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The use of modelling techniques in the definition of the UK electricity market

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Disclaimer

This work is original and has not been previously submitted in support of any other course or qualification.

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Abstract

The electricity market in Great Britain has been progressively de-regulated over the last fifteen years. Competition has increased at an exponential rate during this period as new companies have begun operating in the market, which is now arguably the most sophisticated and successful competitive utility market in the world.

This success has been achieved only with a degree of complexity. There are now more than a hundred “organisations” that must inter-operate, where prior to competition there were only about twenty, operating independently. An organisation in this sense is an identifiable business unit carrying out one of more than a dozen defined roles.

Within this complex structure individual organisations need to know their responsibilities and the processes for carrying out market transactions must be defined. (e.g. a customer wishing to change supplier) This requirement has been met by the production of an “industry model” which comprises a series of diagrams, formal definitions and English prose. These are delivered using a combination of a proprietary business modelling tool, a database and textual documents.

In this paper the model is explored and an attempt made to classify its components by relating them to the Zachman framework. From this the model’s

strengths and weaknesses are postulated. These are then tested by means of a survey of the intended users of the model.

Finally, conclusions are drawn about the use of modelling techniques for the definition of a utility industry infrastructure, and recommendations for further research are made.

Acknowledgements

This dissertation would not have been possible without the help and support of many people.

I should first like to thank the staff at University College, Chester, in particular John Zlosnik for his apposite advice throughout, and Janet Thorniley who always managed to come up trumps no matter what the problem with which I needed help.

Thanks also to the many people in the electricity industry who gave up their time to complete the questionnaire that formed a part of the research, to my work colleagues who also gave me invaluable guidance in its design, and to Gemserv Ltd., through whose good offices the questionnaire was distributed and the results collected.

Finally, thanks to my family and especially to my wife, Carole, who has provided much needed encouragement throughout.

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1 Introduction

1.1 Purpose and scope of the work

The electricity market in the UK has been progressively de-regulated and opened up to competition over the last fifteen years. As a result it has become increasingly complex and the independent companies that the market comprises need to inter-operate in order for it to function acceptably. For this inter-operation to be successful a set of industry protocols, to which all companies comply, has been defined. These protocols are set out in a series of documents, referred to here as the "UK Electricity Model".

Companies use this model as part of the definition of their internal business processes and, in many cases, their business applications.

(A business process, in this context, is a series of tasks, both manual and automated, that link together in a defined way to complete a business scenario, for example "change of tenancy". A business application is an ICT system that automates some or all of one or more business processes). The model is, in part at least, defined using techniques similar to those that ICT application designers might use. Ideally, the model should provide companies with a clear, definitive statement of the requirements to operate in the market, with minimal need for further analysis and design work.

This study explores how well the model satisfies this need. Two approaches are adopted. First, a theoretical taxonomy for the “ideal” model (based on related work) is investigated and an assessment made of how the UK electricity model measures up to this. Next the perceptions of the people who actually make use of the UK electricity model have been obtained by means of a questionnaire.

From these analyses it should be possible to indicate where the strengths and weaknesses of such an industry model lie, and where the UK electricity model might be improved. Similarly, where such industry models are required in the future, in other utilities or in other countries, this study will provide a useful starting point on the necessary content.

1.2 Structure of this report

This report is structured as follows:

- Introduction (this chapter)
- A description of the survey of previous, related work.
- An introduction to modelling, with particular reference to the design of ICT systems
- A discussion of the development of design taxonomies.
- A brief history of the de-regulation of the UK electricity industry, relating this to the need for an industry model.

- An analysis of the UK electricity model using the Zachman framework as a reference
- The survey and its results
- Discussion and conclusions, and recommendations for future work
- References to work used directly in this study and for further reading
- A glossary of terms used
- Appendices containing the detailed materials used to compile this report

2 Literature Survey

An extensive search for previous work in the area of modelling was undertaken over a period of several months. Sources used include the university libraries at Chester, Liverpool and the London School of Economics, the Internet and Amazon.com. No previous work similar to this one was found.

Some thirty papers, books and electronic references were obtained and studied in detail. Many more were investigated but found to have no direct relevance. Three papers were found to be particularly pertinent, one by Richard Nolan in 1979 and two by John Zachman in 1987 and 1992 (the second being in conjunction with John Sowa). These develop a taxonomy for the definition of systems designs and are referred to extensively within this paper.

3 Background to de-regulation of the electricity market

3.1 Objectives of de-regulation

Twenty or so years ago utility industries in the UK, including electricity, gas, telecommunications and water were monopolies, either nationally (as in the case of telecommunications and gas) or locally (as for electricity and water). Consumers, whether domestic, industrial or commercial, had no choice of supplier for these services. Standards of service were set by a regulator for the industry and prices were controlled.

The industries were highly regulated. Such regulation is required where there is insufficient competition (Beesley M.E., 1997, p134) but it left little incentive for improvements in service levels, innovation and price competition for the consumer, or for efficiency improvements that would reduce the overall costs.

Successive governments have concluded that, to achieve real cost savings that can be passed on to the consumer, competition must be introduced. As this competition has been rolled out, so it has been possible for regulatory controls to be relaxed, as the natural economic forces of the competitive market hold and drive down prices.

Today in the UK there is extensive competition in electricity, gas and telecommunications and a desire to extend this to include water. The European Union has also passed legislation that will result in cross-European competition in all utility markets during the next few years.

3.2 Phases of electricity de-regulation in the UK

Prior to 1989 the electricity industry comprised the Central Electricity Generating Board (CEGB), who were responsible for all power generation and high voltage transmission, and fourteen Regional Electricity Companies (RECs), who distributed low voltage electricity to the consumer. (Bergman et al, 2000, pp 89-90)

The 1989 Electricity Act split the CEGB into a number of generators and the National Grid Company, who became responsible for high voltage transmission. At this point they also introduced the ability for large industrial customers, whose consumption rate was greater than 1MW and of which there were around 5000 in number, to purchase power directly from a number of suppliers. The Electricity Pool was created, whose role was to “broker” power between generators and suppliers.

In 1994, further changes gave consumers of 100KW and over a similar capability. This encapsulated around 50,000 industrial and commercial consumers.

In 1998, supply competition became available to domestic consumers, of whom there are over 20 million. With this increase in consumers of three orders of magnitude it became necessary to define more precisely how the market must operate, and the need for an Industry Model (see below).

The Electricity Act (2000) brought about the separation of the original RECs into their supply and distribution components. Since distribution is a natural monopoly of the wires that carry the electricity from the national grid (very high voltage) to the consumer, there was, until this point, the potential for the REC to give favourable terms to its supply arm. With business separation all suppliers compete on an equal footing.

A further development, active at the time of this paper, is the introduction of competition into the distribution of electricity, thus breaking down even this monopoly.

Beyond that, Europe is gradually moving back the frontiers in utility competition and it will not be long before electricity is freely traded across borders throughout the European Union.

3.3 Structure of the Industry and the need for an Industry Model

The UK has the most sophisticated, and arguably the most liberalised, electricity market in the world. Some would argue that it is too complex but that is not the subject matter of this paper.

This sophistication brings with it a level of complexity that can be difficult to grasp. Consider the following:

> Prior to de-regulation each consumer interfaced with one supplier (the REC) who carried out all the functions necessary for electricity supply, including maintenance of the distribution network, installation and maintenance of meters, meter reading, dealing with supply faults, billing the consumer etc. The REC, in turn, purchased electricity from the CEGB. (Figure 1)

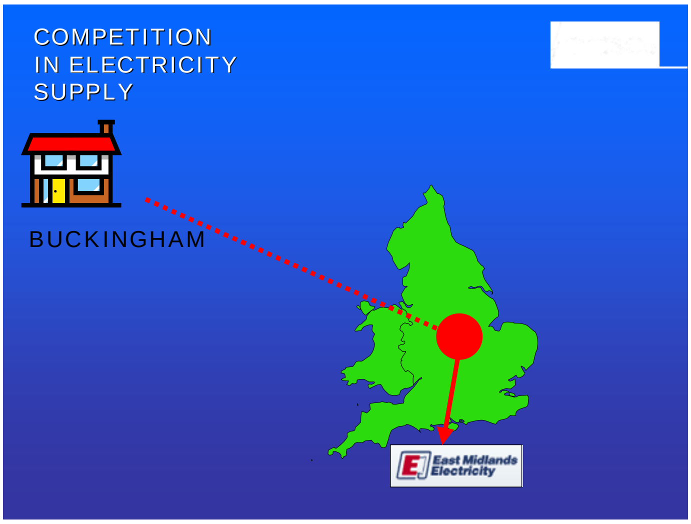

Figure 1 Prior to competition

In today's market, according to OFGEM (2002), business consumers have a choice of more than 40 suppliers, and domestic consumers can purchase from any one of over 25 suppliers (Figure 2).

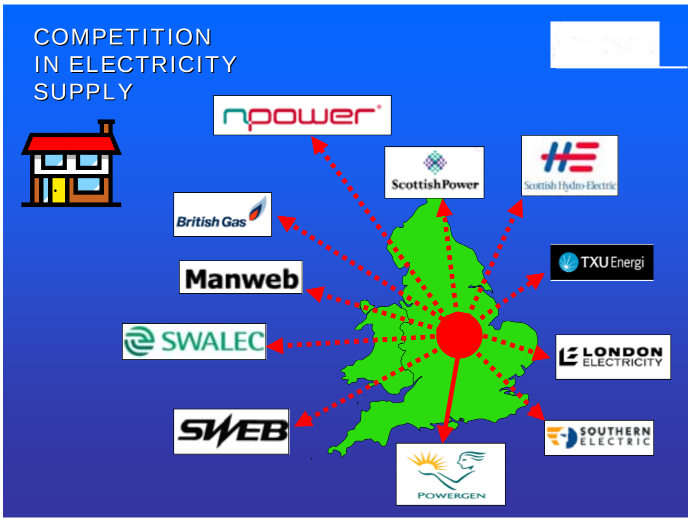

Figure 2 Consumer has a choice of supplier

But this is only the start of competition. Suppliers must provide services for meter reading, consumption forecasting, meter operation (installation, removal & maintenance) and a number of other services, all necessary in providing the consumer with a full service. They do not themselves have this expertise and must therefore choose from a number of organisations (known as metering agents) who have to be accredited to carry out these tasks. The metering agents may all be part of the same company (Figure 3), but could be from different companies if the supplier judges this to give the most competitive arrangement (Figure 4).

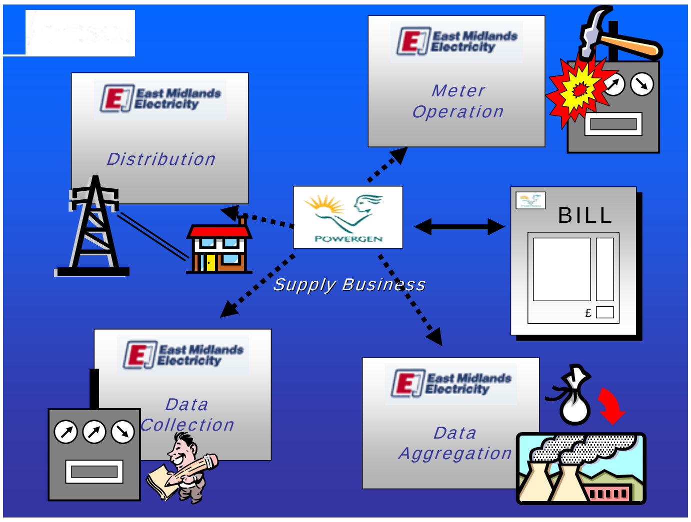

Figure 3 Supplier chooses metering agents from same company

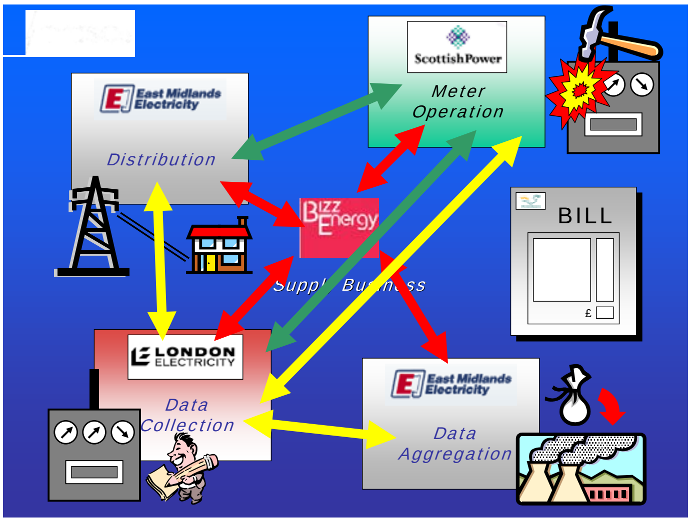

Figure 4 Supplier chooses metering agents from different companies

There is no central data repository for the industry as a whole. The only central service (in the retail market under consideration) is the data transfer network, which enables inter-communication for all market participants.

There are also a number of registration services, where data about each point at which electricity is consumed, and which supplier and metering agents are responsible at any point in time is held. One such service is provided for each geographical area.

