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# Defining a modular approach for mapping and documenting of Manufacturing Engineering process.

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# Abstract

Traditionally, enterprise and functional process understanding were not considered a priority in the Aerospace industry. The build of an aircraft was carried out sequentially. Now, due to increased competitive and customer pressure, time to market has been reduced. Work must be carried out concurrently to satisfy these new competitive forces. In recent years there has been a focus on Business Process Reengineering (BPR). The solution is to have a clear idea of sequence and clear top-level process defined. Therefore it is imperative to have a clear framework to capture the process.

The research demonstrates the development of a methodology to capture process within a major aircraft manufacturer. The research starts by looking at the present practices across the whole organisation. Examination of the present working practices within the organisation facilitated an objective analysis of three modelling techniques within different working groups. This fragmentation was addressed through the presentation of a generic framework. Condition of Supply processes was modelled as a demonstration to the organisations' practitioners.

Through consultation with practitioners from the working groups framework benefits were realised;

- Understanding of mapping organisational processes
- Generic technique for capturing working processes
- Continuation of framework
- Future opportunities.

Conclusions highlight that the proposed framework is adaptable and easy to use, addressing user requirements; top management and operational level staff. Furthermore maps generated utilising the framework provides capability of drilling down, detailing lower level processes.

# Acknowledgements

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# Notations

| | |
|---|---|
| BAe | British Aerospace Limited |
| ME | Manufacturing Engineering |
| JAR | Joint Aircraft Regulation |
| GIE | Groupement d'Interet Economique |
| COS | Condition of Supply |
| BPR | Business Process Redesign/Reengineering |
| SAP | Systems, Applications and Products in Data Processing |
| SCAMP | Supply Chain And Manufacturing Process |
| PIP | Product Introduction Process |
| ACE | Airbus Concurrent Engineering |
| IDEF | Integration DEfinition for Function modelling |
| UML | Unified Modelling Language |
| CSC | Computer Sciences Corporation |
| QMap | Quick Map software |
| PEGS | Production Engineering Group System |
| KPIs | Key Performance Indicators |

# Chapter One

# Introduction

## 1.1 Manufacturing Engineering

Currently there is a lack of understanding in the way that the Manufacturing Engineering (ME) process should be represented. Traditionally the culture of the organisation has been functional, with a lack of understanding on how the various functions inter-act with each other. There are process maps of the Manufacturing Engineering process already in existence but none of these share a common format. This leads to a disintegrated view of the function. No general consensus has been reached on how to depict the Manufacturing Engineering process.

There is some confusion over the engineering process. For example tooling produce tools without a final design. The suppliers are making the tools to preliminary designs. This presents several problems, regulatory authorities such as the Joint Aircraft Regulation (JAR) demand that all procedures are written in a defined manner.

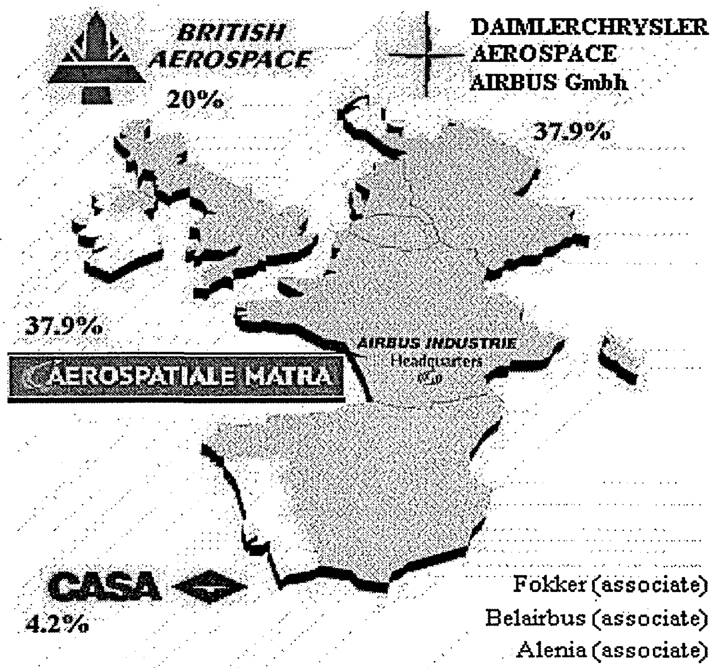
Another challenge facing the organisation is working in a Concurrent Engineering environment. The principal of concurrency states that activities must be performed concurrently to the greatest extent possible within the budget constraints of the organisation. This principal is motivated in part by the success of the science and by the practice of Concurrent Engineering over the past decade. There is a requirement to understand the procedure. Once the process is understood the correct sequence can be followed. For example in the automotive industry where Concurrent Engineering is common practice, the rear end of a vehicle might have been finalised, therefore the tooling for the rear end of the vehicle can be made. At the front of the vehicle the design engineers might be finalising the headlamp arrangement which affect the front panel therefore the pressing tools cannot be made. At BAe Airbus a problem occurs because it is difficult for the engineers to identify when the final design freeze has occurred. The tooling department might authorise a tool to be made. The design then changes, in this scenario the best that can happen is the tools under go modification. This might not always be possible. In the worst scenario the tool is destroyed. This has negative cost and time implications.

In the past process understanding was less important, work on the aircraft was carried out sequentially. This was easy to manage, when one phase finished another phase started. Time to market has been reduced; work must be done concurrently to satisfy the time restraints. The solution is to have a clear idea of sequence and clear top-level process defined. Therefore it is imperative to have a clear framework to capture the process.

## 1.2 Company overview

Wholly owned by British Aerospace PLC, the role of British Aerospace Airbus Limited is to manage the company's partnership share and industrial responsibilities in Airbus Insdustrie. Airbus Insdustrie was formed on December 18, 1970, 18 months after the launch of its first aircraft, the A300B. The partners each bear responsibility for their assigned part of the project. Airbus has responsibilities for flight test and certification and to perform all sales, marketing and commercial activities. The new company was set up as a Groupement d'Interet Economique, (GIE.) A GIE is a joint venture under French law that enables two or more partners to form an association facilitating the development and improvement of new products. Airbus is owned within the GIE umbrella by a partnership comprising of four Companies.

The diagram below shows the partners in the consortium and their respective holdings:



British Aerospace has excellence in the design and production of wings. It holds the prime contractor responsibilities for the wings of the Airbus aircraft family, even though it does not entirely produce them. In addition, British Aerospace is responsible for producing one of the two additional fuselage sections that are used to stretch the A320 into the A321 version (Airbus Industrie Italian associate Alenia builds the other). The English A321 fuselage work is handled at British Aerospace Aerostuctures at Filton.

British Aerospace's research centre at Hatfield designed the original A300 wing, following a tradition that also included wing design for the Comet and Trident commercial airliners.

Wingbox structures of the entire Airbus product line are assembled at Chester. For the A320 family, the wing is completed at Chester with the installation of hydraulic, electrical and environmental control system hardware before being shipped to Toulouse (for the A320) and Hamburg (for the A319 and A321).
For the Widebody Airbus aircraft, wings depart Chester for system installation at Daimler-Benz Aerospace Airbus plant in Bremen, then are shipped to Toulouse.
The company has two sites in the UK. A large engineering organisation and component and sub-assembly manufacturing unit are based at its headquarters at Filton, near Bristol, whilst at Broughton in Flintshire, North Wales, the manufacturing and wing assembly facility can be found. It is from here that several hundred sets of wings a year leave on route to the Airbus final assembly lines in France and Germany. Filton site has the Design authority for the wings as well as maintenance and cargo conversions for aircraft. Filton directly employs 4000 people. Broughton has a core permanent workforce of 3,000 employees with an additional 800 employed on temporary contracts. Airbus wing production represents 80% of Broughton's activities and Hawker wing and fuselage production represents the remaining 20%.

The break down of the activities at Broughton is as follows:

- Produces the wings for all Airbus aircraft
- Airbus Twin Aisle wing box assembly
- Airbus Single Aisle wing box assembly and equipping
- Airbus wing panel machining and assembly
- Production of wings and fuselages for all Raytheon Hawker Jets.

## 1.3 The Current Family

From short- to ultra long-haul routes, with seating capacities from 124 to approximately 400 seats, Airbus Industrie offers a complete family of aircraft that are proven in service with operations around the world.

The A318/A319/A320/A321 has developed into a top-selling family of single-aisle aircraft that provide excellent operating economics -- as well as cockpit commonality with Airbus Industrie's top-of-the-line widebodies. Today, these aircraft have become the airliners of choice for operators around the world.

A320 FAMILY STATISTICS*
Total orders: 2,120
Total deliveries: 1,046
In operation: 1,040
Customers: 86
Operators: 90
(*as of 31 July 1999)

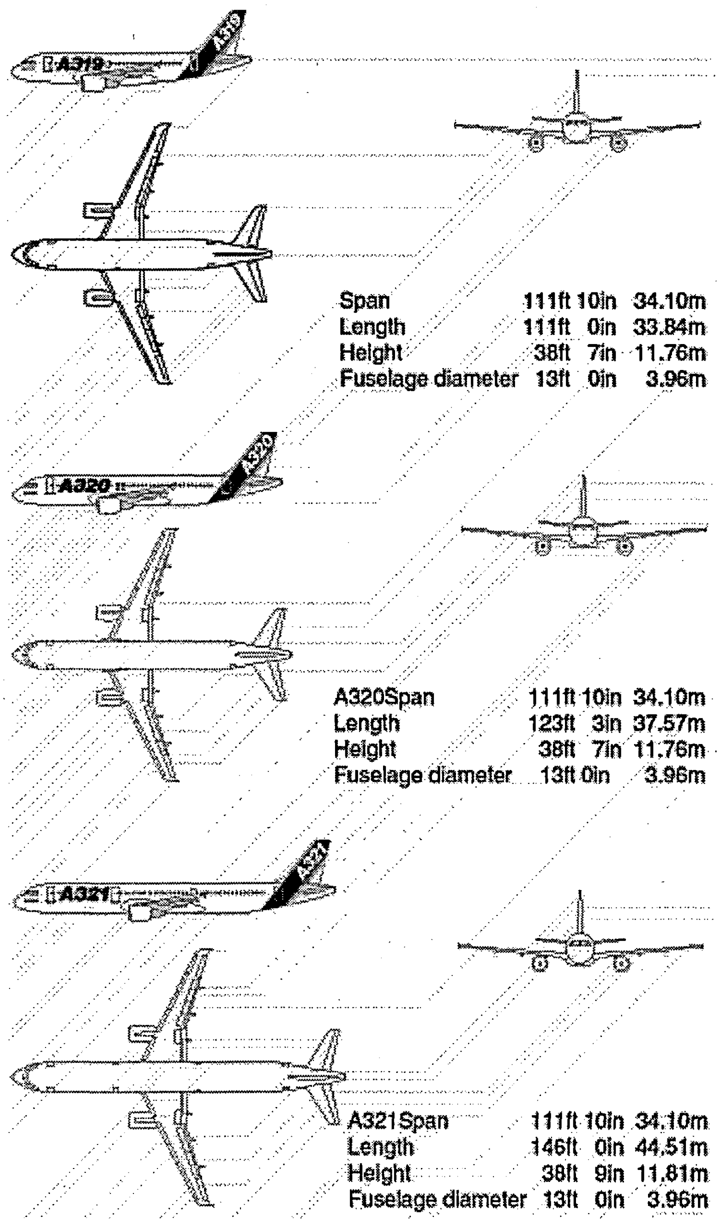
As the cornerstone of the Airbus Industrie product line, the popular A300/A310 are workhorse transports in the service on short-, medium-, and longer-haul segments. The widebody A300 has been in revenue airline service since 1974.

