this, '**output based**' specifications have become popular where the model concentrates on describing the present or required outputs. Taking the above example of an appointment system, an output based specification would focus on the reports required rather than the processes and input required to produce them, at least initially.

We will return to discuss 'what a system is' in far more depth latter in the course when you have learnt a number of modelling techniques, however for now I feel you have enough information to be able to recognise a System.

Exercise 1.

Look once again at the diagram on the previous page and particularly the template on the left hand side. Notice that the inputs, processes and outputs are considered in terms of:

Who, Where, How and When

Can you think of two other aspects, both starting with the letter 'W' that are missing?

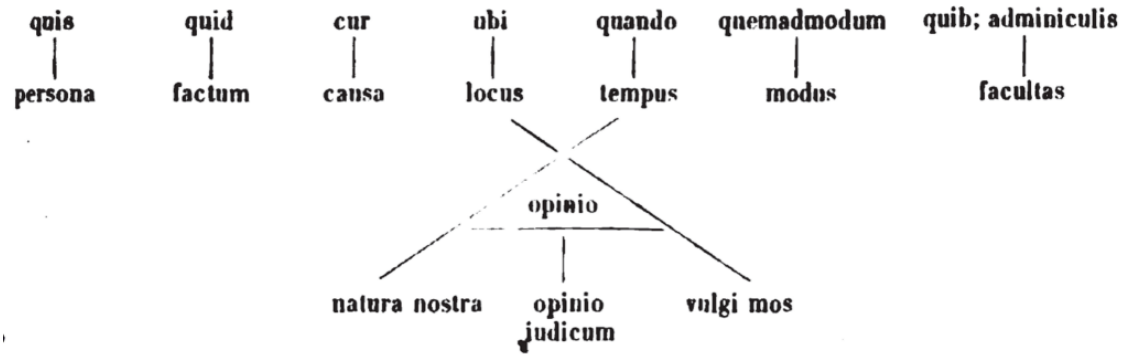
4. Five 'W's and 'H'

You may have ended up with the following list of aspects to consider when thinking about the input, processes and output of any system:

- Why
- What
- When
- Where
- Who
- How

I call these the 5 Ws and H. Pondering on these aspects is basically what modellers (or 'systems analysts' if you prefer the more old fashioned term) do. Unfortunately, like all professions they have developed a specialised vocabulary to describe this activity and the tools they have developed to help the process.

The fascinating Wikipedia entry, http://en.wikipedia.org/wiki/Five_Ws, concerning the five Ws has a mesmerizing history of them including their use by the Roman philosopher Cicero and a poem about them by Rudyard Kipling



Quis, quid, quando, ubi, cur, quem ad modum, quibus adminiculis
(Who, what, when, where, why, in what way, by what means)
Gaius Marius Victorinus's diagram (4th century) of the correspondence of Cicero's (106 BC - 43 BC) circumstances to questions
[taken from the Wikipedia entry]

5. The Zachman Framework

The above description may appear overly simplistic but one can imagine how it can be developed to represent a complex framework for analysing a system. One such example is the Zachman framework. This is used to analyse organisations (or "Enterprises" using the term in the literature) not only from the five perspectives listed above but in addition each is also considered at a number of levels (or alternatively 'roles', depending upon who's interpretation of the framework you are reading).

Exercise 2.

Look at the diagram below. Do not attempt to understand what is in the various cells just notice the bold top row and the first bold column.

	Areas of Interest:					
Scope/Role:	**Data (What)**	**Function (How)**	**Network (Where)**	**People (Who)**	**Time (When)**	**Motivation (Why)**
Top level Objectives / Scope	List of things important to the enterprise	List of processes the enterprise performs	List of locations where the enterprise operates	List of organizational units	List of business events / cycles	List of business goals / strategies
Business owner/ Model of the Business	Entity relationship diagrams	Business process model (physical data flow diagram)	Logistics network (nodes and links)	Organization chart, with roles; skill sets; security issues.	Business master schedule	Business plan
Information Architect/ Model of the Information System	Data model (converged entities, fully normalized)	Essential Data flow diagram; application architecture	Distributed system architecture	Human interface architecture (roles, data, access)	Dependency diagram, entity life history (process structure)	Business rule model
Technology designer/ Technology Model	Data architecture (tables and columns); map to legacy data	System design: structure chart, pseudo-code	System architecture (hardware, software types)	User interface (how the system will behave); security design	"Control flow" diagram (control structure)	Business rule design
Bulder / Detailed Representation	Data design (denormalized), physical storage design	Detailed Program Design	Network architecture	Screens, security architecture (who can see what?)	Timing definitions	Rule specification in program logic
	(Working systems)					
Function System	Converted data	Executable programs	Communications facilities	Trained people	Business events	Enforced rules

The Zachman Framework Taken from **"**The Zachman framework: an introduction" by David C. Hay, Essential Strategies, Inc. http://www.tdan.com/i001fe01.htm

The Zachman framework itself has been modified a number of times. The most important modification is that initiated by the USA government to develop the Federal Enterprise Architecture Framework (FEAF) framework:

"The Clinger-Cohen Act of 1996 [= The Information Technology Management Reform Act (ITMRA)] mandated that Federal Agencies develop and maintain an enterprise IT architecture. The Federal Enterprise Architecture Framework (FEAF) was established in 1999 by the Chief Information Officers (CIO) in response to this mandate. The purpose of the FEAF is to facilitate shared development of common processes and information among Federal Agencies and other government agencies.