In order for the market to work there is a need for all of these organisations to inter-operate. Imagine a typical scenario, where a customer decides to change their electricity supplier. The incumbent supplier and his agents need to inter-operate with the new supplier and his agents. They all need to inter-operate with the distributor and the central registration service. Thus, there are potentially ten organisations involved, leading to up to 45 channels of communication. The opportunity for things to go badly wrong is immediately apparent from this simple analysis.

So that this does not happen, the major transactions (e.g. change of supplier) have been defined in terms of agreed series of exchanges of data. For example, when a customer changes supplier, there are some 50 interchanges of data that need to take place, even in a straightforward case. Also, the number of channels of communication has been reduced by routing many of the interactions through the supplier. These transactions and the organisation described are the essence of the Industry Model.

3.4 The Electricity Industry Model

This Electricity Industry Model comprises a series of hierarchic data flow diagrams, definitions of the data flows that appear on these, and supporting documentation giving further detail on interpretation as necessary.

The diagrams are developed and maintained using a product called “Enterprise Modeller” (see below).

The dataflow definitions are maintained on a database and distributed in this format. Standard reports are included and many users choose to print out the definitions for general use.

Supporting documents are distributed in electronic documentary form.

A recent development is to integrate the diagrams, definitions and supporting documents, taking advantage of new features of Enterprise Modeller. The user can now open up dataflow definitions and applicable supporting documentation directly from the diagrams, using the “point and click” mechanism.

The Industry Model is used by all organisations that operate in the electricity market as the design reference point for formal communications with other market participants.

3.5 Enterprise Modeller

The Enterprise Modeller was conceived about 15 years ago by Alastair Heslop as part of a PhD on the subject of business modelling. He recognised that all of the tools then available for drawing and capturing information (e.g. CASE tools) were targeted on information technology and he identified a need for a tool that was aimed at capturing business objects, for example people, business units, processes, dataflows etc.

The product, marketed by Enterprise Modeller Solutions, is aimed at modelling businesses rather than computer systems. Eleven types of object are available in all, from which it is claimed any business can be defined.

Whereas most tools available at the time were diagram based, this product was object based. It is fundamentally an object database with a diagramming tool sitting on top. It was originally intended as a support tool for a business consultancy service. Once in use, the tool itself generated a good deal of interest and was marketed separately.

Since then, it has been recognised that one model does not fit all situations and so a meta-modelling facility has been added, whereby new objects can be defined and the tool customised for a specific client's requirements.

The tool now also has the capability to attach metrics to objects, to define algorithms and use these for analysis purposes, for example, to determine how long a business process would take.

4 Background to modelling

It is difficult to think of any field in which modelling is not used to good effect. Clocks, thermometers, maps, sheet music, Braille, x-ray images, computer games, GPS navigation and films are all examples of modelling techniques in use in everyday life.

So what is a model and why do we use them?

4.1 What is a model?

According to Harry M. (2001, p68)a model is simply a representation of something. It could be, for example, a physical object (e.g. a bridge), a property of something (e.g. the pressure within a boiler), or the behaviour of something (e.g. the sequence of operations in a manufacturing process) etc. This is a very broad and not very illuminating definition, so what more can we say? First, let us look at the reasons for using models.

In the world at large, there are many reasons for using models, some of which are described below:

- Cost. It is cheaper to develop a model to demonstrate ideas than to construct the real thing. It is also considerably cheaper and quicker to make changes. This applies to the modelling of structures and computer systems, for example.

- Understanding and agreement. A suitably constructed model can be used to communicate a common understanding amongst a group, promote discussion of different ways of achieving the goal, and lead to agreement on the form of the object being modelled. Typically, a model is an abstraction that shows only the aspects that are of interest in the context (Marvin, n.d., p ii).

- Aid to clear thinking. Even where only one person is working on a design, the use of modelling techniques can be an aid to evolving ideas and testing their efficacy (Martin & McClure, 1985a, p9). Testimonies to this are the designs of the great engineers, for example Stephenson, Telford and Brunel.

- Communication. As construction of the object proceeds, different aspects of the model can be used to communicate requirements to the next stage. For example, in the construction of a house, plans for the plumbing are used to instruct the tradesmen on the positioning of taps, radiators, soil pipes etc.

- Safety. Many safety situations can only be tested by modelling. For example, testing the effect of a car crash on a person cannot practically be achieved without the use of dummies that model the characteristics of the human body.

The first four of these are all reasons for modelling ICT systems. They are also the underlying motivations for the creation and development of the UK Electricity Industry Model. When the model was first being designed, the first three were of paramount importance. Now that the model has been implemented, communication of the design has equal importance.

A model may provide its representation using one of a selection of techniques, including:

- Physical models, which are typically scaled-down versions of the object being modelled. Often, physical models represent only a subset of the properties of the original object, and there may be several different models, each representing different properties. For example, a building would perhaps have one physical model to demonstrate the external aesthetics and others to show how the interior may be designed.
- Analogue models, where a property of the original object is mapped onto a (usually) different property of another. For example, a vehicle's speed is represented as the position of a needle on a dial, and moves continuously as the speed varies. (This is an example of a model used operationally rather than for design or research purposes)
- Symbolic models, where the original object(s) is represented by symbols. For example, $d=ut+0.5at^2$, the mathematical formula for

distance travelled(d) over time(t), given the initial speed(u) and acceleration(a).

Models can themselves include sub-models. A flight simulator, for example, would make extensive use of all of the above types of model.

Considering the above, the following definition is proposed:

"*a model is one, or a series, of representations of a real world object that allows the properties of the object to be discussed, modified and tested at much reduced risk*."

4.2 Modelling in ICT

The above discussion has been about modelling in general across a whole range of domains. So, how is the concept of modelling used in the domain of ICT?

Early attempts at explaining a proposed system used natural language. Such a natural language description, where the characteristics of the object are fully described using narrative, is a valid modelling technique. Indeed, according to Sowa & Zachman (1992, P591), natural languages, such as English, are capable of describing everything necessary for a design. Why, then, has so much effort been put into the development of the multitude of diverse modelling techniques used across practically every field of human endeavour?

First, we need to consider the whole concept of thinking and communication. Philosophers believe that what we are capable of thinking is dependent on the language we use for thinking (Martin & McClure, 1985b, p109). For example, when only Roman numerals were used, ordinary people could not multiply or divide. This capability spread only with the arrival of the Arabic system of numbers that we use today. So it is with natural language. Whilst it is theoretically possible to express any concept in natural language, it is too imprecise, and it becomes very difficult to express and understand, when applied to complex concepts (Fowler & Scott, 2000, p7). It is also informal, and as such will be subject to misinterpretation (Jackson, Embley & Woodfield, 1995, p273).

Thus, to deal with new and complex concepts, other types of expression have been invented. These are what are referred to as “modelling techniques” within this paper. They are themselves a form of language, but they are often aimed at, and comprehensible by, only people within a specific field. Harold Nielsen (cited in Stolterman, 1999, p12) calls the process *diathenic graphologue,* based on the Greek meaning *letting a thing be seen through representation.* In the field of ICT there are hundreds of modelling techniques. Many of these are graphical in nature. Graphical techniques are attractive because they can convey a great deal of information in a precise and concise form compared to, say, narrative, and tend to be less ambiguous (Martin & McClure, 1985b, p110) A few examples are data flow diagrams, entity-relationship diagrams, class diagrams, use cases, Jackson structure charts and state transition diagrams.

Even with all these techniques available, natural language still forms an essential part of the modeller's armoury.

4.3 How are models are used in ICT?

In the development of ICT systems, symbolic models are used extensively, where diagrams represent system objects and their properties, and where we are concerned with what the system comprises and what it does. (Harry, M., 2001)

There is a wide variety of modelling techniques available, aimed at different types of system, different paradigms and simply alternative approaches to the same problem, though according to Barros & ter Hofstede (1998, p314) there has been little change in these techniques since 1991.

Some techniques are in the pubic domain (e.g. entity-relationship modelling, dataflow diagramming), whereas others are proprietary and intended to work with the specific (CASE) product that implements them. For example the Information Engineering Facility is an integrated CASE workbench that uses a tightly integrated set of tools to implement the Information Engineering methodology (Butler, 2000, p176). This includes various modelling techniques such as Action Diagrams, which are not generally used outside of this environment.

Martin & McClure (1985a, p11) set out a list of techniques with which they felt any analyst should be comfortable. These were:

- Decomposition diagrams
- Dependency diagrams
- Data flow diagrams
- Action diagrams
- Data structure diagrams
- Entity-relationship diagrams
- Data navigation diagrams
- Decision trees and tables
- State-transition diagrams

All of these techniques are in general use today, and though it was an early attempt to define an "analysts toolkit", it is mainly suited to application for business systems design and never became a *standard*.

There are now a number of different sets of modelling techniques available, each supporting a particular methodology, for example those favoured by SSADM, Information Engineering, ARIS, DECModel, Processwise, BDF (Bradley et al, 1995) and many more.

The closest approximation to a standard has come about more recently in the object-oriented community with the publication of the Unified Modelling Language (UML). UML brings together and rationalises the techniques advocated by Booch, Rumbaugh and Jacobson and has been standardised through the Object Management Group. It comprises a series of eight, mainly graphical, modelling techniques fundamentally aimed at improving communication in object-oriented designs (Fowler & Scott, 2000, p7). These are:

- Use case diagram
- Class diagram
- Interaction diagram
- Package/collaboration diagram
- State diagram
- Activity diagram
- Deployment diagram
- Component diagram

Even when a modelling technique has been chosen there are still some decisions to make, as each technique may be implemented in a number of notations. For example, the Entity Relationship diagram can use the Chen, crow's foot or a number of other notations. Nor is it the case that the use of modelling techniques will automatically result in the *correct* design, since research has shown that even beginning from a common definition, different modellers will produce different models (Ledington & Ledington, 1999, p55), and where graphics are used to improve comprehensibility, these may not be readily understood by the reader (Nordbottand & Crosby, 1999, p140).

5 The evolution of ICT modelling taxonomies

5.1 ICT development methodology

ICT systems are normally designed using a defined methodology. A methodology comprises:

- A process. These are the stages that are followed as the design progresses from inception to construction. The process defines the order in which the stages are carried out (with iterations if necessary), the inputs to and outcomes of each stage, and, at the detailed level, the activities that each stage comprises.
- A set of techniques for expression of the design at each stage. These are the modelling techniques, many of which are visual in nature.

The methodology normally sets out the techniques to be used at each stage. Since there are hundreds of modelling techniques available to choose from, each methodology uses only a small subset and there is no accepted "standard" set for all types of design.

So, how does one choose what modelling techniques should be included in the methodology and how do we know when we have the right techniques to provide a full specification at the various stages of development? To answer these questions, we need to turn back the clock over twenty years.

5.2 The Nolan maturity model

In 1979 Richard Nolan produced a seminal paper “Managing the crises in data processing”. In spite of its age, this study still has relevance today with simple adjustments to the terminology to bring it up to date. In this study, he proposes six stages of growth for the use of ICT in an organisation. The characteristics of the stages are reproduced in Reproduced from Nolan (1979, p117)

Table 1 below and can be summarised as:

1. **Initiation**. The technology is established
2. **Contagion**. A period of rapid , fairly uncontrolled growth, as innovation is encouraged by management
3. **Control**. Management regains control by implementing formal controls and standards. There is a concentration on IS providing efficiency gains
4. **Integration**. Use of the technology increases rapidly as it brings benefits to the business
5. **Data Administration**. Data is recognised as an important asset and efforts are made to manage it
6. **Maturity**. IS applications mirror the business and contribute to the business strategy

Reproduced from Nolan (1979, p117)

Table 1 Characteristics of the stages of maturity

Organisations that are long-established will have progressed through these stages and will have reached a level of maturity somewhere around stages 5 and 6. Typically, in larger organisations, there will be some diversity of maturity, as measured by this model, across the various divisions. Younger organisations may have skipped one or more of the stages by the use of IS from the outset.

One of the key messages in Nolan's paper is the recognition of "processes" and "data" as two distinct aspects of an organisation's systems infrastructure. In the early stages, the priority is on using ICT to speed up processes and there is a strong emphasis on existing functional organisation. As the organisation matures data are recognised as an important asset and the need for cross-functional management of both processes and data becomes important. This leads to the integration of the "process" and "data" models across functional areas and the management of “data”, and ultimately “information”, as a corporate resource. Even today, this is regarded as the classical functional approach to ICT design (Savolainen et al, 1995, p258).

5.3 Martin & MCClure

By the mid 1980s structured methods had become accepted as the way forward for ICT development projects. These methods break development down into a series of discrete stages, the output of one stage becoming the input to the next stage. As we progress through the stages, the people involved require a different, generally more detailed view of the design to that stage, and will elaborate the design.

In their book, Martin & McClure (1985a, p12) retained Nolan’s “data” and “process” views and proposed a second dimension. This dimension reflects the different information needs of the development staff at each stage. They proposed four stages and eight modelling techniques, as shown in Table 2.

Reproduced from Martin & McClure (1985a, p12)

Table 2 The four stages and two abstractions of Martin & McClure

This taxonomy found much favour at that time and was the basis for a number of proprietary methodologies, including “Information Engineering”, the methodology marketed by companies with whom Martin was associated.

5.4 The Zachman framework

One of the enduring challenges of information systems is to identify a complete, coherent set of design elements that can be said to provide a complete design picture. As we have seen above, Nolan saw the need for “process” and “data” views of any system. Martin & McClure saw the need for a second dimension, representing the views required at the different stages of development.