TheA330 and A340 mark Airbus Industrie's expansion into the upper end of the widebody market segment. Launched as a joint program, the aircraft offer a comprehensive aircraft family for regional, long-range and ultra long-range routes. Growing lists of international airlines are using the twin-engine A330 and the A340 four-engine aircraft on routes ranging from medium- to ultra long haul.

What follows are illustrations of the range of aircraft that Airbus currently offers its customers.

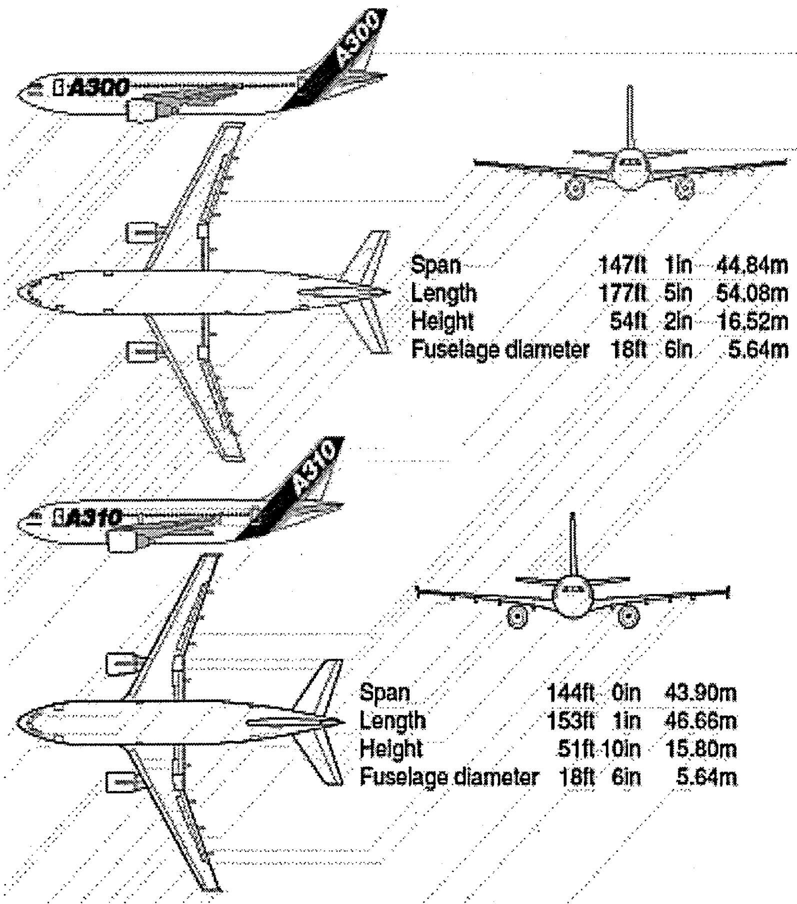
*Range of single - aisle aircraft*

Designed for short to medium-haul routes, the A318, A319, A320 and A321 form the A320 Family, the world's most profitable single-aisle aircraft family. All derived from the same fuselage, they provide operators the highest degree of commonality and economy for aircraft in the 107-185 seat category.



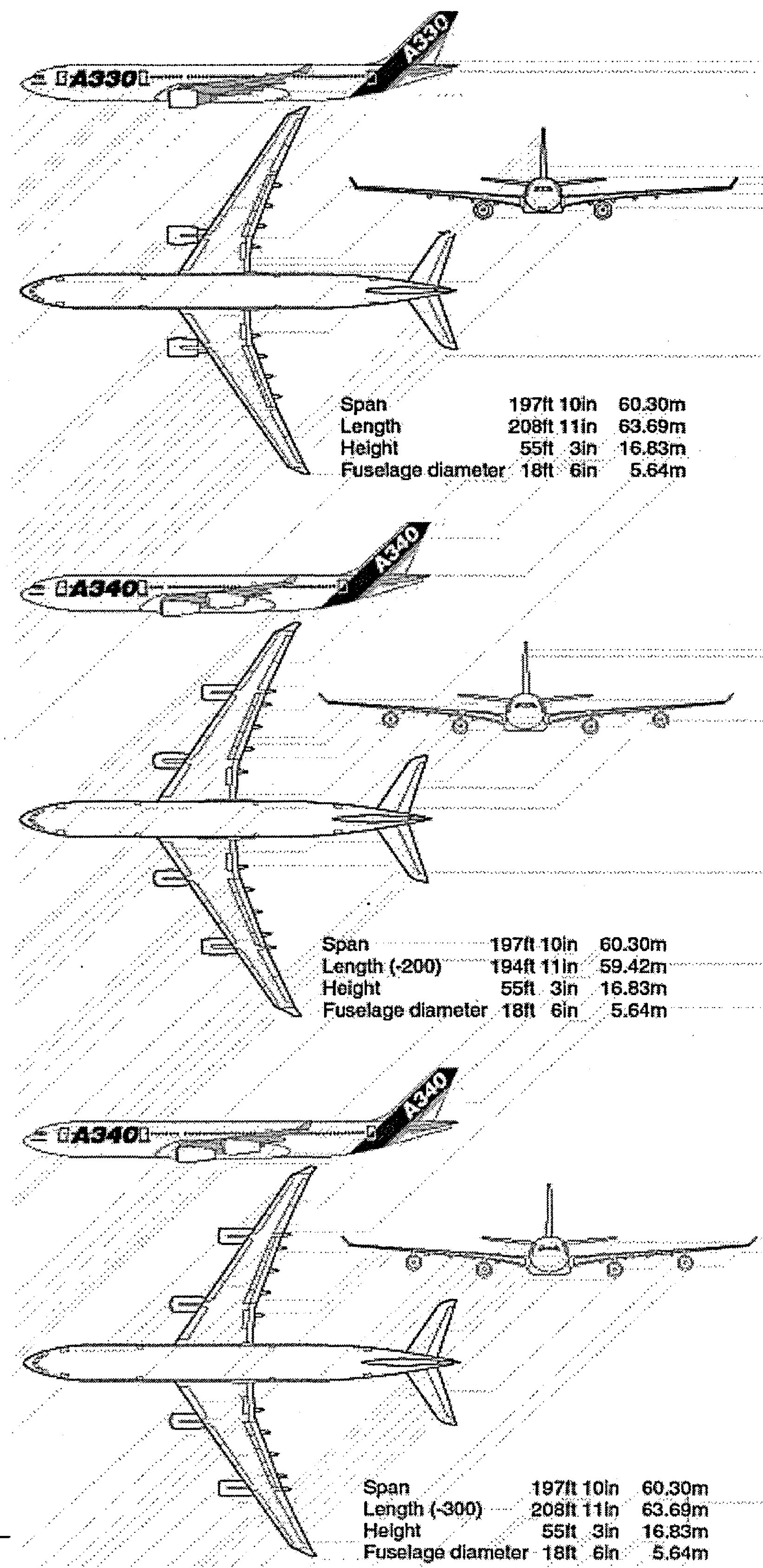
*Medium range wide body aircraft*

220-seat A310 and 266-seat A300-600 are the versatile, medium capacity widebodies of the Airbus Industrie aircraft family.



*Large widebody Aircraft*

A330/A340 Family of aircraft has established market leadership in the 239-380 seat category. The family offers operators a choice of two or four engines on the same aircraft fuselage.



## 1.4 Future

Airbus Industrie continues to look to the future determined to maintain its position as an industry innovator. The consortium is at forefront of research on man-machine interface for modern cockpits. Improvements in aerodynamics are being pursued, as are further refinements in the use of composite materials.

The consortium also has set its sights on the very large aircraft market to meet expected demands for aircraft capable of seating more than 500 passengers. Work on a large aircraft, designated the A3XX, is continuing under the management of an integrated division to handle all pre-development activities. One of the new division's tasks will be to further refine the new airliner's basic specifications, taking into account the design studies performed since 1990 as well as inputs from an active -- and supportive -- airline working group. Other tasks will include studying a potential broadening of the industrial and financial structures for the large aircraft project, as well as establishing the business case for the program.

## 1.5 Business case

Increasing production:
Airbus is enjoying a period of an increase in production. With this increase there is a challenge for management to discover how department's co-operate and inter-act with each other. The result will be greater operational capability and effectiveness.

Regulatory changes:
There is increasing pressure by the regulatory authorities such as the JAR to provide a visible and uniform approach. A clear approach to the capture of process will provide a clear auditable trail.

Partner integration and greater business efficiency:
There is pressure from the consortium and external competitors for greater business efficiency. BAe Airbus spends a lot of resource on teams to investigate how to conduct the core business functions in a more efficient manner. By providing a generic framework for process understanding cost and time savings can be realised.

## 1.6 Processes

Every business decision taken must be based on a sound and detailed knowledge of the underlying processes and how these affect the realisation of the objectives. It is through processes that human, material and financial resources are consumed to deliver business results. These results have to be measured and checked against the set objectives. By having the visibility of how the business is performing management can make informed business decisions. It may be the case that corrective action has to be taken or that an issue arises that merits further investigation. In addition, an understanding of process will lead to overall business improvement. ME must demonstrate that they have designed a capable manufacturing system. This is critical for providing an audit trail; the aviation authorities require visibility of systems because of the safety implications. One way of creating the required visibility, is the understanding of how the various functions operate, within the wider organisation and ME.

## 1.7 Thesis structure

The structure of the thesis is as follows:

Chapter:

2. Literature survey reviews the current literature on the subject of measuring process and the business benefits. Includes models from consultancy practices.
3. Objectives scope and methodology of the research.
4. Current process modelling practices.
5. Top down approach to capture process the results from COS and how it fits within the suggested framework.
6. Discussion provides the next steps to implementation and a summary of current practice.
7. Conclusions and future research provides the conclusions for the research and future research opportunities.
8. Appendix.

# Chapter Two

# Literature survey

## 2.1 Introduction

This chapter provides an overview of the significance of process understanding within a business organisation. In the early 1990's the Hammer and Champy book Reengineering the Corporation encouraged organisations to rethink the way they were operating. Coincidentally Business Process Reengineering (BPR) coincided with a downturn in the economy. As a result businesses looked at ways of greater efficiency whilst, reducing costs. The first BPR Projects translated into significant downsizing efforts. The criticism that was levelled at BPR is it threw everything out and started again. Many organisations found that they lost valuable resources and expertise in the change. Another problem was that many of the new processes where unsustainable, thus the project lost momentum and with it credibility for the whole change process.

The chapter reviews the need for understanding business processes within the organisation. Moreover it gives a current view of performance improvement, and the need to present an easy to understand and powerful tool, on which the organisation can gain an understanding of process.

## 2.2 Modular Processes

The modularity principal states that the decision making agents must be placed (to the extent practical) where the work is performed. A direct implication of this principal is that control will be engineered into the business process.

The term modular process is used by Reinerstein[1] he suggests that:
"The simplest approach to combining structure and flexibility is to build the development process out of modules".
The idea with adopting a modular approach is to design
"A development process to create standardised building blocks that are defined primarily at their interfaces rather than by their internal procedures".

This statement summarises the aim of the research. The Manufacturing Engineering department requires a standardised set of "building blocks" that will enable the function to build on the process understanding. The advantage of establishing building blocks is two fold.

1. It give management a quick reference to the processes of a particular function
2. It prevents the process understanding getting bogged down with the mechanics of the function. The actual mechanics are hidden behind the modular blocks of function.