According to the FEAF document, the Framework allows the Federal Government to:

- Organize Federal information on a Federal-wide scale
- Promote information sharing among Federal organizations
- Help Federal organizations develop their architectures
- Help Federal organizations quickly develop their IT investment processes
- Serve customer needs better, faster, and cost effectively.

Taken from: http://government.popkin.com/frameworks/feaf.htm no longer available.

6. Does an Information System need to involve Technology?

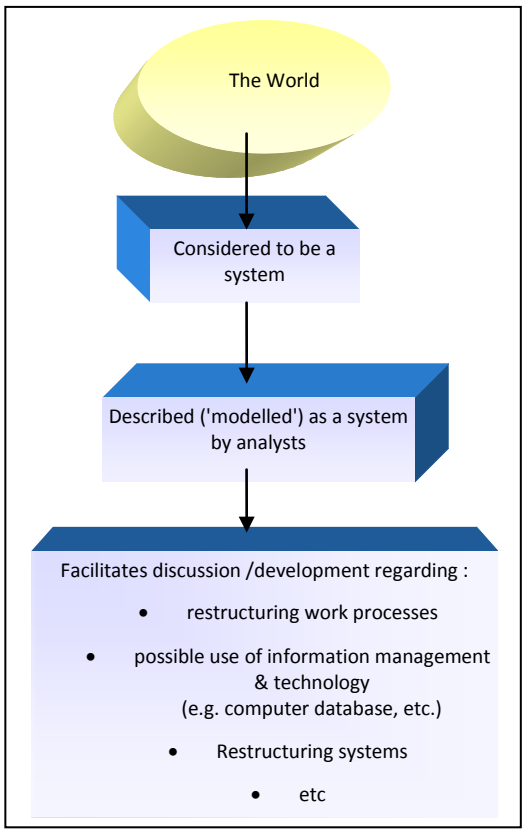
From the above it should be clear that an Information System (IS) does not necessarily involve the use of a computer or any form of technology for that matter. It is the characteristics (the five W's and H) that are important in deciding if the thing under study is a system?

For example in the above table concerned with the Zachman framework, it might be used to develop a clerical based system with only humans. One confusing thing is that the term Architecture is used several times in the table, in this situation the term is synonymous with modeller or analyst, It does not mean technology.

7. What is a Model?

It is very important to note that the modelling process is not attempting to develop a copy of reality. It is much more concerned with describing the important features of the system in terms of processes and information considered important by the analysts and important people in the system ('stakeholders'). The important thing to note is that every model serves one or more purposes.

It might be a description of the present system to help understand it more clearly or at the other extreme an attempt to define and develop some utopian type of system.



When a model is an attempt to define and develop some utopian type of system it may be subsequently forced upon the original system. This is what has happened to a large extent in the healthcare community in the UK where systems have been designed to mimic the ideal (from the managers' perspective) rather than the actual processes. The dire consequences of such an approach are obvious with users blaming the new system rather than the actual 'change' per se. In this situation implementation of a model is seen as a **method of social engineering**.

It is important to realise that change in any organisation must be handled extremely carefully to reduce the degree of anxiety as much as possible. This issue is discussed in much greater detail in the chapter concerned with communication and Systems development elsewhere. (see section 5.5 at http://www.robin-beaumont.co.uk/virtualclassroom/contents.htm)

The purpose dictates the particular form the model will take. It can be seen very clearly in architecture where small scale physical models are often created to provide additional information or to verify computer simulations. One important aspect to remember is that models are usually created to provide a method of description to those who may know little about the system (i.e. database developers). Occasionally the model may appear to be very useful to those who have created it within the organisation -- such as the managers and prospective users -- as a method of clarifying their needs. But at the same time it is virtually useless to those who may need to develop something from it -- such as the database developers. This is frequently the problem with models that provide a way of helping people to clarify their thoughts such as 'Rich pictures' and 'MindMaps'. Managers love them, but they are virtually useless at helping to clarify details required to build the model from a technical perspective. Once again the situation can be seen in architecture, where the beautifully crafted physical model provides a method of communicating to the managers and prospective users, but is virtually useless for the engineers in actually developing the building where detailed plans using a specialised language are required.

Latter in the modelling material (see section 11 at http://www.robin-beaumont.co.uk/virtualclassroom/contents.htm) we will be learning some of the techniques used to build models which are of use to IT professionals. Unfortunately while software developers favour such techniques most people, such as managers or users, find them difficult to learn.

The following chapters will look at the following aspects of modelling:

UML Unified Modelling Language – A sophisticated graphical technique used to model information and process requirements.