Zachman (1987) proposed that the design of a system must include fifteen elements similarly structured into a matrix, but with three columns representing the “abstractions” (i.e. views of different aspects of the design - data, function, network) and the five rows representing the “perspectives” (scope, business model, system model, technology model, detailed representations) each intended for use by different roles (e.g. sponsor, designer, programmer). He called this “a framework for information systems architecture” . It is now commonly known as “the Zachman Framework” and is referred to here by this name.

Within the framework, each row represents a complete picture of the system from one perspective (e.g. that of the designer), whereas each column provides a complete top-down picture of one abstraction (e.g. all of the functional views - for the planner, owner, designer, builder etc.)

Some years later, Sowa & Zachman (1992) extended this architecture by adding three more abstractions for "people", "time" and "motivation". The number of perspectives, however, remained the same. It is illustrated in the figure Figure 5 below:

Figure 5 The Zachman Framework (Zachman Institute, 6th November 2002)

Whereas the cells can be viewed in isolation, clearly there are inter-dependencies between them. For example, if the data abstraction is incomplete in, say, the designer perspective, it is possible (or even likely) that the processes for the creation and maintenance of the "missing" data will be omitted from the function abstraction.

Sowa and Zachman do not stipulate how the cells of the framework should be populated. They give examples, as can be seen in the figure, and proffer that all of the cells must be appropriately populated in order that the definition can be deemed complete. The actual techniques to be used are to be decided by those who are involved in the design process, either as designers or as domain experts working with them. Thus, for example, where SSADM is being used, the designer perspective of the data abstraction would probably use a logical data model, whereas in an object oriented design it is more likely that class diagrams would be employed. The framework allows for the possibility that several techniques could be used in a single cell, and that the same technique may be used to cover more than one cell.

Whilst the Zachman framework was originally intended as a framework for classifying the design elements for information systems, Sowa and Zachman recognised that its use could be extended to cover other types of design. For instance, the design of a product can be similarly described in terms of framework elements, and also the processes the company uses to design and manufacture the product. The ICT systems design would draw on these definitions. Thus we have a hierarchy of frameworks from product to process to ICT system (Figure 6).

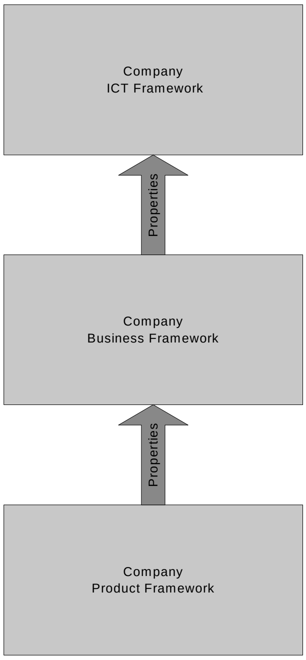

Figure 6 Framework hierarchy

The product framework, when fully populated, is a complete model of the product or services of the company.

The business framework, when fully populated, is a complete model of how the business operates. This includes those aspects concerned with the production of the product, and will infer product properties from the product framework. To these are added models of all of the other aspects of the business, for example finance, commercial, personnel etc. functions.

The ICT framework, when fully populated, is a complete model of the ICT infrastructure of the business. It includes all aspects of the business, and will infer properties from the business framework. To these are added models of all other aspects of ICT within the business, for example network and security management.

6 The UK Electricity Model and the Zachman Framework

The UK electricity model is in no way a template for a fully functional company . For example it does not include any reference to marketing, billing or finance, though all of these would be expected within each of the operating companies.

Let us consider the Zachman framework in the context of an industry model such as that in place for the UK electricity industry. As we saw earlier, in the UK electricity market, the transactions that allow the market to operate must be realised by a number of different types of organisations acting in concert. Since these organisations are independent, there must be a commonly held definition of how these transactions are to be achieved. Thus, these companies' business and ICT (Zachman) frameworks must include these common elements. For each type of organisation, therefore, the industry framework provides a subset of the full framework for that type of organization, these being industry level functions (Figure 7). For example, the industry framework will include "register metering point" because this is required in order for the market to operate, but would not include "check credit rating" as this is entirely internal to the organization.

The industry framework as a whole, therefore, comprises the union of all of the subsets for each type of organisation represented.

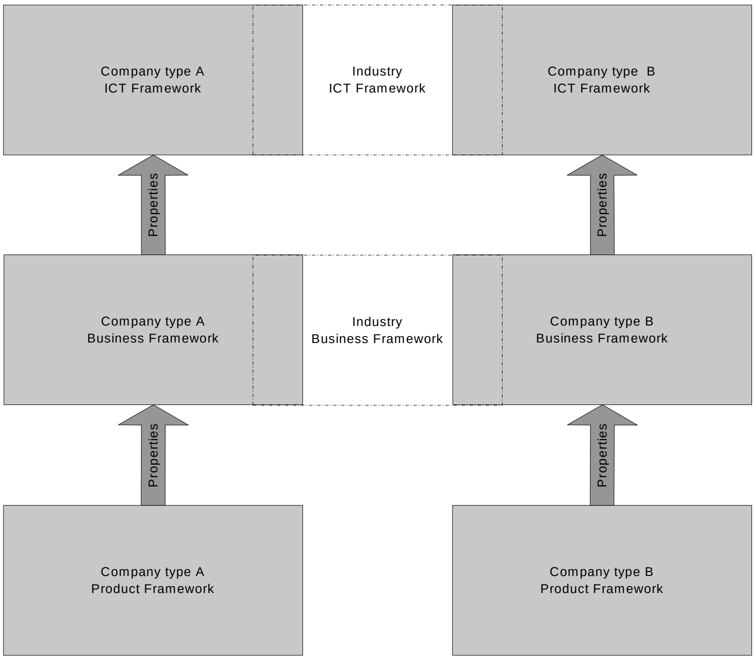

Figure 7 Framework hierarchy showing industry framework

These subsets are not drawn from the operating organisations themselves but are centrally defined for inclusion by these organisations into their day to day businesses.

The question that this study has set out to answer is whether the UK electricity model provides all that is required of it? There are two ways to examine this:

- How well does it populate the Zachman framework? We can analyse the elements of the model and propose which elements of the framework they support and to what extent they provide coverage within these elements
- What are the views of those people who use it? Whilst the above may give a theoretical view, it is ultimately the perceptions of those

who use the model on a day to day basis who determine how successful it is at achieving its job.

Before coming to these, let us set out precisely what is in the UK electricity model and then consider each of the abstractions in turn.

The UK electricity model comprises:

- A set of some 70 dataflow diagrams, known as the “End to End diagrams” (E2Es), including a number of defined paths through the dataflow diagrams for commonly executed transactions known as “the golden threads”
- A set of definitions for the data flows that appear on the E2Es. This is known as the Data Transfer Catalogue (DTC) and defines each data flow in terms of:
  - the content as a hierarchy of data groups, each containing data items
  - the order, cardinality, optionality and conditionality of the groups
  - the order, conditionality and optionality of the data items
- a natural language legal document that sets out all of the obligations with which participating organizations must comply, known as the Master Registration Agreement (MRA)
- natural language guidance documents that explain how all of the above should be interpreted where further explanation has been deemed necessary by the industry as a whole. This is known as the “Working Practices Product Set” (WPPS).

In Table 3 a Zachman framework has been populated with the components of the UK electricity model. This gives a rough and ready view of coverage, but does not give any indication of the effectiveness of the model in those areas that are covered.

Noted that, in general, views 4 and 5 of the framework are not applicable to the electricity model since these are implementation levels and will be determined entirely by each organization independently. The one exception to this is the network abstraction because a data transfer network, complete with interfacing hardware, is provided as part of the market infrastructure.

	A. Data	B. Function	C. Network	D. People	E. Time	F. Motiv- ation	
1. Scope	---	MRA	---	End to End diagra ms	---	---	Industry level
2. Business Model	MPAD (MRA) DTC	MRA WPPS	---	MRA WPPS	MRA WPPS	WPPS	
3. System Model	MPAD (MRA) Data Items (DTC)	End to End diagrams Data flows (DTC)	UFDS	---	---	---	
4. Technology Model	---	---	---	---	---	---	Company (implementation) level
5. Details	---	---	---	---	---	---	
Functioning System	MPAS systems	---	Data Transfer Network	---	---	---	

Table 3 The electricity model mapped onto the Zachman framework

At the aggregate level, it can be seen that the framework is far from fully populated. Even if we consider only columns A-C, which were the abstractions in the original paper (Zachman, 1987) only six of the nine relevant cells are in any way populated.

As noted above, the fact that a cell is populated here does not necessarily mean that the requirements for that part of the framework are fully satisfied.

For example, considering cell A3:

- o there is no model of the entities necessary for the market or their relationships. The MPAD is a single entity definition. The DTC, whilst containing definitions of many data items would require considerable analysis (and additional information) for such to be produced.
- o cell C3 contains only message packaging information.

Also, the MRA and WPPS are natural language documents. Whilst, as we have seen, natural language is capable of describing the concepts targeted by the framework, it is by no means the ideal method for doing so.

When measured against the Zachman framework, therefore, it seems that the UK electricity model is some way from providing a complete picture. It would be expected that those who make use of it would find it particularly weak in the areas of networking, people, timing and motivation, and also lacking in the modelling of data.

So, how well does the model provide coverage of the Zachman framework? In order to answer this, each of the abstractions is now considered in turn.

6.1 Data abstraction

There are elements of data definition in the DTC, MRA and WPPS. The DTC contains by far the greatest contribution here, those by the other two being very limited.

The DTC, however, is wholly focussed on “exchanges of data” – i.e. the packages of data that must be sent from one participant to another in order to accomplish the various business transactions.
The perspective that any participant gains from the DTC is of the data flows that they must support - either sending or receiving. Each of these views is different, comprising only those data items required for a specific business context.

Many data items occur on several data flows, and in different data groups. Thus this view of data is un-normalised.

Few business rules for the data have been defined. For example, many data items are described in the DTC as “optional”, however, in many cases these “optional” data items are mandatory in certain business contexts. Hence, optionality is only partially defined.

In spite of all of the above, the DTC does provide a vast amount of data about the data used in the electricity market, and provides an advanced starting point for the modelling of information about the data. More analysis work would still be needed, however, to produce a complete data model for each of the three perspectives under consideration. There is no high level information (for example a list of entities) to satisfy the “Scope” perspective, and little information at a business level (for example a semantic data model).

The expectation, given the above arguments, is that the electricity model conveys information about data at the three levels as follows:

Outline	Not at all
Detailed (business context)	Somewhat
Detailed (technical context)	Mostly

6.2 Function abstraction

The functions of the retail electricity market are modelled primarily by the End to End diagrams, with further elements described in natural language in the Working Practices and Master Registration Agreement. The End to End diagrams are dataflow diagrams that use a subset of the available symbology. There are no data stores for example. These are unnecessary since, at the industry level, there is no central repository of information – it is held in a distributed fashion across all of the participating organisations and can be accessed only by an exchange of dataflows.

The diagrams contain only data flows and activities. Links to other pages at the same level are achieved by “gateways” and there is a symbol for complex activities, which are further broken down into more primitive activities on other diagrams.

Using the Enterprise Modeller features it is possible to obtain a list for activities for each participant type in a particular context (e.g. supplier in the contexts of gaining or losing a customer). Thus, though the scope perspective is covered, there is still work to do to obtain the information about functions in all contexts.

The Enterprise Modeller provides the capability to navigate around the diagrams, between sibling pages or following the hierarchy. The objects on the diagrams have links to the other elements of the electricity model:

- Dataflows are linked to the DTC
- Each activity has a brief description, but is not fully defined
- Both activities and data flows are linked to working practices, as applicable. The working practices describe recommended methods and standards for specific issues, as identified by the industry.

All of this adds to a reasonable picture of the functions from a business perspective.

No attempt has been made in the electricity model to analyse the business functions to identify common and related functions to produce a system view. This would have to be deduced from the business model described above, and by further detailed analysis of the processes involved.

Therefore, at the three levels under consideration, it is concluded that the electricity model conveys information about functions as follows:

Outline	Mostly
Detailed (business context)	Mostly
Detailed (technical context)	Somewhat

6.3 Network abstraction

All companies that wish to operate in the UK electricity market must be able to support the exchange of information with their counterparts across the industry. An industry communications network (the Data Transfer Network – DTN) has been implemented to facilitate this.

Most such exchanges use the data flows defined in the DTC, as discussed above, and use the DTN as the medium. The use of the DTN is mandatory for some exchanges, but for others alternative means may be used, for example facsimile or e-mail.

No specific representation for the network elements within the model at any level has been identified, except for a definition of the way that data flows must be packaged for transmission across the data transfer network. Companies are referred to the service provider for the DTN for information.

It would be expected, therefore that, for the network abstraction, the electricity model would be rated as follows:

Outline	Not at all
Detailed (business context)	Not at all
Detailed (technical context)	Somewhat

6.4 Organisation abstraction

The market has a complex structure, with more than ten different types of organisation involved. A list of these can be produced from the End to End Diagrams. This would largely satisfy the “outline” perspective for the organisation abstraction.

Each organisation type has specific responsibilities and a set of relationships with other types. As we saw in 6.2, a list of activities (with brief definitions) can be produced from the End to End diagrams for each type of organisation and obligations are defined in the MRA, however there is no *coherent* definition of the responsibilities for each type of participant.