## 2.3 Origins

Champy[2] himself describes Hammer and himself as the "self proclaimed progenitors" of business process re-engineering. However the concept suggests a broader heritage. Davenport an Stoddard[3] develop a more holistic assessment of re- engineering's antecedents,

"Business processes have been with us at least since the mid 1940's when they became the focus of continuos improvement efforts. Process analysis really goes back to Fredrick Taylor, who first advocated the systematic study of work procedures. However re-engineering proponent advocate the redesign of broad cross-functional business processes. The idea is more recent than Taylor, but is older the re-engineering; witness the value chain concept (Porter 1995) or the idea of design for manufacture."

## 2.4 Process Definition

As organisations strive to be more competitive they are increasingly looking at the underlying business processes and systems which make them successful. Such efforts assume a number of labels, such as Business Process Reengineering, employee empowerment, Total Quality Management and customer focus. The literature describes the core emphasis of these efforts in different ways. It is useful to make the distinction between the different improvement levels. The US Department of Defence[4] makes three distinctions when defining business process methodology these are as follows:

1. *Continuous Process Improvement* (CPI) that reduces variation in the quality of output products and services and incrementally improves the flow of work within a functional activity.

2. *Business Process Redesign* (BPR) that removes non-value added activities from processes, improves our cycle-time response capability, and lowers process costs.
3. *Business Process Reengineering* (BPR) that radically transforms processes through the application of enabling technology to gain dramatic improvements in process efficiency, effectiveness, productivity, and quality.

This project is concerned with providing ME a methodology to map the various processes. This in order for the function to have a unified approach to process understanding. There are many definitions of process. What is common amongst the business definitions is the need to serve the customer, through a series of actions. The customer can either be internal or external to the organisation.

The term process as defined by the Oxford English dictionary:
"The fact of going on or being carried on, as a series of actions or events".

Hammer and Champy[5] defines process as:
"A collection of activities that takes on or more kinds of input an creates an output that is of value to the customer."

Harrison and Pratt definition of process[6]:
"A sequence of activities that fulfils the needs of an internal or external customer."

Anderson Consulting defines a business process[7] as:
"A set of logically related and continuously evolving activities combined to satisfy a business objective."

Davenport and Short[8] capture the essence,
"Processes have two important characteristics:

- They have customers: that is processes have defined business outcomes and there are recipients of the outcomes. Customers may be either internal or external to the firm
- They cross organisational boundaries, that is they normally occur across or between organisational sub-units. Processes are generally independent of formal organisational structure."

If confusion exists within the business, on what those activities involve, it is very difficult for the management to determine strategy for the business. As Peters[9] readily points out
"What gets measured gets done"

This is one of the first things that the organisation needs to consider. If the organisation is unable to put a measure on what it does it is never going to be able to achieve competitive results. Process understanding and appreciation is the first step to organisational understanding. Galloway[10] reinforces this concept:

"Process mapping is an enabling tool, as it creates a starting point of understanding, leading the way into creativity and knowledge expansion".
The process maps create outline steps in a system, both physical and informational, at whatever level deemed appropriate.

## 2.5 Performance Improvement through Process

"In the 21st century, sustainable competitive advantage will come much more of new process technologies and much less of new product technologies."

Lester Thurow
MIT Sloan School of Management

This observation is poignant, new product technology reaches the market with increased speed, the key to gaining the competitive advantage is an understanding and development of the process that operates within the organisation. Competitive advantage can be gained with an understanding and refinement of the process.
Anderson Consulting state[4]:

- In the ultimate delivery of any product or service the excellence of the under-lying processes is as critical as the product or service itself.
- Process excellence is critical to sustainable competitive advantage and it is therefore a strategic imperative for any organisation that seeks to avoid obsolesces.

Researchers at the Massachusetts Institute of Technology (MIT) have pinpointed the following challenges for the 21st century corporate management.

- Learn how to adapt

- Learn to position for continuous unpredictable change
- Learn to develop unfamiliar but necessary skills
- Learn to manage
- Learn to adjust to the impact of new technology
- Learn to redesign ways of working
- Learn to innovate
- Learn to measure success

The key to meeting these challenges is to find an approach that can order the chaos. The solution can be found in understanding, redesigning and managing the core business processes.

According to Anderson Consulting[4] business process excellence enhances competitive advantage in the following ways:

- Increases efficiency by eliminating unnecessary activities
- Fosters Innovation
- Focuses effort on the most high value – added improvements
- Improves flexibility/agility through continuos critical feedback and redesign
- Stifles competition by erecting greater barriers to entry
- Improves performance measurement
- Shifts from an introverted functional or departmental view to an outward, holistic customer focused view.

## 2.6 Definition of type of process

The literature points to performance improvement gain by a comprehensive understanding of processes.

There are three broad types of processes that Ould[11] identifies:

1. Core processes
2. Support processes
3. Management processes.

This is represented by Figure 1 below.

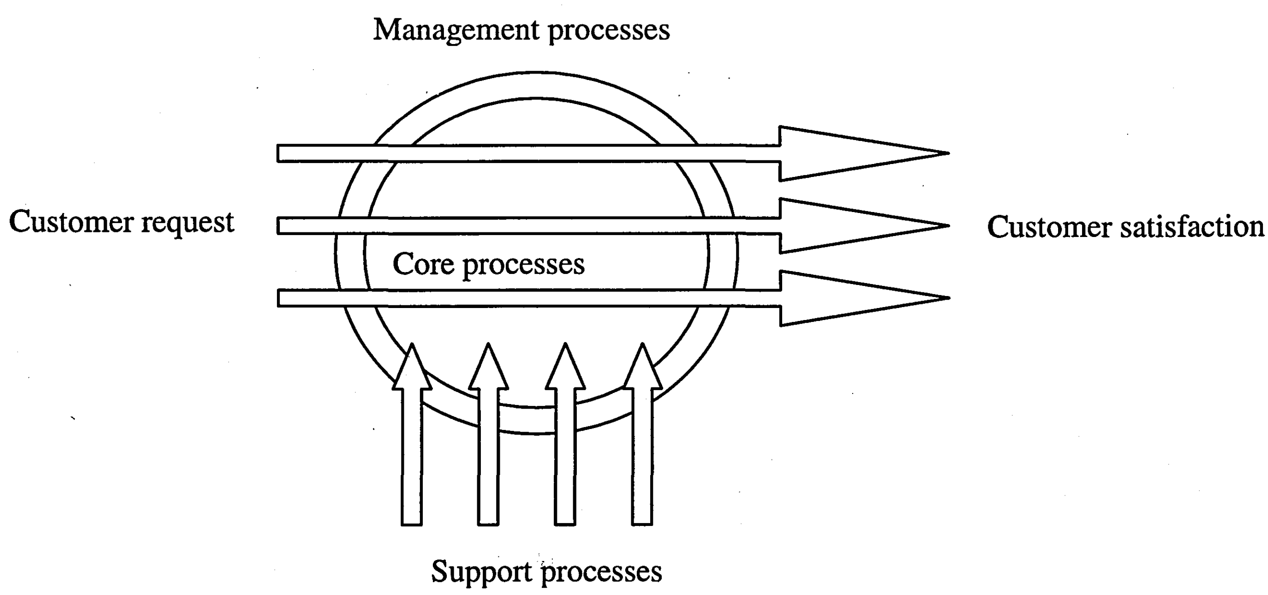



**Figure 1 Model showing Core, Support and Management processes**

Ould[11] further refines the definition of the processes:

"Core processes concentrate on satisfying external customers. They directly add value in a way perceived by the customer of the business. They respond to a customer request and generate customer satisfaction". The organisation can have more than one core process.

"Support processes concentrate on satisfying internal customers". They are vital in maintaining the core function.

"Management processes concern themselves with managing the core processes or the support processes, or they concern themselves with planning at the business level".

The idea of understanding and managing process originates within the military environment. Nearly everything from winning a battle to daily routine is driven by process. Therefore to understand the concept it is useful to use a military analogy. The core processes are the front line units such as infantry and amour. The supporting processes support the front line troops; this would be logistic and engineer units. The management process are the Head Quarters and Intelligence units.

Anderson Consulting[4] has devised a process excellence Blueprint.

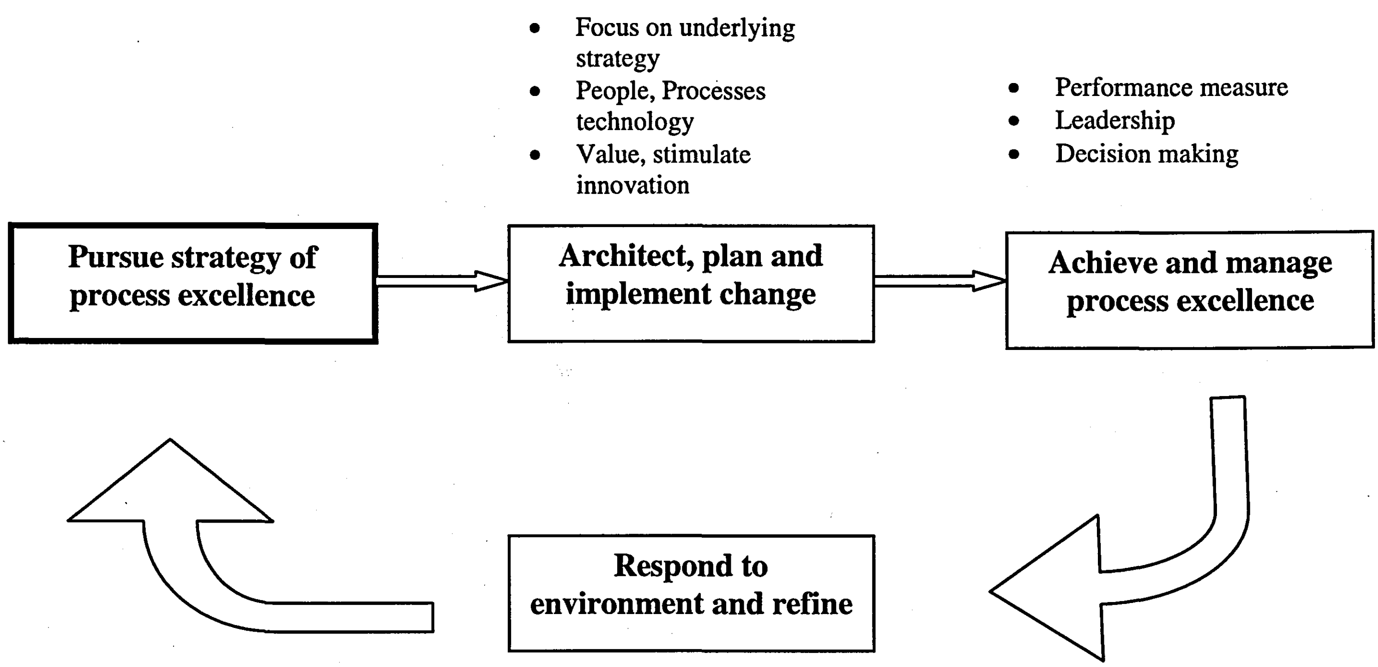



**Figure 2 Process Excellence Blueprint**

Process is the corner stone of robust practice. There has been a shift from traditional approach as represented by the Anderson Consulting[4] model.