ERD diagramming – An older graphical method used to describe certain aspects of the information requirements for database development, still used by a lot of modellers.

User interface modelling - A technique used to describe and model the way a user may interact with a computer system.

It can therefore be seen from the above that every model has a certain purpose and **granularity** (level of detail). A small scale physical model of a building is no use in describing detailed wiring and plumbing details and is said to possess a high level of granularity. In contrast, a very detailed model is said to have a low level of granularity. Think of it as the size of the granules!

The diagram above shows why a model is produced when developing Information systems.

In summary a model, amongst other characteristics:

- **Has a purpose;**
- **Does not mimic reality (i.e. is selective);**
- **Possesses a certain level of granularity**

In the material presented in the next few chapters we will be primarily concerned with investigating various tools that modellers use to help develop information systems. focusing on UML. Remember that the focus of a model may not be a computer system but could be a **paper document management system** (i.e. the traditional, paper based, medical records department of a hospital) or a **set of processes**.

8. Summary

This short introductory chapter we have introduced the concept of systems and modelling. It has also introduced, in an informal manner, the activities that modellers involve themselves in, basically the five W's and H as I call them.

Following on from this introduction, each subsequent will investigate a particular aspect of modelling in far more detail. It is important to keep in mind the information presented in this introduction when wallowing around in the minutiae.

Both the MCQs on the following page, and the list of Learning Outcomes at the beginning provide a way of you revising the material in this document. Please make use of them both.

Robin Beaumont

9. Multiple Choice Questions (MCQs)

1. What is another name for an analyst?

   a. Project manager
   b. Modeller
   c. Programmer
   d. Systems engineer
   e. Database manager

2. What is User Interface Modelling (UI) concerned with?

   a. A technique used to describe the way a user may interact with a computer system
   b. A technique used to describe and model the way a user may interact with any type of equipment
   c. A technique used to monitor the way a user may interact with a computer system
   d. A technique used to describe and model the way a user may interact with computer screens
   e. A technique used to monitor health problems associated with computer systems

3. Which of the following lists represents the basic characteristics of any system?

   a. Inputs, Outputs, Processes, Boundary
   b. Inputs, Outputs, Boundary
   c. Inputs, Outputs, Monitoring system, Boundary
   d. Inputs, Outputs, Processes
   e. Inputs, Outputs, Processes, Power

4. Inputs, along with the other basic characteristics of systems, can be considered from six angles. What are they?

   a. Why, What, When, Where, Who, How
   b. Work level, What, When, Where, Who, How
   c. Why, When, Where, Who, How, How much
   d. Why, Work level, When, Where, Who, How
   e. Why, What, When, Where, Who, How much

5. A model possesses the following characteristics:

   a. Purpose, Selectivity, Cost
   b. Purpose, Life span, Granularity
   c. Purpose, Selectivity, Granularity
   d. Purpose, Selectivity, Stakeholder
   e. Purpose, Selectivity, Builder

10. References

Few books provide a basic introduction to modelling. They usually present a 'method' with little discussion or more rarely discuss the philosophical foundations of modelling. The references below are given in order of relevancy.

O'Connor J, McDermott 1997 The art of Systems Thinking: essential skills for Creativity and Problem Solving. Thorsons (Imprint of HarperCollins, London) ISBN 0 7225 3442 6 This book is the only one I have ever come across which introduces the concepts discussed above at a very basic level. It is an excellent read but unfortunately already out of print. At the time of writing this it was possible to obtain copies of it from the second hand book section of Amazom.co.uk

Cleckland P 1981 Systems Thinking

Bertalanffy L Von 1968 (11th printing 1993) General System Theory. Pub. George Braziller Inc. New York

Benyon D Skidmore S 1987 Towards a Tool Kit for the Systems Analyst. The Computer Journal 30 (1) 2 - 7

Bertalanffy L Von 1967 Robots men and minds

11. Web Links

The Zachman freamwork:

Learn about John Zachman at http://en.wikipedia.org/wiki/John_Zachman and http://www.zachmaninternational.com/2/Home.asp

Also see John A. Zachman 1987 A Framework for Information Systems Architecture, IBM Systems Journal, vol. 26, no. 3. IBM Publication G321-5298.

Systems thinking:

System Dynamics in education Project (SDEP) – use google to search

Nuhoglu H, Nuhoglu 2007 Systems Dynamics approach in Science and Technology Education. Journal of Kurkish science education 4 (2) [September] p91-108 Available at: http://members.multimania.co.uk/egitimar/ogretim/MAKALE%202/2007-12.pdf

Wikipedia has a good entry for Systems thinking with a historical time line and descriptions of how it has been used in various disciplines. http://en.wikipedia.org/wiki/General_System_Theory and http://en.wikipedia.org/wiki/Ludwig_von_Bertalanffy

Gordon Dyer of the Open University provides a recent commentary about systems thinking and how it is used in a social developmental setting at http://www.afscet.asso.fr/resSystemica/Crete02/Dyer.pdf