No specific representation of the organisational aspects of the market for the “technical” perspective (e.g. role definitions) has been identified.

It would be expected, therefore that, for the organization abstraction, the electricity model would be rated as follows:

Outline	Mostly
Detailed (business context)	Somewhat
Detailed (technical context)	Not at all

6.5 Time abstraction

The market requires adherence to a number of timing constraints. For example the meter reading on a change of supplier must be available within eight days.

There is no list of events, triggers or cyclic phenomena to satisfy the "outline" perspective.

Though all mandated timings are defined in detail within the MRA and WPPS, they are embedded within the general text and must be sought out, and there are no schedules defined, as would be expected in a business perspective.

No specific representation for the timing aspects of the market within the model at any level has been identified (e.g. a processing structure for cyclic readings).

It would be expected, therefore that, for the timing abstraction, the electricity model would be rated as follows:

Outline	Not at all
Detailed (business context)	Somewhat
Detailed (technical context)	Not at all

6.6 Motivation abstraction

No doubt when the competitive market was being launched there was a list of objectives for it, and this would probably have satisfied the outline perspective of the motivation abstraction. If this was so, it has not been carried forward into the current model.

In the business perspective, no specific representation for the motivation (objectives, reasons etc.) aspects of the market within the model has been identified, but within each working practice there is a background section that would cover this. It has to be noted, however, that the working practices do not refer to the fundamental design of the market but only to those areas that have proved in operation to need clarification or for conventions to be defined. It therefore covers only a subset of the requirement.

No representation to cover the technical perspective (e.g. ends-means analysis) has been identified.

It would be expected, therefore that, for the motivation abstraction, the electricity model would be rated as follows:

Outline	Not at all
Detailed (business context)	Somewhat
Detailed (technical context)	Not at all

6.7 Summary and analysis

Carrying down the results from the above analysis, the effectiveness of the electricity model in populating the cells of the Zachman model are summarised in Table 4.

	A. Data	B. Function	C. Network	D. People	E. Time	F. Motiv-ation	
1. Scope	---	Mostly	---	Mostly	---	---	Industry level
2. Business Model	Some-what	Mostly	---	Some-what	Some-what	Some-what	
3. System Model	Mostly	Some-what	Some-what	---	---	---	
4. Technology Model	---	---	---	---	---	---	Company (implementation) level
5. Details	---	---	---	---	---	---	
Functioning System	---	---	---	---	---	---	

Table 4 Effectiveness of the electricity model

We saw in section 5.4 how there are interdependencies between the cells of the framework. Since a number of cells of the framework are unpopulated and yet others are populated with only "weak" definitions it is worthwhile considering what the implications of this are likely to be. Below are postulated some examples of the consequences that may derive from this. Further investigation would be required to ascertain whether these occur in practice.

6.7.1 Data abstraction

We have seen that there is no complete view of the data required to operate the market. Because of this, there can be no complete view of the responsibilities for the different subsets of the data, which is likely to lead to data duplication, gaps in the data and the problems associated with these – contradictory and missing values, unclear where the source is located, higher costs for data maintenance and retrieval. This is supported by the lack of any entry in cell D3 of the people dimension and the “weak” entries in cells D1 & D2.

6.7.2 Network abstraction

No specific representation of the network elements of the market have been identified, save for the details of message packaging for communication across the data transfer network. This is, perhaps, surprising given the high reliance of the market on data exchange. One could expect, therefore, some confusion in new organisations coming into the market on what communications methods might be used. For example, a small supplier may expect to be able to use telephone, facsimile or e-mail to cover external communications, whereas in fact they would normally be expected to use the data transfer network, which involves significant technological support and additional cost.

6.7.3 Motivation abstraction

The motivation abstraction is almost completely bereft of definition in any perspective. There is therefore little formal definition of why the industry design takes the shape that it does. Such information is particularly useful when changes are being considered. Those involved in change will therefore be reliant on the recollections of those individuals who have been involved with the model for some time, perhaps since the inception of the market. As time passes, this pool of expertise will naturally diminish and the reasons for designing aspects in a particular way will be lost. This will lead to situations where, say, functions are carried out in particular way “because that is the way it has always been done” and the impact analysis for changes will increase. It could become impossible for some aspects to be changed simply because the objectives are not understood and the consequences of getting it wrong would be untenable.

7 The Survey

In the previous section it was suggested where, and how well the electricity model would satisfy the Zachman architectural framework from a theoretical viewpoint.

To test out this hypothesis the perceptions of the users of the electricity model were sought, using a survey. A questionnaire was designed and circulated to a cross section of people within the electricity industry.

7.1 The Questionnaire

The questionnaire had a number of objectives:

- To ascertain what the electricity community sees as the purposes of the electricity model.
- To determine how useful the electricity community perceived each of the six abstractions in the Zachman framework to be.
- To determine how well the electricity community feels that the electricity model covers each of these abstractions in three perspectives.

The questionnaire consisted of several sections:

- An introduction that set out its purpose, broad guidance on how it should be completed and to where it should be returned.

- A number of questions aimed at determining the context of the respondent in terms of the type of company for which they work, their role, their level of comfort with information technology and the degree to which they use the electricity model. This was used later to determine if respondents with different profiles have different perceptions.
- A question seeking the respondents view on how useful each abstraction, with possible answers of *Not at all, Fairly useful, Very useful and Essential*.
- A question seeking the respondent's view on how well the electricity model conveys information for each abstraction for each of the three higher level perspectives (see below for explanation of why this subset of perspectives was chosen). Possible answers were *Not at all, Somewhat, Mostly, Completely, Don't know.*
- General questions aimed at ascertaining the respondents view of the strengths and weaknesses of the electricity model.

E-mail was selected as the distribution method for the questionnaire. This meant that it had to be clear and unambiguous and look easy to complete (Bradburn, 1988, pp103-4). This was achieved as described below.

Zachman defines six abstractions and five perspectives. In the UK electricity industry there is no implementation at the industry level i.e. there are no centrally developed systems. Therefore, design at the implementation levels is determined by each of the participating organisations according to their own standards and preferences. The lowest two perspectives (perspectives 4 & 5 in Zachman's framework) are, therefore, not expected in the industry level design. They still exist, but there is a set of them, comprising the system designs within each organisation. Consequently, only the upper three perspectives have been addressed in this research.

The names of the perspectives proposed by Zachman would be familiar to a system developer but they may be alien to people in non-IT roles. The electricity model is used by a wide cross-section of people in the industry, many of who may not be comfortable with Zachman's terms (nor have they the need to be so). Clearly it would have been unwise, therefore, to use this terminology in seeking their views through a questionnaire. Thus, for the purposes of this research, wording that is felt to be more widely recognisable has been used for the three perspectives referred to above.

These are shown in the table below (Table 5), together with their mapping onto Sowa and Zachman's original perspectives:

Sowa & Zachman perspective	Perspective in this research
Scope	Outline
Business Model	Detailed (business context)
System Model	Detailed (technical context)
Technology Model	Not mapped
Detailed representations	Not mapped

Table 5 Mapping of perspectives

Once the questionnaire was completed in draft form it was tested on a small number of colleagues, as recommended by Orr, D.B. (p326) and revisions made accordingly. This was repeated several times before it was deemed ready for general circulation.

7.2 Circulation of the questionnaire

The questionnaire was circulated to 85 people in around 40 organisations. The aim was to reach a wide cross-section of organisations and roles so that as many perspectives as possible would be obtained. The distribution mechanism was e-mail and the completed questionnaires could be returned either via e-mail or as printed paper. A contact point was given so that respondents could obtain advice on the questions if necessary.

Seventy two responses were received. This was a pleasing completion rate and meant that the recipients must have been highly motivated to respond, regarding the subject matter of importance to them (Bradburn, N.M., 1988, p104). Also, the quality of the responses was excellent, with very few unanswered questions or answered “don’t know”.

7.3 Analysis of the results

The responses on the questionnaires were entered into a statistical analysis package (SPSS V11.0.0).

SPSS was then used to produce graphs for the early, overall analysis.

It may be expected that respondents with different profiles would expect different things from the electricity model and would, perhaps, view the strengths and weaknesses of this model differently.

To identify such potential interaction effects between the independent variables, the ANOVA, analysis of variance technique (ANOVA, 6th February 2003) was employed, again using SPSS.

A significance of around 0.05 or below and/or an “F” value of 2 or above in the ANOVA analysis indicates some pattern of response.

Where possible interactions were uncovered, the corresponding cross-tabulation is then examined so that the detail of the interaction could be seen.

7.4 Profile of respondents

From Figure 8 we can see that just under half (47%) of respondents were from organisations who are operational in the market (supply and distribution). Just over one in five (21%) came into the “governance” category. This represents that part of the industry that is responsible for maintaining the electricity model. Just under one in five (19%) of responses were from people in organisations who provide ICT systems and support based on the electricity model or consultancy. The remaining 13% described themselves as working for organisations that provide a variety of services. From the descriptions provided, nearly all of these would fall under the general title “consultancy”.

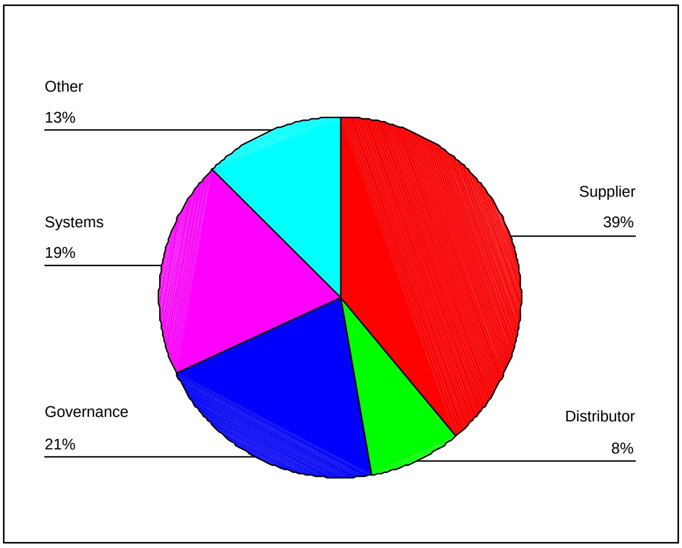

Figure 8 Types of organisation

There was a good spread of individuals’ roles amongst the respondents (Figure 9). About 26% described themselves as business managers, 21% operations, 24% IT staff, and around 17% were directors. The remaining 13% comprised mainly internal and external consultants.

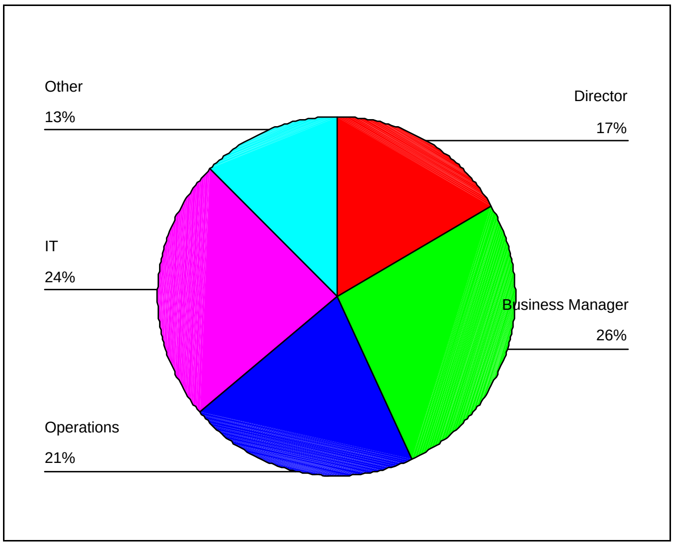

Figure 9 Types of role

The level of IT literacy amongst the respondents was very high, with over half (54%) being comfortable at the technical level and the remainder (46%) being comfortable with IT for business use.

The degree to which the model is used was split equally between those who use it minimally or only fairly frequently, and those who use it very frequently or regard it essential to their role. Some 37% use the model to such an extent that they regard it as essential to their role (Figure 10).

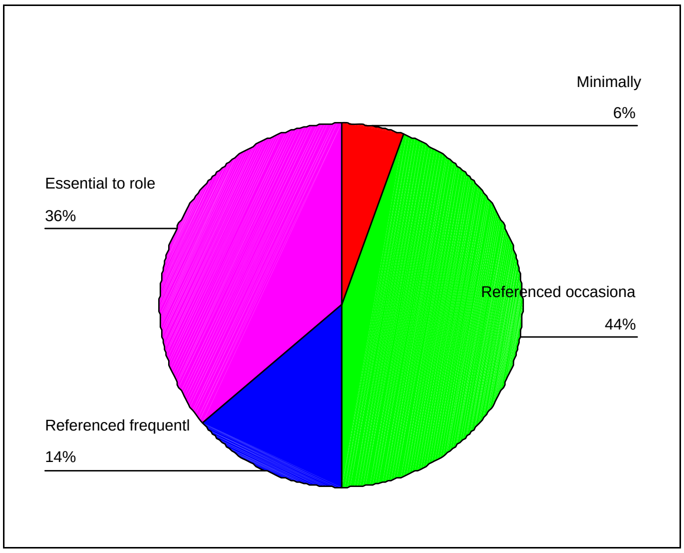

Figure 10 Respondents by extent of use of the model

Those whose role is operational are much more dependent on the model, some two thirds of them regarding it as essential to their role.