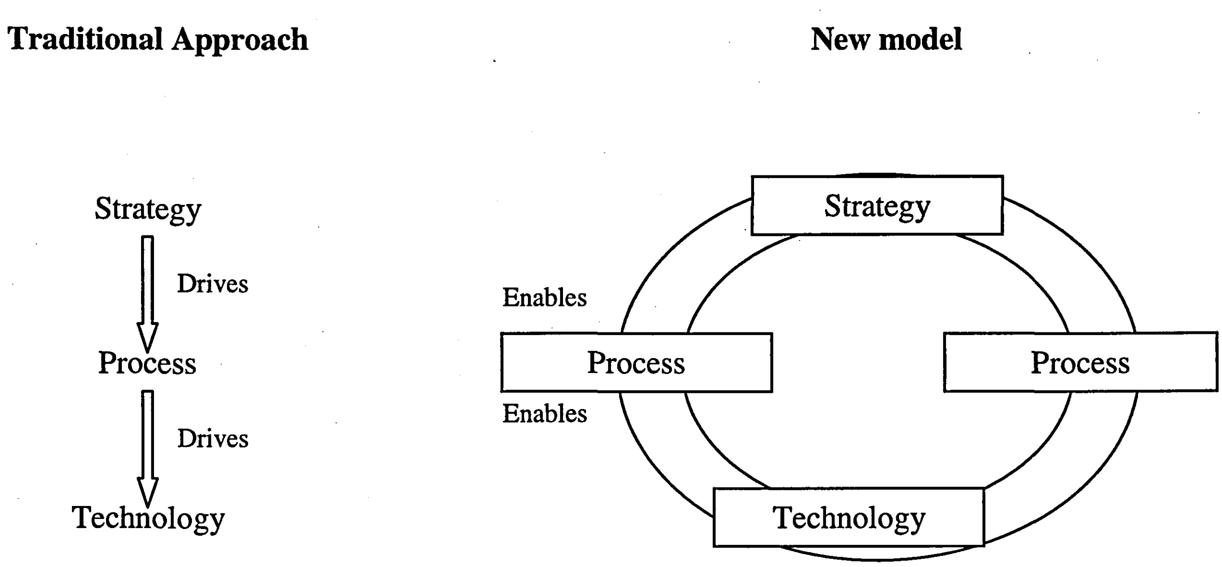



**Figure 3 Traditional Approach verses New Model**

The importance of representing the organisational process is outlined by Anderson managing director of the reengineering practice at Andersen Consulting William Stoddard[12]

"Only by making process management the backbone of the organisations management practices can a consistent readiness to change be achieved. The ability for the organisation to change and adapt in today's business world is paramount."

According to Bill Quinn[4], Vice president of woldwide quality management at Johnson and Johnson
"Process thinking is an organised way of showing how work is done. Working better means picking the right things to do, the right technologies, the right markets to serve. Process improvement helps you execute all of those."

In 1996 it was reported by the Economic Intelligence Unit[4] (EIU) that:
"Process excellence is being pursued by a growing number of leading companies including Unilever, Johnson and Johnson, Eastman Kodak, CIGNA, American Express, Chrysler and Owens Corning."

Bill Russo[4] Process Management Group Leader at Chrysler states
"A company can still focus on product as the key element of strategy".
The caveat of this statement is;
"Products have a short life cycle, while process is ongoing."

An understanding of process is to gain a grasp of the organisational dynamics. Once management has a grasp of this, the business strategy can be more easily derived. A process-orientated approach creates a unit of competitive advantage that can distinguish the organisation from its competitors.

Hammer and Champy[2] describe and highlight the importance attached to business process as:
"The fundamental rethinking and radical redesign of business process to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed."

For a manufacturing environment Parker[4] points towards the elimination of waste: "The analysis and redesign of business and manufacturing processes to eliminate that which adds no value."

Janson's[13] definition of performance improvement is "A radically new process of organisational change that many companies are using to renew their commitment to customer service."

## 2.7 Approach

A common theme in the literature is an emphasis on rethinking aspects of the existing behaviours. Hammer and Champy[2] were radical in their thinking. This approach to reengineering assumes the existing process is not sound and therefore needs to be replaced.
"Reengineering, we are convinced, can't be carried out in small and cautious steps. It is an all or nothing proposition that produces dramatically impressive results."

This view was reflected in many of the texts and practice of the early 1990's. Over time it has been recognised that the most radical approach is not always the most beneficial to the organisation. In an interview conducted in 1995[14], two years after the publication of "Reengineering the corporation: A manifesto for Business Revolution"
Champy replies to the question of why his book was so successful,

"First, I think a lot of its success had to do with timing. Companies, particularly in the States, then in Europe, then in Asia, were struck by a recessionary environment. We came up with a compelling set of ideas about how to compete more effectively in that environment through fundamentally changing your work. So it was a combination of the right ideas at the right time."

Many organisations found that although permanent staff numbers have been reduced, after hefty redundancy settlements; which gives the impression to shareholders that the workforce is lean. However, the number of expensive contractors has increased, thereby not addressing the problem. The "all or nothing approach" can prove unsustainable as Dutta and Manzoni[15] state:

"The improvement proves unsustainable because it was achieved through effort and attention beyond the a call of duty rather by changing the way people worked."

Lalli[16] cites convincing evidence that downsizing reduces the long term value of a companies shares unless considerable effort is put into training the employees left, and thus treating them as valuable assets.

However the original ideas and concept of Hammer and Champy's book remain sound. In 1995 Champy was interviewed in Across the Board[17] he answers the criticism of the original publication by stating:
"What's happening is that companies claim to be reengineering when they're simply downsizing their organisations. The press contributes to this misunderstanding, and the people who work in companies become cynical about what their managers are really up to."

Instead of attempting to reengineer the process, it is of greater benefit to improve and build on the existing process. Harrington[18] calls this Business Process Improvement (BPI). Harrington cites three major objectives for BPI:

1. Making processes effective – producing the desired results
2. Making processes efficient – minimising the resources used.
3. Making processes adaptable – being able to adapt to changing customer and business needs.

Two general approaches characterise re engineering accounts. The first is "process improvement" and the second is "process redesign". Coulson-Thomas[19] observes,
"Process improvement can yield significant but incremental improvement to what exists. This is done by cutting out non- value added activities, redrawing departmental boundaries and empowerment to improve through- put times and save on resource requirements. In contrast, re- engineering involves radical change. This can mean the redesign or re build of individual processes, a whole organisation or the relationships between suppliers and customers. Such restructuring comes after a "blue skies" or vision led examination of the basic elements of people, processes, information and technology. This will look into new ways in which they can be brought together to achieve fundamental transformation."

Harrington advocates Business Process Improvement as opposed to Business Process Reengineering. Harrington[20] identifies organisations that have been successful with BPI. The companies that have tried to understand their processes include, Ford, Boeing, IBM, 3M, Corning, Nutrasweet and McDonnell Douglas. The typical results are as follows:

McDonnell Douglas

- 20 to 40 percent overhead reduction
- 30 to 70 percent inventory reduction
- 5 to 25 percent material cost reduction
- 60-90 percent quality improvement
- 20 to 40 percent administrative cost reduction

Federal Mogul

- Reduced development process cycle time from 20 weeks to 20 business days, resulting in a 75 percent reduction in throughput time.

These figures are impressive, even if there is a certain amount of hype involved in the data the fact remains that the large American corporations have embraced the concept of improvement through better process appreciation.

## 2.8 Frame Work for Change

To gain an understanding of the Manufacturing Engineering function at BAe Airbus it is useful to look at some frameworks for change. Many such frameworks have been developed over the last few years, mostly by authors of management theory and within major management consultancies. Two representative frameworks are the 7 S Model and the Business Integration Model.

Developed in the late 1970's, by Pascale and Athos[21], the 7-S Model emphasises the dynamics of organisational change and develops goals for a performance improvement programme. The model suggests a need to achieve consistency and balance between seven specific dimensions (7Ss). The seven Ss are:

- *Strategy:* a coherent set of actions aimed at gaining a sustainable competitive advantage (and, as such the approach to allocating resources.)

- *Skills:* distinctive capabilities possesses by the organisation as a whole as distinct from those of an individual.
- *Shared Values:* ideas of what is right and desirable (in corporate and/ or individual behaviour) as well as fundamental principals and concepts which are typical of the organisation and common to most of its members.
- *Structure*: the organisation chart and related concepts that indicate who reports to whom and how tasks are both dived up and integrated.
- *Systems:* the processes and procedures through which things get done.
- *Staff:* the people in the organisation, considered in terms of corporate demographics.
- *Style:* the way managers collectively behave with respect to use of time, attention and symbolic actions.

The other model is Anderson Consulting's[4] four Business Integration Model. This model is based on the premise that the business performance derives from the alignment of a company's people, processes and technology with its strategy.

- *Strategy:* establish a customer-focused strategic vision that will optimise long-term success
- *People:* organise, motivate and empower people to succeed
- *Business Processes:* redefine and streamline business processes to implement strategic vision and to achieve maximum effectiveness and efficiency of all resources.
- *Technology:* apply appropriate technology to support streamlined process, to provide information and tools to support the entire workforce and to enhance customer/supplier relationships.

The reader will note that from both these examples for organisational improvement the key to understanding the organisation is to understand the structure and the business processes. Once this is understood the organisation is empowered to plan its short to long term strategy. This is depicted in the business integration model over.

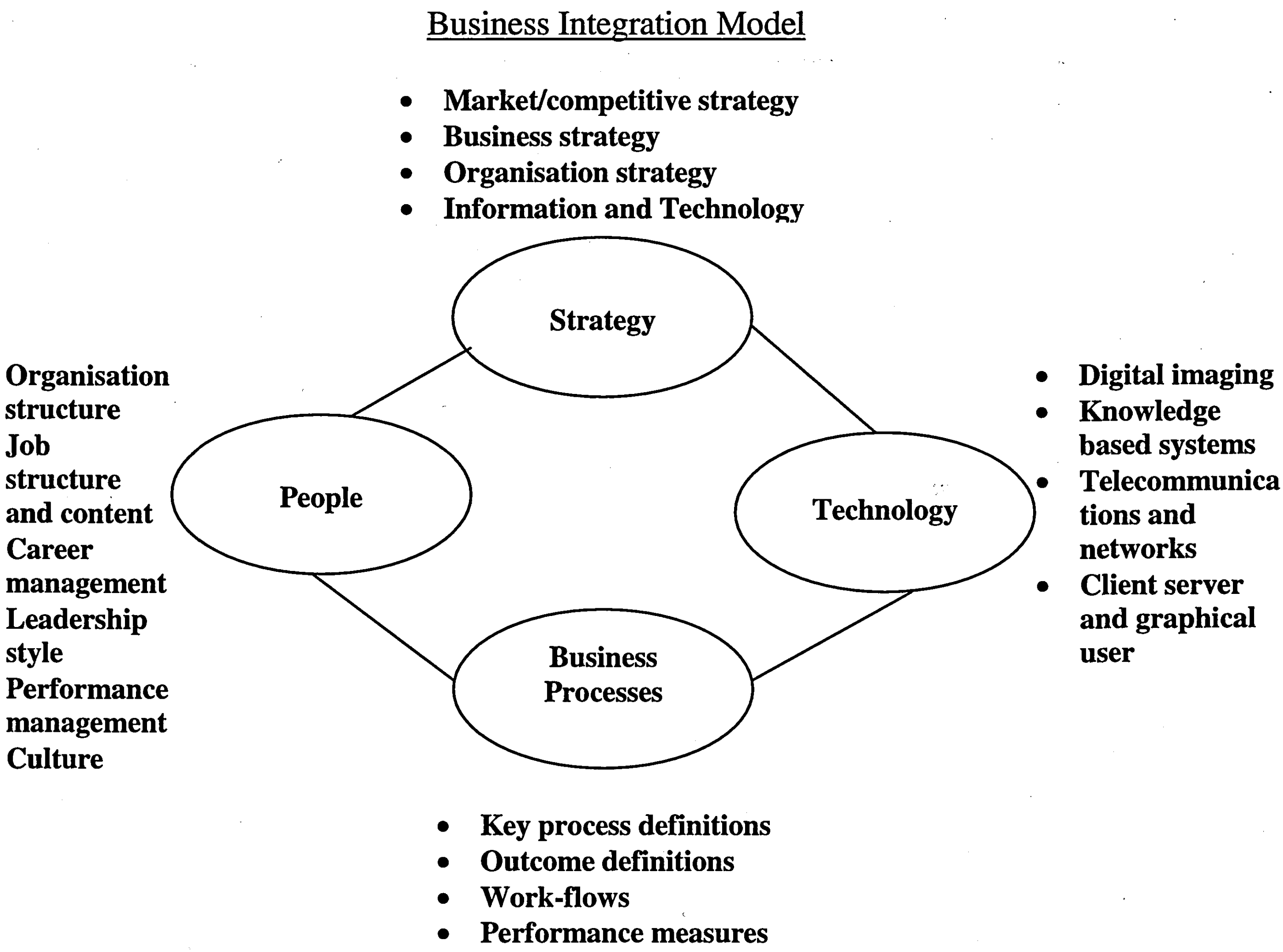



**Figure 4 Business Integration Model**

Anderson Consulting[4]

## 2.9 Tools

The tools are available to assist the workers in the organisation to go about their daily business. In order for the workers to perform their tasks they need support. The aim of the tools are to:

- Model the business
- Model the people
- Model the work that is carried out.

This then becomes an Information Technology requirement, which is then satisfied by the tools.

Process simulation is the technique that allows representation of processes, people and technology in a dynamic computer model. According to Dean[22] there are essentially four steps to process simulation:

1. Building a model
2. Running a model
3. Analysing the performance measures and
4. Evaluating alternative scenarios.

A model, when simulated, mimics the operations of a business. De Bono[23] described a model as "a method of transferring some relationship or process from its actual setting to where it is more conveniently studied". In able to understand the manufacturing Engineering function it is useful to create a model of the process.
This is accomplished by stepping through the events in compressed time while displaying an animated picture of the flow. Because simulation software keeps track of statistics about model elements, performance of a process can be evaluated by analysing the model output data.

Tools define business processes using graphical symbols or objects, with individual process activities depicted as a series of boxes and arrows. Special characteristics of each process or activity may then be attached as attributes of the process.
Many of these tools also allow for some type of analysis depending on the sophistication of the underlying methodology of the program. According to Turnay[24] business process simulation software tools can be categorised into three major categories:

1) **Flow diagramming-based simulation tools.** At the most basic level, flow diagramming tools that help define activities and routings. Flowchart-based models are methodology- independent and are the easiest to learn. Unfortunately, the ease-of-use results in limited modelling and simulation analysis capability. Examples of flow charting-based simulation tools include Process Charter, QMap and Optima. At the present time QMap is the preferred tool for the SCAMP process.

2) **System dynamics-based simulation tools:** At the next level are continuous simulation software products that utilise the systems dynamics methodology. Models built with these tools consist of methodology-specific constructs such as levels, stacks, flows, converters and connectors. Examples: ithink and PowerSim.

3) **Discrete event-based simulation tools:** The most capable and powerful tools for business process simulation are the discrete event-driven simulation products. These tools provide modelling of entity flows with animation capabilities that allow the user to see how flow objects are routed through the system. Some of these tools even provide object-oriented and hierarchical modelling which simplifies development of large business process models. Examples: BPSimulator, ServiceModel and SIMPROCESS.

Once the information flows have been gathered, there is a need to display this information in a common schematic format. Figure 5 over, represents the characteristics of the various techniques:

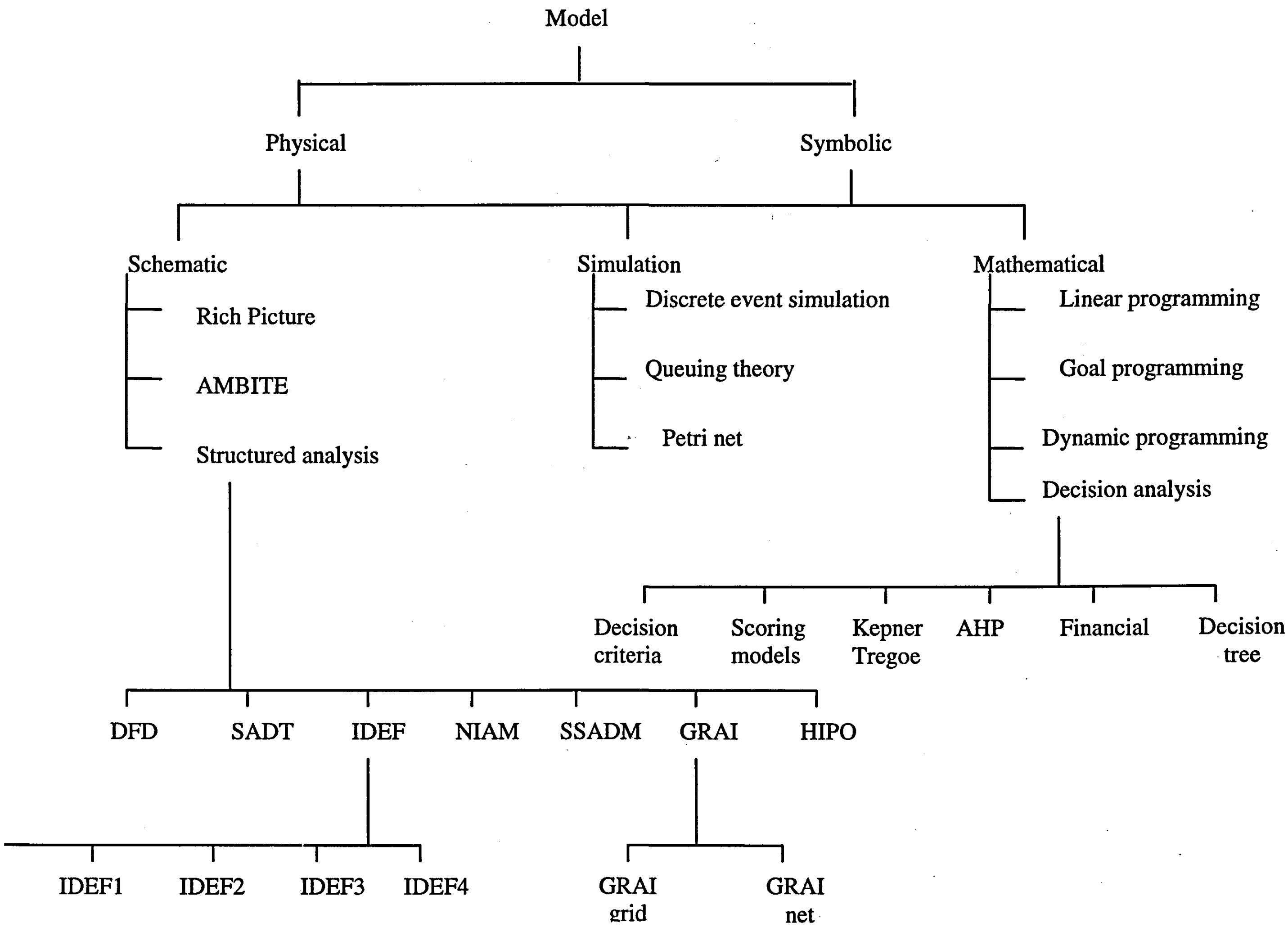



**Figure 5 Characteristics of Various Techniques**

Wainwright[25] classifies the main modelling techniques to include:

AMBITE:

To provide high level strategic information to aid identification of key performance indicators.

GRAI: (Graphical Results and Activities Inter-Related)

To provide a macro model of the manufacturing system to aid analysis of effects of proposed strategic change.

IDEF0 (Integrated Computer Aided Manufacturing Definition)

Provides a detail model of the implications of specific change.

SADT (Structured Analysis and Design Technique) approach.

Provides top down decomposition.

DFD (Data Flow Diagram Approach).

Shows data flow of information through the system.

SSADM (Structured Systems Analysis and Design Methodology) approach.

Used for developing information systems.

Wainwright[26] reviews the merits of each technique:

"DFD's are a sub-set of SSADM and provide the benefits of good traceability of data flows. The approach, however, does not describe the subject of investigation, and is lacking in timing and control aspects.

SADT provides very structured models using "top down decomposition.....the approach does not enable inter-action between timing and implications of decisions. The limitation in SADT is overcome in IDEF, however, criticism of IDEF include the difficulty in understanding where data is coming from and where it is going".

## 2.10 Analysing a Process Model

Once the model of the business process has been drawn out by whatever means, the aim is to improve the process. A process that originally started life as being simple and clean can over time become complex and messy. In Hammer's article Reengineering Work: Don't automate, Obliterate[27], Michael Hammer lists some principals for restructuring processes. Hammer uses role activity diagrams to apply the following principles.

"Organise around outcomes not tasks".

An outcome can be considered as a goal, a desired state of the process. Hammer proposes that case managers perform the entire process, so that one person/group/department perform all the steps in the process. Rather than having an assembly line of roles taking the case through the case process, consider whether the activities and decisions necessary can be carried out by a single role.

"Have those who use the output of a process perform the process"

"Now that computer based data and expertise are more readily available, departments units, and individuals can do more for themselves. Opportunities exist to re- engineer processes so that the individuals who need the result of a process can do it themselves". The aim is to reduce interfaces at hand-overs. It is useful to look at the parts of the process where a service is requested from a service group and consider whether utilising Information Technology can modify the part of the process for greater efficiency.

"Subsume information-processing work into real work that produces the information". Separate roles might produce information and process it. Do they need to be separate? Is it possible to remove the interaction that becomes necessary because the production is separated from the processing?

"Link parallel activities instead of integrating their results".
If there are two strands of a process proceeding separately and then coming together it makes sense to try and integrate their work. It is useful to search out opportunities for earlier collaboration to ensure that integration takes place smoothly.

"Put the decision point where the work is performed, and build control into the process". Hammer explains this principle in greater depth "suggests that the people who do the work should make the decisions and that the process itself can have built-in control. Pyramidal layers can therefore be compressed and the organisation flattened".

## 2.11 Summary

Regardless of the starting state of the organisation and the nature of its performance improvement efforts, processes are useful for focusing the minds and energies of the organisation on the customer. Dutta and Manzon[28]i state:
"The redesign of appropriate processes can yield significant enhancements in delivered customer value and increase the overall effectiveness of the organisation".

The literature highlights the importance of process understanding within the business. For this context an understanding of the process and what is produced rather than how it is produced is imperative.

The lessons learnt from the late 1980's and early 1990's indicate a consensus that BPR is not always the best methodology to follow. It is apparent an understanding of current processes is more important. Once this is established, organisational strategy can be formulated. The aim of the project is to formulate a user-friendly tool to start the building block of process understanding within ME. The project is not concerned with reengineering Manufacturing Engineering but rather setting the stage for business process improvement.

# Chapter Three

# Methodology

## 3.1 Introduction

The first task undertaken was to establish what process ME and BAe Airbus use to capture process. Key managers, the industrial supervisor and leads generated in ME, identified the key people to be interviewed. The people interviewed and their particular area of expertise can be found in Appendix B.

## 3.2. Problem statement

A lack of understanding on how each function inter acts and relates to one another. There is a requirement for a top-level understanding of process. There is no uniform method available to capture or represent process within ME and/or BAe Airbus.

## 3.3 Objectives

The aim of the project is to define a methodology for the mapping for Condition of Supply, a Manufacturing Engineering (ME) sub function. The methodology will be modular; thus it can be applied to any area of ME or the rest of the business. It is vital to have the correct methodology before application of the modelling tools. Ease of application and integration with current practices is considered and taken into account.

It is vital that the function understands why it is important to map processes. From this point of understanding a model can be built up of the whole department. ME can input into other areas of the business by having clearly defined and de-marked processes.