7.5 What is required of the electricity model?

Two questions were aimed at finding out the purpose of the electricity model so far as its users are concerned. Clearly, an individual's views could be expected to be dependent on his/her needs for their role.

The first question sought to determine what level of understanding the respondent needed. The majority (57%) of respondents require a detailed understanding from a business perspective (Figure 11), with 31% needing a detailed technical view and the remainder (around 13%) requiring only an outline view.

Almost four out of five (78%) of those who require a detailed technical view use the model frequently or regard the model is essential to their role.

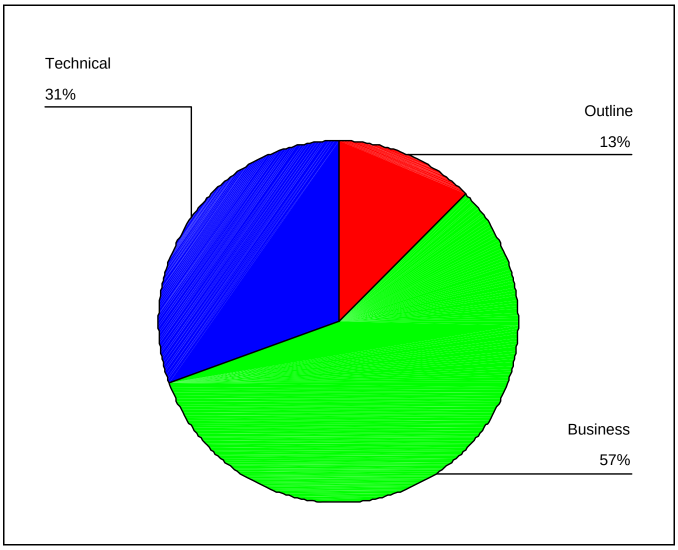

Figure 11 Level of understanding required

Whilst it might have been expected that IT staff would require a more detailed technical understanding than business users, the responses did not bear this out, there being a slight, but statistically insignificant, weighting in this respect.

Martin & McClure (1985a, P9) proposed a number of purposes for using diagramming techniques. Four of these were suggested to the respondents and they were asked to select which ones they felt were appropriate in the electricity market. All four gained substantial support (Figure 12) but clearly, in the view of the respondents, the *Precise communication of the Industry Design* is by far its most important purpose, with 85% selecting this.

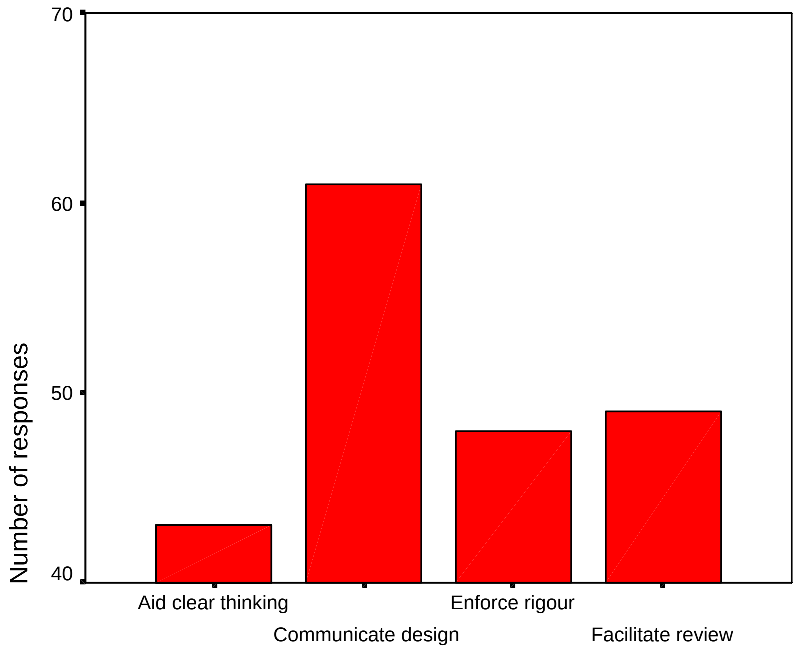

Figure 12 Purposes of the electricity model

Though this is the pattern overall, respondents from Supply companies and from Systems providers felt that the main purpose is as an "aid to clear thinking", with around 80% selecting this.

It is perhaps interesting that facilitation of review did not come out with the top score here. Reviews are the mechanism through which changes to the way the market operates are approved. These tend to be carried out by people who are well versed in the way the market works, expert groups often being convened to discuss a particular issue. These people, therefore, may not need the same precision and detail in the model as those who are using the model as a reference for implementing systems that must adhere to the industry design. Clearly, the above figures indicate that the prime target audience for the model is those who need to understand the design but have not necessarily been involved in its development.

7.6 Usefulness of the abstractions of the Zachman Framework

The Zachman framework includes six abstractions. Each abstraction contains definitions of different aspects of a system. These are Data, Function, Network, People, Timing and Motivation.

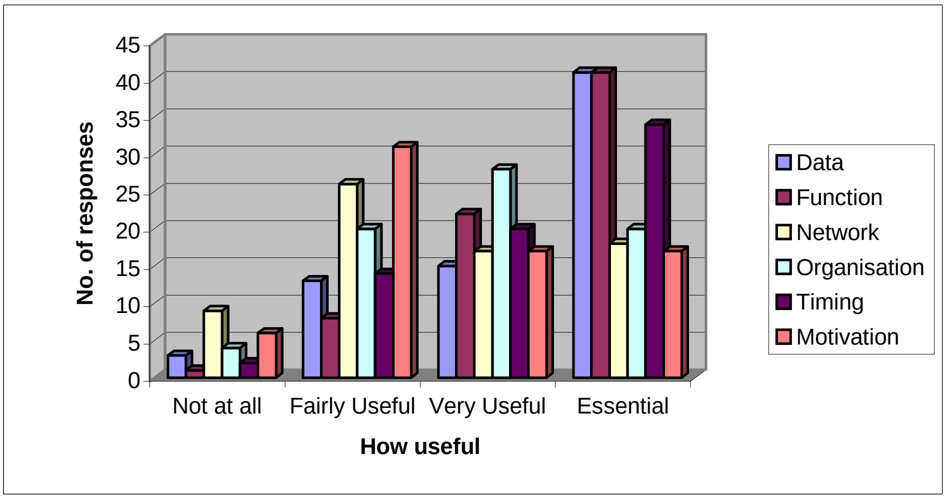

Figure 13 Necessity of the Zachman abstractions

These were discussed in section 5.4 above.

One of the areas of interest for the survey was the relative importance placed on each of the abstractions by the respondents. These are shown in summary form in Figure 13.

The *function* abstraction is seen as the most important, with 87% of respondents rating it as essential or very useful. Similar analyses for the *data* and *timing* abstractions raised 78% of responses in each case, so these are clearly very important too. Also, two thirds of respondents thought the *organisation* abstraction essential or very useful, though in this case the majority resided in the *very useful* rather than *essential* category.

The *network* and *motivation* abstractions ranked somewhere between very useful and fairly useful.

It is worth noting that these results indicate that all of the abstractions are considered worthwhile, though clearly some are considered of greater importance to the industry design than others. This lends validity to an attempt to determine how well the electricity model satisfies each of the abstractions for the top three perspectives of the Zachman framework, as discussed in the next section. Ideally, it will be found that the electricity model supports best those abstractions found to be most important.

At a more detailed level, those who use the model most (and, as we saw above, tend to require a technical understanding) are far more supportive of the data, function, timing and network abstractions than those with other needs. For the other two abstractions, the frequency of use and the level of detail required has no bearing on how useful they are perceived to be.

7.7 How well the electricity model supports the Zachman framework

The questionnaire elicited a score from each respondent for how well the electricity model conveys information in each of the eighteen cells at the top of the Zachman framework, these representing the six abstractions in the three perspectives of scope, business view and system view, as discussed earlier.

7.7.1 Overall observations

It can be seen in Figure 14 that the electricity model covers all 18 abstraction-perspectives to some degree. Indeed, from the responses to the questionnaire, it performs fairly well in even its weakest areas.

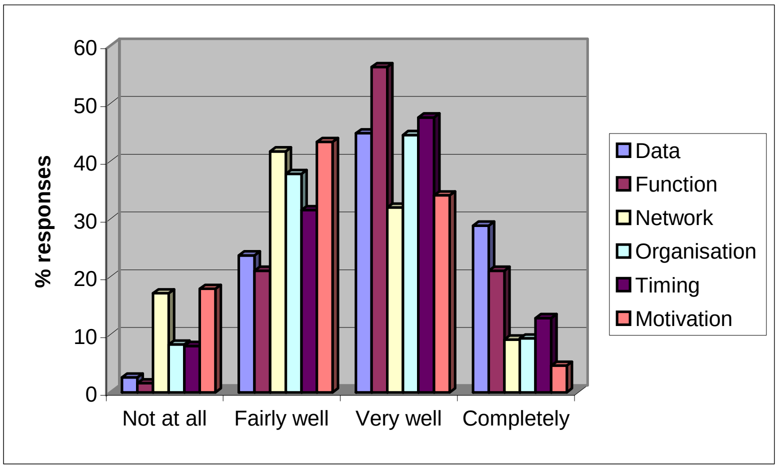

Figure 14 How well the abstractions are covered

The model is strongest in the *Function* abstraction, with 77% of respondents stating that it covers this completely or very well. This is closely followed by the *Data* abstraction with a score of 74%. The *Timing* and *Organisation* abstractions scored 60% and 54% respectively. Interestingly, more respondents thought that the *Data* abstraction is covered completely than for any other abstraction.

Overall, then, the electricity model covers best those abstractions considered most important by the respondents. Perhaps the *Timing* abstraction needs more attention in the model since, though it is considered almost as important as the data abstraction, it is not so well addressed by the model.

Similarly, we can look at how well it performs overall for each *Perspective* (Figure 15).

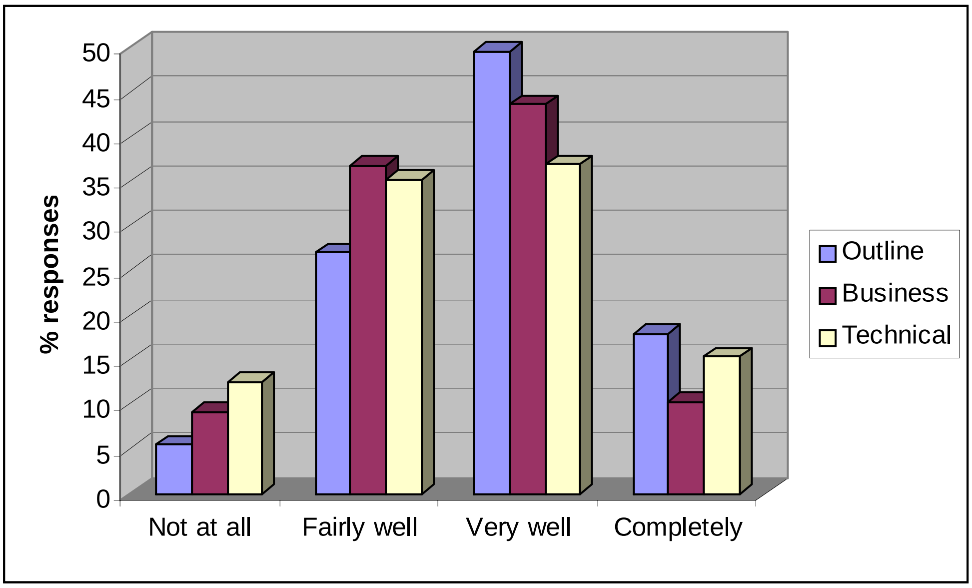

Figure 15 How well the perspectives are covered

From this we can see that, across all six abstractions, the model conveys information best in the outline perspective, with 68% of respondents indicating that it meets this need completely or very well. In contrast, the business and technical perspectives achieved scores of only 54% and 52% respectively. This is in contrast to the indication seen above in Figure 11 that 57% of respondents require information at a detailed business level and 31% at a detailed technical level, whereas only 13% of respondents require the outline perspective.

It would appear, therefore, that in terms of the Zachman perspectives the electricity model is most effective for the least important type of information, and relatively weak for the types of information for which its audience has greatest need.

One can conclude from this that the priorities for any developments should be the business perspective first, followed by the technical perspective.

In Figure 16 the responses for each cell of the Zachman framework have been given a simple weighting – 0 for *Not at All*, 1 for *Somewhat*, 2 for *Mostly* and 3 for *Completely*.

This gives a more holistic view and shows that the electricity model performed:

- best in the Data abstraction in the Outline and Technical perspectives, and in the Function abstraction in the outline perspective
- fairly well in the Outline perspectives of the Timing and Organisation abstractions, in the Business perspectives of the Data and Function abstractions and also in the Technical perspective of the Function abstraction
- in all other areas it is significantly weaker.