The main objectives are as follows:

- A common approach and understanding of why process mapping and documenting is required.
- A demonstration of how and what model will operate in the Manufacturing Engineering.
- Show current practice and transition to next stage.

- Future opportunities through the report and next steps.

## 3.4 Scope of research

The scope of the research is confined to looking at one particular function within BAe Airbus. However the research does extend to reviewing the current company practice. Due to time restrictions it was not possible to review all core processes that are contained within ME. The process improvement process only starts with using the correct methodology for process capture. Once this is established performance measurement can begin. It is not in the scope of this project to review what needs to be measured.

*Timetable of Research*

A timetable of research can be viewed in appendix A.

## 3.5 Methodology of research

The first step of the thesis was to establish the current practice of illustrating process within BAe Airbus and ME. A literature search was then carried out using the British and Cranfield University libraries. The Internet was utilised in the quest for current thinking and practice in the area of process understanding and improvement. At the present time there are three ways in which process is represented within BAe Airbus they are:

1. IDEF
2. Unified modelling language (UML)
3. ABC flow charter, QMap a flow diagram software package

It is vital to establish quality data for input to the models. As the old adage, garbage in equals' garbage out applies to this scenario. To develop the framework semi structured interviews were conducted with key members of ME who are involved in raising Conditions of Supply (COS). It was important to speak to the expert people from the outset. Stephen Bryce, the industrial supervisor, initially identified these experts. Leads began to develop form the experts initially identified. These experts were then interviewed. A framework could then be established on the information gained from condition of supply. The framework can be applied to any function within BAe Airbus or ME.

## 3.6 Condition of Supply (COS)

To understand and capture the Condition of Supply (COS) process in Manufacturing Engineering. The aim is to:

1. Understand the process
2. Give examples of what is contained in a Condition of Supply
3. The important elements of a Condition of Supply
4. Give examples of Condition of Supply forms.

The intention here is to support process modellers that are involved in a situation with similar requirements.

The procedure of understanding the process can be broken down to a five-stage process:

1. The objectives of modelling the COS activity is to apply the methodology to a ME activity, the methodology in turn can be applied to any of the ME activities.
2. Interview senior people, extract the knowledge that the people hold about the process and how it fits into the overall function.
3. Interview individuals about their role in the process.
4. Review, revise and validate the models.
5. Analyse the process.

## 3.7 Procedure

To capture this knowledge the research was undertaken using semi- structured interviews. The interviews were recorded on audiotape. Key people where identified who are involved in raising the COS. Robson[29] suggests a semi-structured interview should include the following:

- Introductory Comments
- List of topic headings, with key questions under these headings
- Set of associated prompts
- Closing comments.

The following procedure is an outline of how to capture an expert's knowledge:

1. Researcher to introduce themselves and the topic. Establish what is required. Researcher to phrase questions in a straightforward, clear and concise manner.

2. Explain the aim of the meeting, the method and the interview procedure.
Some warm up questions, these are easy, non threatening questions designed to settle down interviewer and interviewee.
Main body of interview this will cover the main purpose and aim of the interview, which is covered below:

Aim:

- Understand the process
- Give examples of what is contained in a condition of supply
- The important elements of a condition of supply
- Give examples of condition of supply forms.

Method:
Draw knowledge out of experts regarding processes to be mapped. Through semi structured interviews with the purpose of obtaining research relevant information.

Procedure:
Develop process, using Input, Process and Output schema.

3. Define the time period:
Ask the interviewee how much time that they have available. The initial interview is not planned to be longer than one hour.

4. Display an example of the input, output process schematic.

5. Make clear that key interview topics are covered the interview s will be recorded. All information given is to be kept in strict confidence within BAe Airbus, and not to be used for external publication.

The questions asked can be found in Appendix B. The aim of these questions will help the researcher in establishing the process. The final stage of the project required validation from the key users of the framework in ME.

# Chapter Four

# Current process Modelling Practices

## 4.1 Introduction

BAe Airbus is a large organisation so it is inevitable that different groups within the organisation capture process in different ways. What follows is a summary of the main groups that were interviewed (ACE, PIP and SCAMP) to establish how they capture process. This chapter also incorporates the outputs of the data collection phase. The results show the main modelling techniques that ACE, PIP and SCAMP use. The data was gathered through holding and semi structured interviews with key people. The interviews were recorded on audiotape. A review of the modelling technique and how it operates follows in the latter half of this chapter.

## 4.2 Airbus Concurrent Engineering (ACE)

The Airbus consortia of companies have established a team of people who are looking at the future requirements of the organisation. This team is called ACE. The group consists of engineers from the four main companies, Aerospatiale, Chrysler Benz Aerospace, CASA and British Aerospace. Its role is to progressively develop and implement concurrent engineering methods and processes between the partners by the year 2000. The aim of ACE is to "Develop tools, methods, organisation and processes across the partnership, to support the aircraft programmes in reducing cost and lead times, while improving quality and delighting customers".

ACE recognised that a prerequisite of Concurrent Engineering is the common understanding of the aircraft design, "which demands for definition of a structured design process". Major events in the downstream design process to develop a new aircraft or major derivatives are marked be generic milestones. These milestones start at zero and result in aircraft delivery at fourteen. The fourteen milestones can be found in Appendix C.

## 4.3 The Product Improvement Process (PIP)

The mission of the organisation is to "Progressively develop, implement and support cross business process capabilities associated with the introduction of our products; thereby enabling aspirational levels of business performance to be achieved." The objectives of PIP organisation is as follows "Develop and deploy new processes and tools to enable BAe Airbus to design, build and support aircraft in less time, at reduce cost with improved quality". The aims of PIP are in line with the Airbus Concurrent Engineering project and will be achieved in conjunction with Airbus aircraft programmes, these are:

- Provide a strategy for common processes and team working across the Airbus partnership, including suppliers and customers by the year 2000
- Implement a process system that enables Airbus Industry to complete the cycle from "go ahead" to "entry into service" for new products with a 30% reduction in costs.
- Implement a process system that enables Airbus Industry to achieve a 30% reduction of maintenance costs.

The functional manager has ownership of their particular functions process. It is the manager's responsibility to develop the processes. A simplified process map and PIP interaction with functions can be found in Appendix D.

## 4.4 Supply Chain And Manufacturing Process (SCAMP)

SCAMP is responsible for the role out of a new SAP system within BAe Airbus. Foe the SAP modules to function correctly it was necessary for this group to map the manufacturing process. The system went live on July 5. SCAMP provides one integrated business plan with a single database using SAP software, replacing a variety of older supply chain applications used in various parts of the business. According to the promotional literature "SAP will automatically generate orders for components from our suppliers when they are needed for manufacturing".

## 4.5 IDEF0 at BAe Airbus

The ACE team makes extensive use of IDEF0 mapping. This is due to the fact that the ACE program is run across the consortium. The intrinsic structure is represented by figure 6.

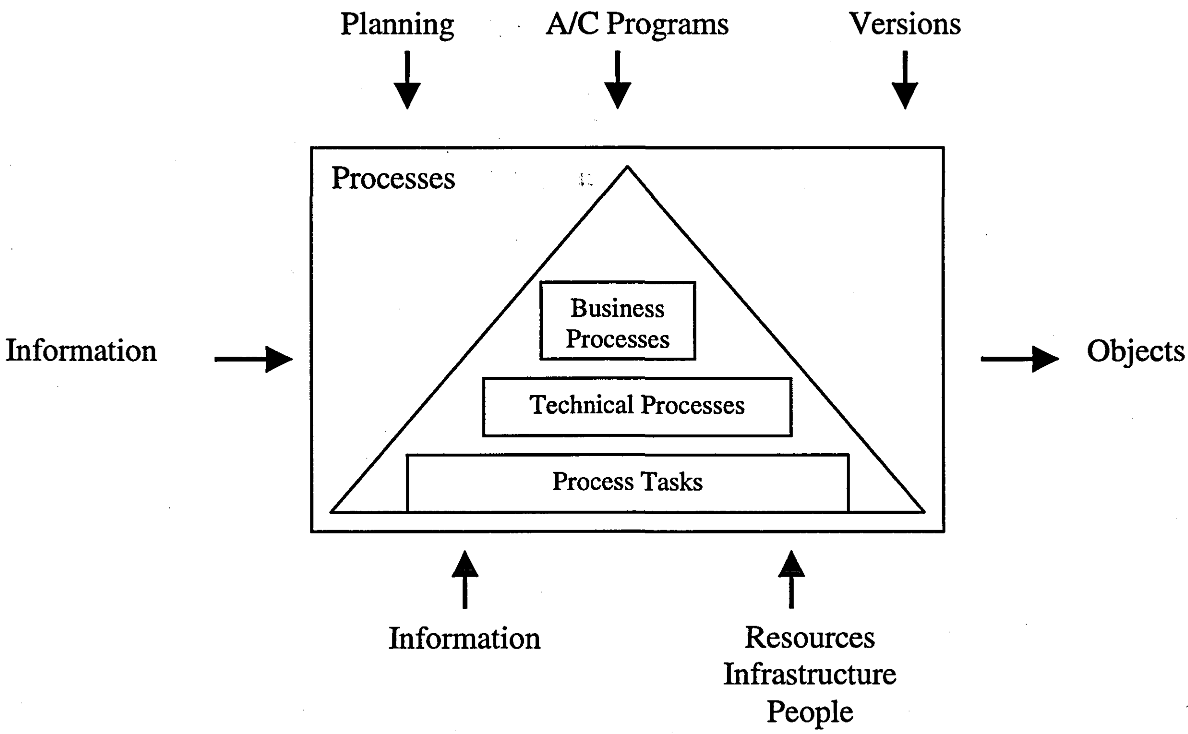



**Figure 6 ACE Intrinsic Structure**

## 4.6 IDEF0

At the present time the most commonly used tool at BAe Airbus is IDEF0. The ACE team has made extensive use of IDEF0. The partners in the consortium also favour the technique. To this end it provides a common modelling platform. However the general consensus indicates that it is difficult to understand and the model has a tendency to drill down too far into a particular function. This means that when IDEF0 has been used in the past the user has ended up with a mass of unfathomable processes.

As Mayer states[30]

"One of the observed problems with IDEF0 models is that they often are so concise that they are understandable only if the reader is a domain expert or has participated in the model development".

The purpose of IDEF0 is summarised by deWitte, and Pourteau[31]:

IDEF0 accomplishes the following:

- Captures the elements needed to execute a process
- Models relationships, not steps
- Identifies core processes
- Identifies redundant, non-value-added processes
- Assists activity-based costing scenarios.

The IDEF0 model diagram displayed over is based on a simple syntax. Each activity is described by a verb based label placed in a box. Inputs are shown as arrows entering the left side of the activity box while the outputs are shown as exiting arrows on the right side of the box. Controls are displayed as arrows entering the top of the box and mechanisms are displayed as arrows entering from the bottom of the box. Inputs, Controls, Outputs, and Mechanisms (ICOMs) are all referred to as concepts.

Figure 7 below is a graphical representation of the IDEF modelling process.

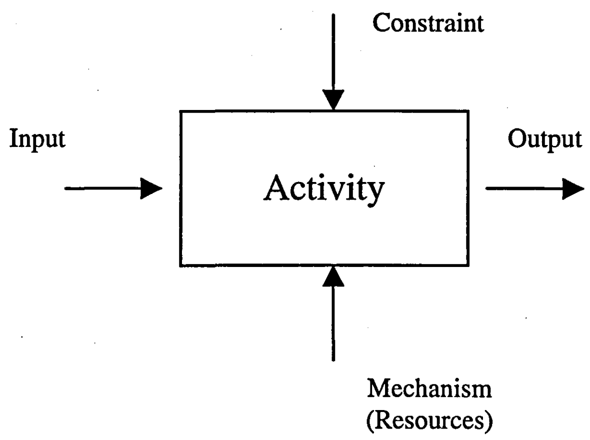



**Figure 7 IDEF Process**

An IDEF0 model diagram is then composed of several activity boxes and related concepts to capture the overall activity. IDEF0 not only captures the individual activities but also reveals the relationships between and among activities through the activities' related concepts. For example, the output of one activity may in turn become the input, control, or even a mechanism of another activity within the same model

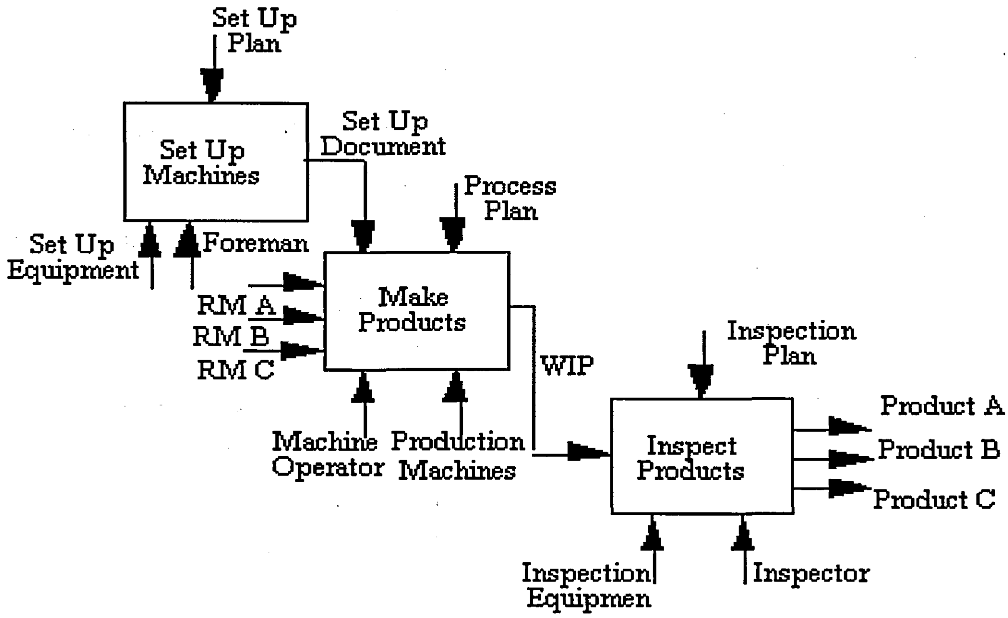



**Figure 8. Basic Construction of an IDEF0 Model**

Wu[32] summarises the disadvantages with IDEF0 as follows:

- Difficult to comprehend in a short period of time
- Cumbersome
- Ambiguity of function specification
- Static nature

Wu concludes:

"Such a hierarchy of functions model does not explicitly represent the conditions or sequences of processing-these are usually described in the text of a functions descriptions, but not shown in the model itself".

The confusion that lies behind IDEF0 is the tendency of IDEF0 models to be interpreted as representing a sequence of activities. IDEF0 is not intended to be used for modelling activity sequences, it is easy to do so. The activities may be placed in a left to right sequence within a decomposition and connected with the flows. It is natural to order the activities left to right because, if one activity outputs a concept that is used as input by another activity, drawing the activity boxes and concept connections is clearer. Thus, without intent, activity sequencing can be imbedded in the IDEF0 model. In cases where activity sequences are not included in the model, readers of the model may be tempted to add such an interpretation. This anomalous situation could be considered a weakness of IDEF0. However, to correct it would result in the corruption of the basic principles on which IDEF0 is based and hence would lose the proven benefits of the method. The abstraction away from timing, sequencing, and decision logic allows concision in an IDEF0 model.

## 4.7 UML at BAe Airbus

UML modelling started at the Filton site in January 1999 on the PIP project. Consultants from Computer Sciences Corporation (CSC) are conducting the modelling. The aim of the exercise is to understand the activities so that the information technology can be designed to support the activities of the workers. This in turn allows the workers to integrate with the IT system so the worker becomes an actor. When the modelling started the consultants had IDEF type process models. There are 14 milestones to pass through when producing an aircraft. This was decomposed on to two hundred and fifty sheets of A0. The original aim to understand the process was lost in mountains of paper work. The engineers felt that a useful way of understanding the process was to decompose all 14 milestones on to a single piece of A0 paper. The aim of this modelling activity is to show who are the external actors, that derive services from BAe Airbus. These external actors express the main reason why the organisation is in business; this has been established as follows:

- Manage partnerships
- Manage PLC relationship
- Manage government relationship
- Mange regulatory bodies
- Manage suppliers
- Manage customers.

This list is the basis for the top level model. From this basis organisational units are also modelled. This gives a picture on the way the business is organised to provide the core services

The consensus from the consortium is a move away from IDEF and a shift to UML. The way in which the transition occurs will be of significant importance for the rest of BAe Airbus.

## 4.8 Unified Modelling Language (UML)

It became apparent that the lack of standardisation of the object oriented modelling field had become a serious problem. Every method, tool and practice has its own set of symbols and terminology, resulting in confusion and frustration for those constructing the models.

There are many different vendors of the software, CSC uses Rational Rose. The definition of UML from the Rational web site is as follows[33]: "The Unified Modelling Language (UML) is the industry-standard language for specifying, visualising, constructing, and documenting the artefacts of software systems. It simplifies the complex process of software design, making a "blueprint" for construction". Rational Software's industry-leading methodologists led the UML definition: Grady Booch, Ivar Jacobson and Jim Rumbaugh.

The goals of UML, as stated by the designers:

- To model systems (and not just software) using object –orientated concepts
- To establish an explicit coupling to conceptual as well as executable artefacts
- To address the issues of scale inherent in complex, mission – critical systems
- To create a modelling language usable by both humans and machines.

UML models requirements visually and allows the user to analyse those requirements from a verity of views. Within BAe Airbus there has been at attempt to establish a standardised modelling procedure within PIP area. This is important for the integration with the other members of the Airbus consortium. The aim of UML is to provide a seamless interface from the enterprise right through to the information technology solution. The model can be utilised either on engineering solutions or process driven solutions. UML models visually requirements and to analyse the requirements and give a variety of views. The views that it can offer are:

- The workers
- Business logic that is being used to produce the services that the workers require

These are modelled by a variety of diagrams. The use case diagram that has an "actor" and a "use case". The actor is the person who is getting the service. The use case describes the service the actor is going to receive. The use case than can be expanded in terms of sequencing diagrams, state transition diagrams, and activity diagrams. This system allows the user to understand what is happening by giving different views and expose any gaps or problems. UML allows

- The user to capture business requirements
- Leaves an audit trial back to the original user
- Generation of test scenarios for the use case.

The test is related back to the original requirements, which are listed in the test case.

The IEDF0 model does not show who is getting the services of the organisation, the inter action between activities and concurrency. The result is using IDEF0, as a tool is that a lot of different people in different departments working in parallel using each other's information might not realise the fact. Hence people could be replicating effort and time spent on an activity. UML addresses these shortcomings of IDEF0.

Object orientated technology has been a growing technology during the late 1980's early 1990's. It is claimed to hold out the best prospect for large-scale software systems because it is modular. Object orientated technology is about creating classes and sub classes, which inherit the functionality of the superior class.

It is component-based architecture where the executables are bundled together inside components that declare an interface. Other software programmes then call up that interface. The advantage is that the user can change the components as much as required however, the process remains the same

Many UML tools are starting to appear. The most popular visual modelling tool is Rational Rose from Rational Software the originators of UML. The diagrams are the actual graphs that show model element symbols arranged to illustrate a particular part or aspect of the system. A system model typically has several diagrams of each type. Examples of these diagrams can be found in the Appendix E, these include:

- Activity Diagrams

An activity diagram shows a sequential flow of activities. The diagram is typically used to describe the activities performed in an operation, through it can also be used to describe other activity flows, such as a use case or an interaction.

- Use-case diagrams

This shows a number of external actors and their connection to the use cases that the system provides. A use case is a description of a functionality that the system provides. The description of the actual use case is normally done in plain text as a documentation property of the use case symbol, but it can also be described using an activity diagram.

- Sequence diagrams

A sequence diagram shows a dynamic collaboration between a number of objects. The important aspect of this diagram is to show a sequence of messages sent between objects. It also shows an interaction between objects, something that will happen at one specific point in the execution of the system. The diagram consists of a number of objects shown with vertical lines. Time passes downward in the diagram, and the diagram shows the exchange of messages between the objects as time passes in the sequence of function. Time specifications and other comments are added in a script in the margin of the diagram.

- Collaboration diagrams

A collaboration diagram shows a dynamic collaboration, just like the sequence diagram. It is often a choice between showing a collaboration as either a sequence or collaboration diagram. In addition to showing the exchange of messages, the collaboration diagram shows the objects and their relationships. The decision to use sequence or collaboration diagrams is determined by:

- If time or sequence is the most important to emphasise, sequence is appropriate
- If the context is important collaboration should be the choice.

- Class diagrams

A class diagram shows the static structure of classes in the system. The classes represent the "things" that are handled in the system. Classes can be related to each other in a number of ways: associated (connected to each other) dependent (one class depends/uses another class) , specialised (one class is a specialisation of other class), or packaged (grouped together as a unit).

- State diagrams

A state diagram is typically a complement to the description of a class. It shows all the possible states the objects of the class can have, and which events cause the state to change.

- Component diagrams

A component diagram shows the physical structure of the code in terms of code components. The component's come in three types, source code, binary component or an executable component.

- Deployment diagrams.

The deployment diagram shows the physical architecture of the hardware and software in the system. The diagram can show the actual computers and devices, along with the connections they have to each other. It is also possible to show dependencies between components.

## 4.9 Construction of UML Model

To make a UML model, the modeller must first collect the data. Eriksson and Penker[34] have produced a flow diagram to assist this data collection process.