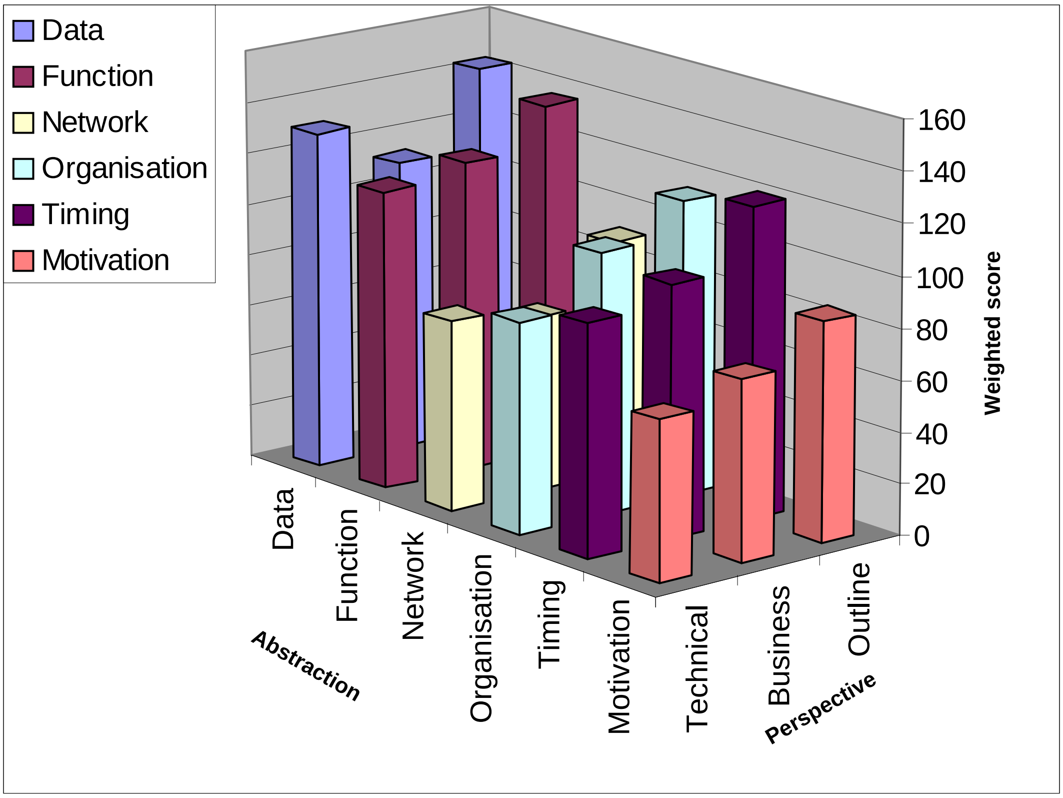

Figure 16 How the electricity model performed in each of the 18 cells of the Zachman framework

> Suppliers are least satisfied with the technical level of information about timing (36%) and organization (26%), compared to levels from 64% to 83% in other groups. Since there are significant timing and organisational constraints that suppliers must adhere to, this is perhaps an area for early attention.

In Table 6 the weighted results from the survey, as described in the previous section, are mapped onto the Zachman framework together with the theoretical predictions from Table 4 in parentheses. Colour coding as been added where:

- green indicates a match between the prediction and the survey result
- amber shows that the survey result was more favourable by one increment than the prediction
- red is used where the prediction and survey result differ by two or more increments

	A. Data	B. Function	C. Network	D. People	E. Time	F. Motiv-ation	
1. Scope	Completely (Not at all)	Completely (Mostly)	Mostly (Not at all)	Mostly	Mostly (Not at all)	Mostly (Not at all)	Industry level
2. Business Model	Mostly (Somewhat)	Mostly	Mostly (Not at all)	Mostly (Somewhat)	Mostly (Somewhat)	Mostly (Somewhat)	
3. System Model	Completely (Mostly)	Mostly (Somewhat)	Mostly (Somewhat)	Mostly (Not at all)	Mostly (Not at all)	Mostly (Not at all)	
4. Technology Model	---	---	---	---	---	---	Company (implementation) level
5. Details	---	---	---	---	---	---	
Functioning System	---	---	---	---	---	---	

Table 6 Survey results mapped onto the Zachman Framework

The results from the ordinal questions in the survey clearly show that the perceptions of the electricity model by those who use it are significantly more favourable in most areas than the theoretical predictions.

This is in contrast to a number of responses to the open questions asked at the end of the questionnaire, some of which are quoted below. The full set of open question responses appears in Appendix D.

- "the documentation set does not provide me with the clear-cut answers I need"

- “people coming to it for the first time always find it difficult to read and understand”
- “it is complex and can be hard to follow”
- “the diagrams are often seen as complex and fiddly”
- “only a few people have the full view of why things are they way they are”
- “unnecessarily confusing, process start and end points are difficult to determine”
- “a full understanding can take several years of high exposure”
- “overly complex”

There are various possible reasons for the discrepancy and these are explored in the following section.

8 Discussion and Conclusions

8.1 Summary

This paper has presented the background to de-regulation of the electricity industry in Great Britain with particular reference to the retail sector. As the market was opened up to the smaller, but far more populous, consumer there was a need for more sophistication in the way the market operates. This brought with it a requirement to model the market processes for implementation by all participating organisations.

The historical development of ICT modelling techniques and taxonomies was examined and the Zachman framework was selected as a classification mechanism for the electricity model.

The electricity model was mapped onto the Zachman framework and its strengths and weaknesses against the top three perspectives of the framework were analysed and ratings postulated from a theoretical standpoint.

The opinions of those in the industry who use the electricity model were elicited by means of a survey, subjecting the results to statistical analysis. From this it was possible to determine the views of those who use the electricity model on:

- the purposes of the electricity model
- the usefulness of the Zachman abstractions
- the effectiveness of the electricity model in each of the 18 cells at the top of the Zachman framework. This was then compared to the theoretical values discussed above.

It is clear that the users of the electricity model see it as serving several purposes, the main one being "*Precise communication of the industry design*". They have a great deal of satisfaction with the model in overall terms. They believe it to be strongest in those abstractions that they consider most important, these being the data, function and timing abstractions. This is not true in the perspective dimension, however, where the model is strongest in the least used perspective.

Whilst there was *some* correspondence between the theoretical assessment and the results of the survey, there was an unexpectedly high level of satisfaction in areas where, from a theoretical viewpoint, the electricity model appears to be weak. The level of satisfaction varied considerably in some cells of the framework for different subgroups of users.

8.2 Critique

This has been an exploratory study of the way modelling techniques are applied in the electricity industry in Great Britain. Compromises have had to be made in order that it could be completed within the available timescale, and the resource and monetary constraints. The following are offered as suggestions to be taken into consideration for any such work.

8.2.1 Passive approach

The survey in this study was conducted passively. That is to say that questionnaires were sent out to potential respondents who then completed them in isolation. Since the concepts involved are fairly complex it is likely that not all of them were fully understood by all of the respondents. Though contact details were provided for further explanation no one made use of this. Responses would therefore have been based on the individual's own experience and knowledge alone.

An alternative approach would have been to elicit answers by interview. By this means concepts and possibilities could have been explained to individuals and any questions answered. Responses would then, perhaps, have related more closely to current theory.

This approach would have been far more demanding, in terms of time and expense, because of the geographical spread of the respondents and for this reason was not practical for this study.

8.2.2 Limitations in the range of responses

In an attempt to relate possible responses to concepts that could be easily explained, the range of answers for the effectiveness of the electricity model was limited to four. There may be a tendency among respondents to express greater satisfaction than they really feel (Moore, 1987, p18), and if this has occurred with such a limited range of possible responses, it would have had a significant effect in lifting the overall satisfaction rating and concentrated responses in the upper part of the range. This is exemplified by Table 6 where 15 out of 18 of the cells have a value of “mostly”, and where a shift of only one point on average would have resulted in a quite different picture. In any subsequent similar study, a wider range of response options is recommended.

8.2.3 Demographics of the respondents

Notwithstanding the recursive nature of the Zachman framework, whereby it is theoretically possible to use it to describe products and organisations, the concepts involved in this study are mainly aimed at providing a framework for the deployment of ICT systems. Clearly, these concepts would be best understood by those working in IT functions. Even here, it is likely that most staff are not up to date on current research. Since only 24% of respondents described themselves as within the IT function it is likely that the majority of respondents had not been exposed to current modelling techniques. They would therefore be by no means fully aware what they could reasonably expect to be provided within a model. As in section 8.2.1, respondents’ expectations would be coloured by their, perhaps, limited exposure to modelling techniques, and their responses would tend to be more favourable as a result.

8.3 Recommendations for future work

Today modelling is endemic in all disciplines. This is nowhere more true than in the ICT field. Modelling techniques in the ICT industry have evolved over several decades and continue to do so. Some of these techniques have been used to model the electricity industry in Great Britain. To be most beneficial, these techniques need to fit together to give a complete, coherent picture. This requires a taxonomy. One such taxonomy is the Zachman framework on which this study has largely been based. Though the paper was completed some ten years ago, it still represents the latest thinking.

This study has found discrepancies between the *theory* of modelling and *real life perceptions*. Further studies will be required to investigate these in more detail to try to explain and close the gap.

It is recommended that one such study would concentrate on a single abstraction and use an action research approach. The data abstraction would be the best abstraction to begin with because of the ubiquitous position that data modelling enjoys (Hitchman S., 1997, p181). A model of the data aspects of the electricity retail market would result, and any shift in opinion as to what is required in the data abstraction could be ascertained. A similar approach could then be applied to the other abstractions in succession.

Based on the success of the above, sufficient interest may be generated to take the research into the operating companies within the electricity market, where the “lower” levels of the Zachman model could also be investigated. From here, the recursive nature of the Zachman model could be researched by investigating the practicality of modelling products and a functioning organisation.

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9.3 Software applications

Excel 2000 from Microsoft used for production of graphics

Publisher from Microsoft used for final presentation of this report

SPSS v11.0.0 from SPSS Inc. used for statistical analysis of the results of the survey

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10 Glossary of terms

The following terms, which may be unfamiliar to the reader, are used in this document.

Term	Meaning
ANOVA	Analysis of variance. A statistical technique for uncovering the main and interaction effects of categorical independent variables (called "factors") on an interval dependent variable
CASE	Computer Assisted Software Engineering
CEGB	Central Electricity Generating Board. The organisation that was responsible for all electricity generation in the UK until 1989
DTC	The Data Transfer Catalogue. A formalised textual document in which all of the formal flows of data on the E2Es are defined

DTN	Data transfer network. The electronic network in place for the interchange of data flows between organisations operating in the electricity market
E2Es, End to End diagrams	A series of dataflow diagrams that describe the inter-operation of the different types of organisation in the electricity retail market
ICT	Information and communications technology
Metering agent	An organisation that has responsibility for one of a number of aspects of electricity metering including meter operation (MO), data collection, (DC) and Data Aggregation (DA)
Metering Point	The point within a premise at which consumption is, or is intended to be, measured
MRA	Master registration agreement. A legal document to which all electricity supply and distribution companies must accede in order to operate in the electricity market in England and Wales. It sets out the legal obligations

	placed on these companies so far as registration of metering points is concerned.
REC (also PES)	Regional electricity company. An organisation that, until 1989, was responsible for all aspects of electricity distribution and supply in a defined geographical area
Registration	The record of the date from which a supplier took responsibility for the supply of electricity to a metering point
WPPS	The Working Practices Product Set. A series of natural language documents, each of which provides further explanation and interpretation of how a specific scenario can or should be handled
UFDS	User File Design Specification. The definition of how data flows are packaged for transmission across the DTN (data transfer network)
UK Electricity Model	The business protocols to which any company wishing to operate in the UK electricity retail market must comply

Appendix A – The Questionnaire

Appendix B – Survey Responses

Appendix C - Cross Tabulations and ANOVA analyses

Appendix D Responses to open questions

No	Comment
1.	Strengths: Well published and documented strong formal definitions of process and data Weaknesses: Although well published the interpretation hasn't guided technology adoption; hence the presence of legacy systems / technology, and a fragmented approach to implementing the model (no Industry Data Manager model for example). This makes it difficult to make effective change as an IT Services provider.
2.	The main documents I use are the DTC and Working Practices. I occasionally use the end-to-end diagrams and MRA. On the whole I find them useful and the DTC is very comprehensive regarding dataflow structure and contents. However I often find that reading some WPs there are ambiguities and in order to get a clear picture I have to contact Gemserv for advise. As I deal with Suppliers on a daily basis in relation to issues, which they experience in the 'real world', I often find that the documentation does not provide me with the clear-cut answers I need. As I deal with software which has to be based on specific rules this can cause problems. I also have to ensure that any changes made to the software complies with the industry standards, but sometimes reading the documentation fails to provide clear statements.
3.	The Electricity Model has been instrumental in the relative success of the deregulation of the electricity supply market in the UK. Compared with other markets in the world, competition in the supply market is open and dynamic. There have been problems of course, but many of these stem from areas which lie outside of the targeted scope of the model. That's not to say that the model can't be improved. For example, I would like to see data quality issues addressed in the model, although improvements here may require new centralized services to be made available to the participants.
4.	Strengths: • Single, industry-wide definition • Implementation using the Enterprise Modeler product • Consistent point of reference for industry processes • In the case of the DTC, a single data dictionary, described in terms independent of the actual file formats used Weaknesses: • The Enterprise Modeler product can not be used directly to implement or drive business processes • More extensive validation of data, enforced upon all participants, would improve the data quality issues which currently cause so many problems
5.	The electronic End-to-End diagrams are a big improvement on the old diagrams as it is now much easier to find what you are looking for, e.g. all actions that could cause a particular flow to be output. I would see the Golden Threads as a definite strength as these reflect real business processes that companies within the electricity retail industry and those supplying software to them need to follow. The weakness of these diagrams is that they do not include timescales. From my experience, the DTC is the part of the electricity model, which receives the widest circulation but people coming to it for the first time always find it difficult to read and understand. It certainly takes a little while to become comfortable with its style and the way it describes the data.

6.	The Model does map out in a good clear manner the roles of each party during a business process using swim lanes e.g Supplier, Meter Operator or Distributor. I would say that most of the Main Market scenarios are covered within the Model. I feel that a Change of Tenancy (within NHH) although Supplier driven, would have been a very useful test to carry out, since during the execution of MSA testing this allows the supplier to test their business process and the ability of there software. Having worked within the electricity supply industry it is not until within the live environment can the area of Change of Tenancy produce possible problems.
7.	Strengths: • From a qualification point of view the model alleviates the need to produce graphical representations of the electricity market for prospective entrant to the market. • From a qualification point of view the model can be deemed to be correct as the qualification body produces it. Weaknesses: • The model has been developed from a MRASCo viewpoint and makes little or no reference to BSCP obligations. The model has not been released at the same time as new versions of the retail design.
8.	Strengths: • The model provides coherence between the E2E diagrams, Working Practices and MRA obligations in a single application. • From a qualification point of view the model alleviates the need to produce graphical representations of the electricity market for prospective entrant to the market. • From a qualification point of view the model can be deemed to be correct as the qualification body produces it. • MRASCo maintains the model so there is little overhead on signatories updating their own (diagrammatic) business models when a new version of products is released. Weaknesses: • The model has been developed from a MRASCo viewpoint and makes little or no reference to BSCP obligations. • From a technical point of view the “refresh” function is required too often. • The sequencing of events in the live market is not always as defined in the model. For example receipt of meter technical detail on CoS is not always dependant upon sending the D0148 to the meter operator. • The model has not been released at the same time as new versions of the retail design. The market scenario qualification tests should be shown as “Golden Threads”.
9.	The model was very good if you had a background in the electricity industry. Customers who are new entrant struggle with the terms and the business context of the model.
10.	Its recognition as the model. I am particularly impressed with the DTC and refer to it regularly.
11.	It has been a while since I used the model in detail but at that time there were one or two inconsistencies with the end to end diagrams and they were not exactly intuitive for the first time user. However, once the conventions were learnt the difficulties in use were reduced and the amount of information conveyed was extensive. The DTC is an essential document for systems designers operating within the UK electricity retail space. However, the set lacks an overall unifying document which describes the purpose of the set and defines boundaries of scope in a meaningful way. Perhaps the best summary would be to say that the documents describe very effectively the market to those who already know it but they represent a significant barrier to new entrants.

12.	The only parts of the Electricity Model that I really use are the DTC and the MRA. I very rarely look at the E2E diagrams or the working practices. As far as the DTC and MRA are concerned however these are vital documents to my day-to-day work. The DTC provides a standard and structured way in which data is transferred between parties. The format of the files is consistent and understood by all parties using it, and similar structures have been used for the new dataflows introduced under NETA. The only weakness that I am aware of is the fact that there are two different DTC file types – user file format and pool transfer file format – and these cause confusion in terms of the structures of file headers and footers. A single format would be preferable. The MRA provides the business context in which our software systems should be developed. As such it gives us the validation rules which must apply when receiving many of the DTC flows. Again it is an essential document on a day-to-day basis. Any weaknesses that are identified in the MRA are resolved through use of MRA change proposals, therefore I do not believe that there are any that cause me a problem.
13.	Strengths: • Centrally co-ordinated design service • Formalisation or where possible, elimination of custom and practice • Effective administration of change control Weaknesses: • Can be difficult to cross reference model components to a business process, particularly in change control, where CP's are related to specific elements of the Design Set. End to End diagrams are overly complex and rely on third party software to support their effective use in analysis and design (noted however that Golden Threads are now giving a more concise representation of the key inter-operational processes Change Controls: Improve the cross-referencing of change control across the Design Set. For example, where a CP is introduced for a Working Practice, note the cross refs to the Golden Thread diagrams where applicable.
14.	It is not easy for a participant in a particular role to find out what is relevant to them. It would be helpful to have a subset of information that applies to each role eg the threads that they need to follow and MRA clauses. This is important to new suppliers and distributors to gain an understanding of what is required. These users would also appreciate a checklist across all governing bodies as to what they have to do to enter the market. The numbering system in the E2E diagrams is difficult to understand, especially with the duplication across pages. The Enterprise Modeller tool is too difficult to use and often help notes are missing or not updated.
15.	Strengths - It gives clear guidance on governance of the electricity baseline and sets out well the contractual relationship between parties. FYI – In the gas market there is currently no Retail governance arrangements. At the beginning of 2002 models for governance were evaluated and the current electricity model was selected in preference to models for other areas e.g. telecoms, Elexon. Weaknesses Bi-lateral arrangements have sprung up between parties which put a different slant on the rules in the MRA, this causes confusion and dilutes benefits of the current governance arrangements.
16.	The main weakness is that the components of the model have differing levels of governance and participants seem to miss-understand this.

	Key amongst the strengths is that it is wide ranging in its coverage and accessible to all.
17.	The Electricity model is comprehensive and covers all functionality of the electricity industry, but it is complex and can be hard to follow.
18.	Strengths are as an analytical tool for the processes. Weaknesses are that it can be taken too literally, and ultimately become prescriptive. From the view of operational staff, the diagrams are often seen as complex and 'fiddly'.
19.	A necessary evil.
20.	As for strengths, there is a good level of detail in certain elements of the Electricity Model. This is essential, especially for new entrants who are trying to make sense of an industry where many different organizations are fulfilling a variety of roles within the market. In particular, the E2E Diagrams and the DTC provide much detailed information. The different parts of the Model generally "hang together" pretty well and through a system of fairly effective change management, changes to one element of the Model which could impact another have been carried through to ensure overall consistency. As for weaknesses, it does present a little difficulty that elements of the Model are not binding. New entrants building their systems, for example, around a particular Working Practice on the understanding that other market participants will behave in a certain way can run into problems in live operation when this turns out not to be the case. Even regarding elements of the model which are intended to be binding, there are a number of market participants who do not adhere to all of the rules all of the time. While this is not a weakness of the Model itself, there doesn't seem to be any official recognition of the deviations from the Model which are known and more or less accepted, albeit sometimes grudgingly, by other participants. New participants must rely on anecdotal evidence as to what to prepare themselves for in the live market in certain particular instances. In other words, the Model does a fairly good job of mapping out how the market is meant to work, but the problem is that market participants don't always follow the map! The only other perceived weakness in my opinion is that there are certain other documents/data in the industry which rest outside the definition of the Model and are under the governance of another body (ELEXON) but which are important to any existing or potential market participant in gaining an understanding of their obligations and the data used in the market. Market Domain Data and the defined service levels for agents come to mind. The Model is therefore somewhat incomplete, as in order to get the full view of one's obligations and the data required to operate in the market, a participant must piece together the Model with this extra material.
21.	Peter, difficult for me since as you know we have shelved our program at the moment. Hence quite a few blank reponsesl
22.	As a minimal user, I thought one of the great strengths was the simplicity in use of the model. Most of my use was of the "Golden Threads", which I found very easy to understand. I liked the links through to the base products (e.g the MRA) . I probably did not use it enough to identify any real weaknesses and I certainly only scratched the surface of the functionality. I'm afraid that, as stated above, my usage was minimal and, not having used it for some time, I can only remember the very specific parts that I used most (e.g. CoS in Golden Threads). Therefore, no real other comments.
23.	The major strength of the electricity model is that at a detail technical level the ins/outs of the complex environment are well specified and detailed. This enables systems to be developed to quite a tight specification. This is clearly a reflection of the nature of the development activity that has gone on over the past 5 – 8 years. This does however have a major drawback in that the language, terminology and business purpose for some of the activities is unclear. It is the case that people operating at a detail technical level would have difficulty understanding the purpose and objective of what they are doing. This enforces a closed shop, such that only a few people who have been within the industry since it began down this particular path, have the full top to bottom view of

	why things are the way they are. The consequence of this is obvious – as these people leave the industry the knowledge of the model goes to and therefore changes and developments lose their focus. Now I am not suggesting that we are in this position yet, merely that from where I sit we're probably not far off, as the gene pool gets smaller.
24.	From an Operational point of view it is not always possible to refer directly to the model in a timely fashion and I feel it is more appropriate for project/business processing documentation.
25.	The main weakness of the current process is the lack of information to users and administrators, this is caused by the failure of communication along business processes. The only strength is the conformity between each pes, supplier and distributor on the information standard, which has been set via the DTC.
26.	The Model provides a solid base from which all Parties can work from. However, especially in the case of the MRA, we have seen over the years that certain aspects of it are open to interpretation and abuse.
27.	My comments are provided in respect of the various components of the Electricity Model as follows: MRA The MRA is written using typical legal jargon and is not easily understood by non-legal Industry personnel. A 'plain English' version should be maintained for those who need to refer to it to comply with defined 'operational' rules e.g. the Objection processes. DTC The DTC is written very much from a 'technical' perspective and does not put things into business context. For example, many data items are defined as 'optional' because (on rare occasions) the data is sometimes not required. However, system designers & unfamiliar users tend to think this is an indication that the data is usually never required. In addition, the Data Item descriptions are often poor and provide insufficient information of what the item is and under what circumstances it might be used. There are also far too many data flows all doing very similar things. E-2-E Diagrams These are unnecessarily confusing, possibly because of the modeling tool used to produce them. Process start points and end points are difficult to determine. The reference number protocols (D & F numbers) are confusing Navigation around the diagrams is very difficult indeed. The electricity design baseline is unnecessarily complex and the documents that support it are therefore also complex. The entire baseline should be re-engineered in the light of experience gained since market opening. There is mounting anecdotal evidence that data used in the marketplace is increasingly unreliable and that there are inconsistent views amongst various market roles regarding the current actual value of certain key data fields e.g. metering energisation status and meter technical details In addition, more could be done to help the understanding of people who are unfamiliar with the current processes. If the processes were simpler and the documentation better constructed, more organisations would probably enter the market and a more vibrant competitive market would result.
28.	It is a readily available industry model 'on your desktop'. It can easily be referenced by those wishing to use it. Importantly someone else keeps it up to date! It isn't really easy to use. I can't really define what it is, but I can best sum it up by saying that I get the feeling that I don't ever feel any enthusiasm for opening it. It certainly isn't enjoyable to use for example. I think there is probably better software out there that could achieve the job.

29.	The increasing number of Golden Threads is making the model much more useful than the activity based diagrams. It enables clear communication with staff at all levels about what should be happening during a process. What is missing, because it comes under Elexon's governance, are the timing of events that are contained with the BSCPs. Inclusion of these would again add another level of benefit to the model.
30.	The MRASCo diagrams are very useful for providing information on what the technical possibilities are within the industry. However because they are generic across the industry they obviously do not contain any tailoring for our particular business so although they are good for providing technically accurate information they do not take into account our internal processes and system requirements which can make them complicated for business users. The MRASCo end 2 end diagrams have been translated into business process diagrams that are supported and maintained by our design section therefore it is very rare that I as a business user would refer to the actual MRASCO end 2 ends.
31.	Strengths Used throughout the industry thereby ensures consistency and compliance Clearly documents vital information in one publication i.e. the MRA, DTC Excellent tools for communicating information/data Weaknesses Little flexibility i.e. compliance is a must Lengthy lead in time for any agreed change Rather bureaucratic
32.	The strength of the model lies in the validity and universal acceptance of governance. The fact that all players agree to abide by such governance and are correspondingly accountable, makes them conducive to the benefits to all of a commonly accepted approach. Players are therefore given confidence to invest time and money in systems and processes which support the model, on the understanding that it is unlikely that a sweeping change will be introduced without consultation. In essence, the governance allows freedoms to operate in the same way that The Highway Code allows freedom to drive. The weakness of the model lies in its complexity and the fact that, without expert help, a full understanding of all aspects can take several years of high exposure to the processes and institutions involved.
33.	Weaknesses – a) to understand a process outlined by the model you need to reference a number of separate documents which do not contain much cross-referencing (eg DTC Flow x may relate to WP y, but nowhere within the documents does it tell you this). b) No clearly defined timelines, or interdependencies, within the model which leave the model open to interpretation c) Change control process on the documents does not always occur simultaneously, eg changes may be introduced to a DTC flow but corresponding WP changes do not necessarily occur Strengths – Contains a comprehensive and reasonably easily readable definition of the data, although the optionality within the dataflows often leads to confusion and mis-interpretation
34.	Strengths: Reasonably well defined with few ambiguities Good control over changes Weaknesses: Overly complex Some processes do not work well in practice To much inertia to allow required change

35.	Strength: • As in all requirements for interoperability there is a need for a set of standards which are understood and applied equally by those participating. The better the definition and clarity of understanding the more effective the standards are likely to be in influencing and aiding smooth interoperations. The current model as stated meets a basic set of common criteria which in some cases may be subject to bi-lateral agreements outside of the model and therefore is open to interpretation and application in different ways. However, it is better than no standard. The model as described is an attempt to combine the often conflicting requirements of providing a theoretically clinical set of standards with the need to be commercially viable in application. Weakness: • The design of the current model has been influenced by commercial considerations which have diluted its effectiveness as exemplified by the need for WPs. Unambiguous prescription of technical standards, timing and sequence requirements should be the benchmark for flow interoperation. The means of creating, applying and processing these flows should not be prescribed. The current model is a mish mash of both. It is more complex than necessary, it could be simplified without loss of precision
36.	I think that one of the biggest issues with the electricity model is the inherent complexity of the way the market has been established. Once experience and understanding has been gained, I think that the information available probably covers everything needed to manage business processes and systems for operating. However, it is quite daunting the first time you are involved in the accreditation of systems and processes. From personal experience, it would have been extremely difficult to deliver Project Cheetah if we hadn't had a wealth of industry testing expertise within the project team. However, having come through the learning curve myself, I now feel I could advise other projects of what needs to be covered and how best to manage the design and testing of the systems and processes.
37.	It's relatively early days for me in finding my way around the electricity model, so I'm not sure how representative my views are ?
38.	Strengths: Defines the business practice which allows for good industry communication. Define dataflow format which ensure industry consistency. Weakness: Limited information on guidelines for waiting times for return flows (i.e timing of the D0086 / D0019's) which result is confusion for timings of critical flows and tensions between industry partners. The Maps are invariably not very clear which could result in critical dataflows being missed as part of Business Processes.
39.	The weakness is commercial – one 'minor' software provider has 'lock in' and programmers not easily found on the open market.
40.	Complexity is both the strength and the weakness of the model.
41.	Main weakness is lack of visibility. The model provided the design for the introduction of the deregulated market in 1998 in a co-ordinated fashion, but since then the model seems to only have visibility to new entrants. Many of the business and technical staff who worked on the 1998 projects have since moved on and new staff have moved in. The model does not seem to occupy a pivotal position in how the electricity market operates anymore. Introduction of change (certainly by suppliers) is not readily controlled or even made visible by the model owners or the suppliers. Hence there can be no certainty that existing suppliers continue to adhere to the model design. Lack of desire by market participants to continue the model. Strengths are the converse of the above. The model does provide a framework for new

	entrants to begin trading. There is a change procedure, which participants do adhere to(sometimes).
42.	I've never been a regular user of the model and have only had cause to reference it on a handful of occasions. I did find the paper version of the model particularly unwieldy due to it's size and complex nature, although I think this is an understandable flaw considering the size and complexity of the processes and interactions that the model represents. I have had the opportunity to view the electronic version of the model (including 'golden threads') using 'Enterprise Modeller' and found this to be much more user friendly.
43.	As with any development the model takes advantage of serving the interest of a number of parties and fulfilling a role in how to do the functions at a technical level and a business level. It also stands on its own to be a point of reference for all parties concerned when disputes and conflicts of interest arise and thus, on this level, is also used for defining points of political principle. Its weakest lies in its foundations. The solution has been based on a fixed solution and additions or changes are not easy to implement (costly or impractical) from either the MRASCo (GEMSERV) perspective or the competitive electricity companies. It contains multiply data flows that hold the same or similar information and could be streamlined. It has processes that could be combined to simplify them. It could also benefit from being modularized so that changes and interface links could be carried out with the minimum disruption.
44.	It does attempt to draw together the different elements of the retail market, ie focuses the governance and work. In that sense it attempts to bring transparency to the complexities of the market. It would be useful to compile an equivalent in Gas and then look for harmonization opportunities
45.	The key strengths of the model is that the golden threads display the entire process on one screen (even though small !) which is a big improvement to the old mechanism where e.g. the COS process spanned 20 pages +. Ideally all the major processes should be modelled in this way as only the COS & NCD processes are currently detailed. I was involved in the industry group looking at this system at the beginning of its creation & fed back a lot of comments to Ian Hickinbotham / Phil Nuttridge (both personally & from a corporate perspective) at the time. There are still issues with aesthetic presentation in some ways – e.g. text size on overall processes at times is impossible to read, & I believe it is still very difficult to print out as a golden thread. Unfortunately nowadays I don't use it that much at all compared to when I managed the change processes for what was Yorkshire electricity so I feel it would be unfair to comment too much now. If it's any help, I have attached the original comments I made…
46.	Strengths: Provides a framework for designing processes and system requirements at functional level. Identifies responsibilities and provides a useful reference check to resolve disputes about who should do what Weaknesses Is only available on internet to people with MRASCo password. In some ways it tries to do too much: Is it a process model or a data model? Doesn't cross reference to other industry documents BSC, BSCPs , service lines MRA, DuoSAa. Licences Simplified data modelsfor different parties would be useful.
47.	Strengths: Electronic E2E application launched in 2001 is easy to use in comparison with the numerous old paper end to end maps

	Useful for seeing which processes are likely to be affected to changes to a D-flow or data item. Weaknesses: To complex to be easily understood/practically used in a paper form. Electronic E2E application, could have much better GUI given time and investment. Possibly a web based front end with better links. For example, clicking on an MRA obligation should link to another web page rather than opening the MRA as a separate Word document, Could better show interfaces between MRASCo activities and BSC (Elexon) activities. Could shows routes through the E2E maps for all processes not just Golden threads. On a Golden thread for change of supplier, does not allow old and new suppliers to be shown in different colours. This somewhat detracts from the usefulness. Other: Model is complex, however I think that is just a reflection of the market it is trying to represent! Not enough communication about the existence of the model, or national design in general within many operational businesses. More detailed training courses on the model and national design would be useful. Seems that it is largely confined to use in Supply Design Authorities, rather than as a tool to educate employees about the complexities of the market. Would be useful to see change history and impact of future changes within the model. Incorporating more interactive versions of the DTC, Working Practice Product Set and MRA into the electronic model would be very useful. Development of the 'compliance tables' produced by MRASCo/Elexon and representation of these in the model would also be useful, as would incorporation of qualification scripts.
48.	Strengths: A robust framework of rules and guidelines that all can follow, to achieve interoperability. Mostly clear & easy to follow. A clear source of answers to most questions about how the electricity retail market fits together, e.g. “What should we receive if we send a D0142 to Meter operator?” Electronic access to End to End [E2E] diagrams, with navigation aids & cross-refs a great enhancement. “Golden thread” diagrams clear and “user-friendly” for common processes. The electricity model gives a much better steer, and more certainty, than the gas model, which started from a position of laissez-faire. Weaknesses: Paper versions of End to End diagrams require a good deal of knowledge of how they fit together. Arguably over-prescriptive in places (but this IS arguable). The retail electricity market does not work perfectly, but it would be in a far worse mess without the underlying model. It could be argued that the competitive framework that was created for 1998 had no right to work as well as it does; this must be due in no small measure to the model, and the way it was developed and implemented.
49.	Strengths – detail held in DTC, and Data Item Catalogue. All flows detailed in one ‘document’ (compared, for instance, to the gas industry). Weaknesses – lack of cross reference, e.g. which flows contain item ‘x’. Detail of header

	and footer not held in DTC; difficult to find. E2E diagrams difficult to navigate. Instances where the same item has two 'identities', e.g. MPAN Core & Metering System ID. Different file formats (i.e. 'Pool' and 'MRA')
50.	The Electricity model provides a structure which given the number of players and the complexity of the arrangements is essential for making the market work. It is an essential reference to small suppliers for handling events which do not happen on a day to day basis. It's biggest weakness is its ability to change with the market. Although change request can be raised, these only happen when the process is seriously hindering a party's ability to work. No one has responsibility (or the time) to make the many small changes that would improve the efficiency of the process. It also constrains how parties work with each other, with bi-lateral working arrangements technically being in breech of the rules.
51.	Strengths: It allows the separate market roles to understand whet it expects to receive/send, and when in a process. I may be used to enforce compliance. Weakness: The model is what is says, a 'model'. Unfortunately as we know people do not adhere to the model. (Not exactly what you are asking!) It does not allow things to happen out of step, very easily.
52.	May be too complicated for the user as there are far to many paths and routes available to the user.
53.	The strength of the electricity model is that it provides governance at an operational level and is more focussed than reliance on the licenses. The product set has evolved over time and in particular the End to End Diagrams are now much more useful. The contrast with the Gas Model is stark and I think that the evolution of a governance model along the lines employed in the electricity industry is a reasonable indicator of the relevance of the Electricity Model to utility market inter-operation. The major weakness of the model lies in the demarcation of responsibility between the retail business (under the governance of the MRA) and the settlement business (under the governance of the BSC). Whilst the processes do not always overlap, the model is compromised in certain areas due to the inability to incorporate a full set of market obligations. In my view the Electricity Model has been an asset to an evolving industry and, despite some flaws, has enabled the inter-operation of the market to be better understood by those involved. The development of a similar model in the Gas Industry does give future scope for harmonisation and, with the importance of Dual Fuel marketing, it is important for the industry to seize these opportunities
54.	Weaknesses: Lack of business co-ordination and connection between responsibilities and activities of the individual organisations (Gemserv, Elexon & OFGEM), purpose, objectives and motivation. A lack of consistency for accreditation of suppliers compared to agents in the supplier hub. Failure to recognise the importance of the Distribution Business role and the part they play in the Electricity Model, moreover the impact and resolution of energy disputes. Strengths:

	A model with the ability to measure and monitor performance. A robust accreditiation process for new market entrants and for assessing change and the impact on the industry/business.
55.	I find the electricity model essential to my ability to function in my role. Having used the electricity model for some considerable time now I find it relatively easy to navigate. I will say that to a new user it can be a bit bewildering, however we do operate in a complex sector, and I do not believe it can be made much more user friendly than it currently is.
56.	The model is a guide for all levels within the industry, either new or established, it provides guidance for all. It is ideal for identifying what happens external to my own area. It is a useful tool for new entrants to ensure that all areas have been covered by their internal testing of systems and Business Processes prior to formal accreditation
57.	The model is a well defined set of products that is the bible for the transfer of information between market participants, and when and where it should be sent. The governance surrounding these products is sound and needs to be so with many different companies having different business drivers. The weaknesses or perceived weaknesses are access to training packages. This may well be available especially to new entrants, but is not seen by the rest of the industry. This could well help new employees within the industry learn about the electricity model.
58.	Strengths: Clear, easy to understand flow diagram approach and the golden threads.
59.	DTC very useful at a detailed level when compiling data flows. End to end diagrams extremely useful when planning testing & the amount of effort involved in this. As a project manager, I work with a lot of in-house systems that require change but do not necessarily need to refer to the Electricity Model to manage such projects
60.	Strengths: o Single point of authority in industry o Accepted by all participants o Common language across industry o Aids dispute definition & therefore resolution o Simplifies/clarifies change implementation Weaknesses: o Technocratic, demands some degree of training o Single product folus in a dual marketplace o Predominantly retail Toolset used not commercially common
61.	Haven't made sufficient use of the model in detail to comment on this. Principal benefit of having E2E diagrams electronically are ability to search for objects, speed, ease of updating by issue of new version You might like to consider the design of implementaion of the equivalent E2E processes in the gas industry – OFGEM Review of Gas Metering Arrangements – which has not employed modelling tools, and accordingly has some fundamental flaws
62.	The model is useful for new entrants to help them understand the processes that are operational at present and therefore to help them design their solution. The weakness is that the model has evolved froma concensus approach at deregulation and as such contains imperfections as a result of compromise. If you started with a blank sheet it would be simpler and probably more efficient There are still opportunities to improve the model but the political (and probably commercial) will to address them is missing

63.	Strengths: They provide coordination of national working practices Weaknesses: There is no governance around the Working Practices
64.	Due to the number of variables & business context scenarios, it is difficult to capture every eventuality of live operational activities. Once participants start to trade in the live market, processes tend to get short-cut or even dropped (maybe intentionally or not) from company BPs or LWIs.
65.	Technical: o Software (E2E) large & slow o Recent changes have been implemented outside of the DTN Operational: o Discipline in building design seems poor. Too many processes duplicated trying to express “what if” o Appears too technical to new entrants who see supplying as being business driven. Golden threads go some way but are still seen as too high level a view Changes: o Too many are made by committee and therefore are watered down, influenced by biggest players and focussed on business advantage rather than best solution Training/Knowledge: o Participants have to “fend for themselves”. The industry does not support training in a gvernance schema.
66.	Some prescription is required to ensure consistent inter-operability Scope of model is excessive Level of detail is interpretive Maintenance is by vote. It is therefore difficult to make a change and this weakens the quality of the model All things to all men
67.	The strengths are that it defines (to a level) an explanation/interpretation of the regulatory requirements of the industry The weaknesses are that a person is only able to interpret it id they have sufficient business knowledge to link detail in the product set It would be beneficial to industry to separate the industry model into participant business models
68.	
69.	Everything is in there but sometimes difficult to find Original process diagrams difficult to follow but golden threads address this Weakness – not the total solution – does not mandate all roles
70.	Strengths: o Electronic version available o Including links to the relevant working practice, reference to the MRA and DTC o Being able to select view by Participant Role Weaknesses: o Lack of business process diagrams (after all they are the driver of the industry) o Choice of DTC flows on Activity Diagrams, nt all are compulsory, are not clearly explained o Cannot link own company model and E2E model, to update more intuitively

	o Publicaton od updated model is not release aligned. This is partly a problem with the process of change nationally. o Additionally, the model is update after the change has occurred, not in advance. The E2E model is a vast improvement on the previous paper only versions