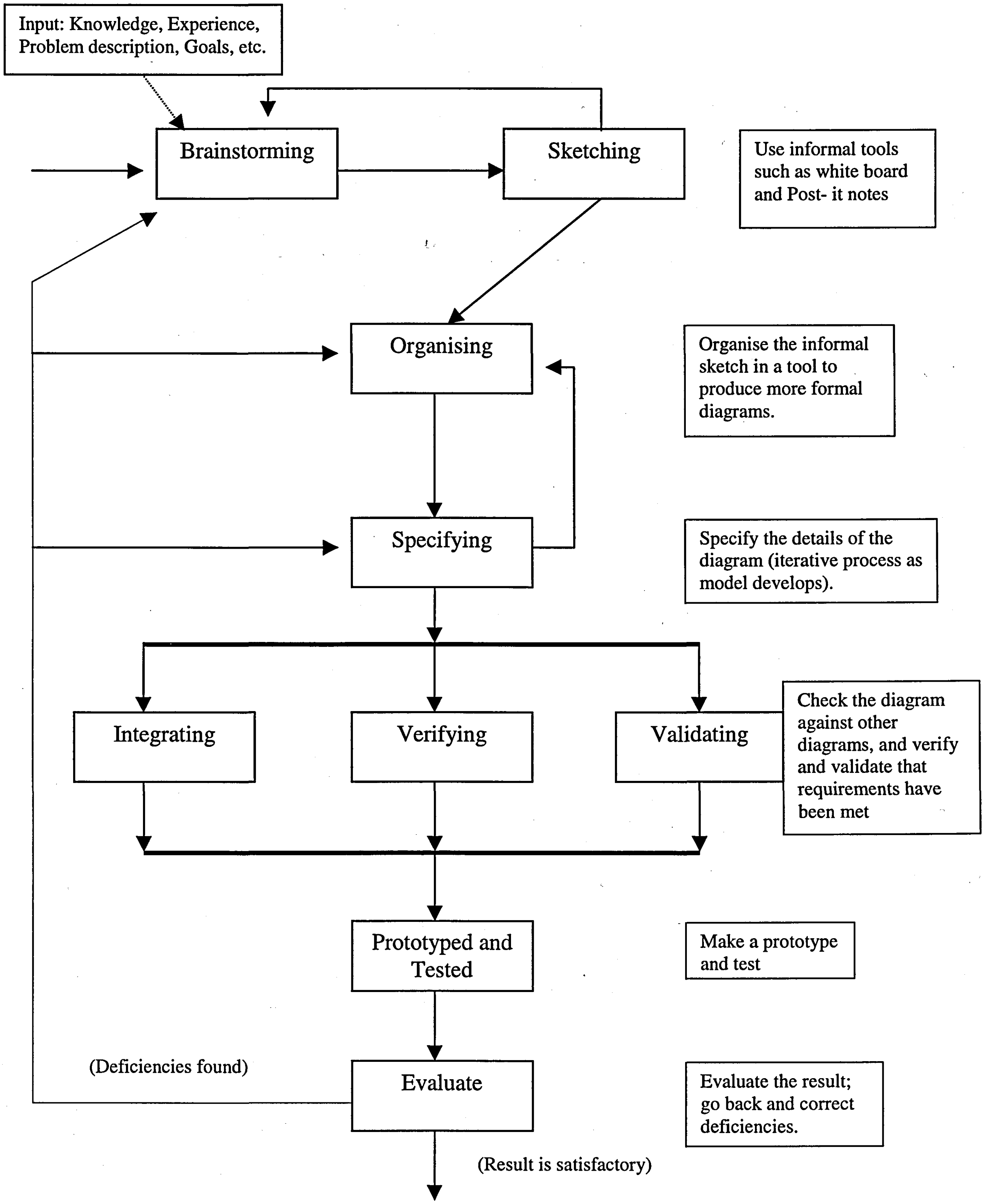



**Figure 9 – Construction of UML Model**

## 4.10 ABC FlowCharter, QuickMap (QMap) and SCAMP

SCAMP utilises ABC FlowCharter to map the business processes that they are concerned with. ABC FlowCharter is a program for diagramming, modelling, analysing, and auditing business processes. With the analysis tools you can create flowcharts for modelling existing processes, graphically portray present job flows, and facilitate improvement through cause - effect diagrams. The inclusion of the ABC Data-Analyser lets the FlowCharter generate statistical quality charts. The analysis tools are not used. The tool is used a way of representing the flow of information that is stored in the experts head. Each process box contains a number, this number relates to a text description about that particular process. An example of this along with a SCAMP process description for COS can be found in Appendix F.

Other parts of the business are starting to adopt a new flow diagram package called QMap. SCAMP will replace ABC FlowCharter with QMap. The package produces the same flow chart diagrams that ABC FlowCharter produces. The program utilises the Inputs, Controls, Outputs, and Mechanisms that IDEF uses (figure7). QMap has a methodology that can be combined with the software. It offers a greater amount of functions than ABC FlowCharter does. At the present time the software is not being used to its full potential. As it is new to the organisation, there is no formal training yet offered. This means that in practice the users interface with the program in the same way they presently do with ABC FlowCharter.

It would be of great benefit if BAe Airbus held structured training in the use of QMap. Training would mean that the tool could be utilised to its maximum capability.

## 4.11 Summary

This chapter has reviewed the current process modelling practices, within BAe Airbus. It is clear that there are several ways of representing process within the organisation. The fact various departments use different measures makes it difficult for the departments to share information. It is conceivable that various departments might be mapping similar process, but because it is represented in different ways a certain amount of duplication and thus waste is occurring.

# Chapter Five

# Top Down Approach to Capture Process

## 5.1 Introduction

A top down approach means that people within the organisation can understand how functions fit together within ME. To develop and validate the approach a case study of COS took place to represent the suggested framework in practice.

This top-level understanding is the first step to achieving modular processes. Building a modular process refers to the ability to hide information behind an external process. For example the basic operation and purpose of condition of supply can be transposed into the following framework. The modules can present a well structured interface to the world, while still preserving design freedom in their internal structure.

The top level at BAe Airbus is from concept to production, the role within ME is to decide on a strategy on assembly, design and to produce a data set for build and assembly drawings. Within ME there are sub functions. There is already a simplified process flow diagram in existence Appendix G. This process flow has been broken down into four simple streams, parts, tools, process specifications and equipment.

Coopers & Lybrand have developed the following table (figure 10) with regard to Business Process Re-engineering. In this case it is not required to re- engineer the organisation. However the table represents the essentials of understanding and gaining benefit from mapping the business process. The philosophy behind the diagram echo Japanese working practices. Workers are encouraged to share different views within the team. The team is made up of people with a cross section of expertise. It is usual in Western organisations that a project team consists of people from similar functions. This makes it difficult for an outsider to participate and contribute new ideas in this sometimes, hostile environment.

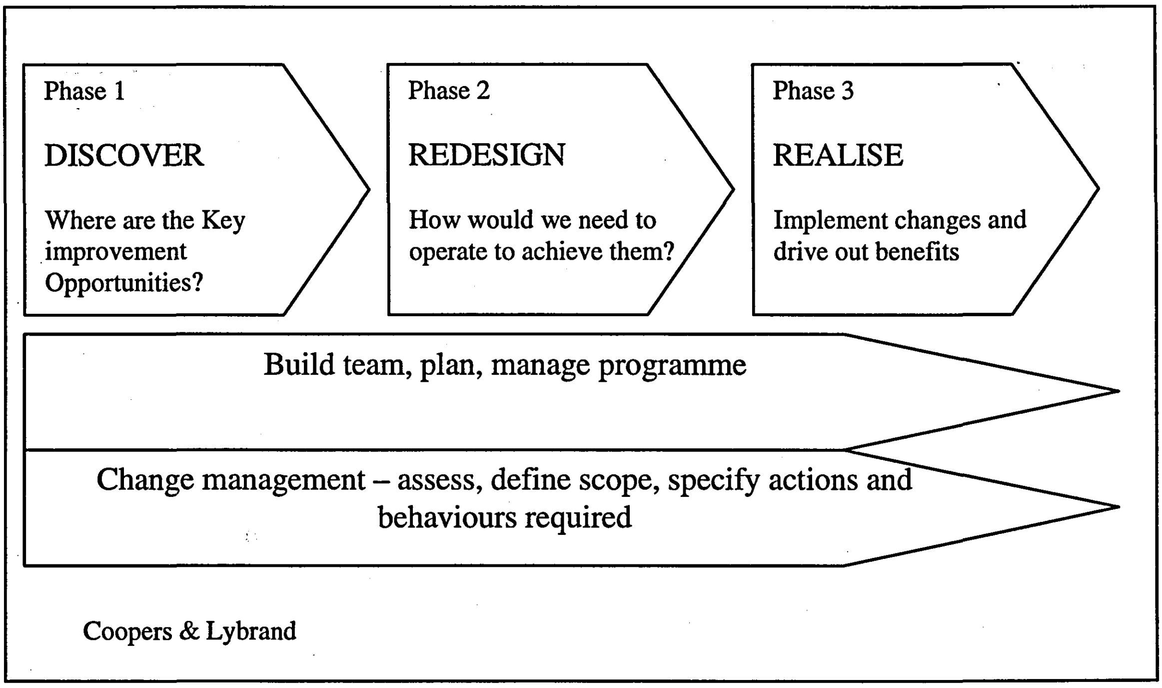



**Figure 10 Coopers & Lybrand Model of BPR**

This model should include a loop back to the start. The process is on going, not just a one off improvement. The key to understanding and improvement of the process is to repeat and modify the process to keep pace with technology and organisational change, as in the Anderson Consulting process excellence blueprint (figure 2). The following top down methodology is easy to understand and execute in a business environment.

## 5.2 Methodology to capture core process

The core processes represent the key activities and outline how these inter-link with each other to create customer value. What follows is the methodology framework to capture the overall business processes that are contained in BAe Airbus or ME. The framework is not concerned about the support functions as theses run across the core functions. Once the core functions have been fully understood, the support functions can be mapped to show how they inter act with the core functions.

The requirement is to provide a methodology that is:

- Easy to use
- Easy to understand
- Can capture data for different modelling tools

- Can be used in ME and the wider environment of BAe Airbus
- Differentiates between core and support processes
- Does not bombard the author or the reader with unnecessary information
- Can be used as a reference aid
- Has involvement of process owners
- Reduces amount of paper
- Not deemed to be a paper exercise.

The following framework has been designed with the aforementioned in mind.

*Flow diagram to show top down approach*

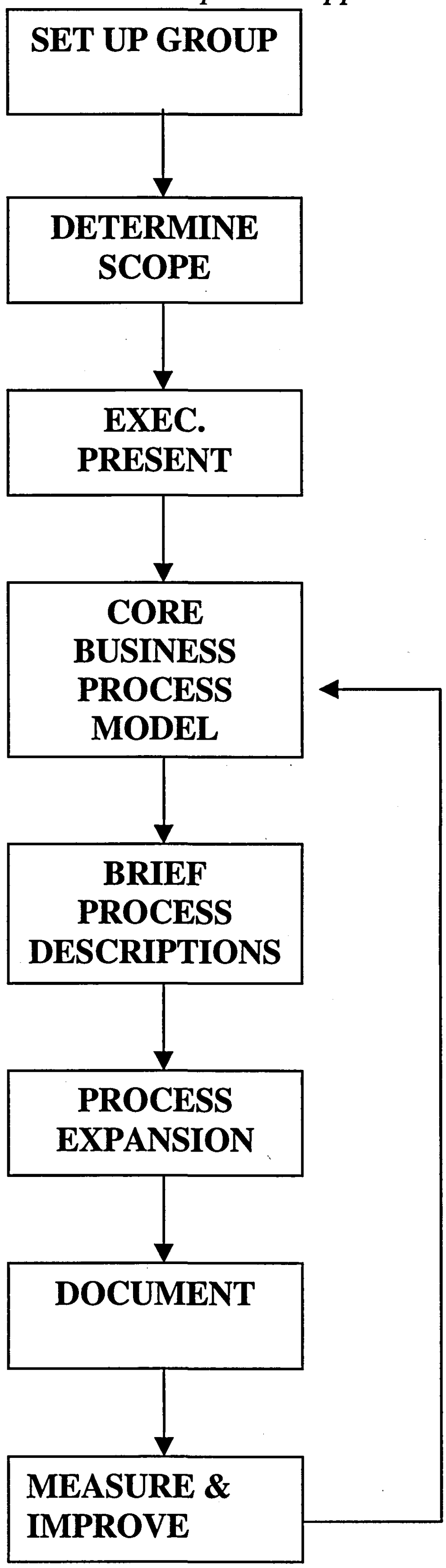



**Figure 11 – Stages of Framework**

To explain the diagram it is useful to brake it down in its constituent stages.

### *Set up group*

This group of people is consists of the managers of each respective process. These people are the experts. They should buy in to owning the process. The process improvement will not happen by itself. The executive improvement team should be deeply involved in setting priorities for the business processes, appointing process owners and reviewing progress.

### *Determine Scope*

The objective of this stage is to make sure that there is general agreement amongst the experts on the scope of the task. The process owners need to reach and agree on the scope of the process and define the process boundaries. For example the purpose of the session might only to be the mapping of a single sub function within a main function. The important point is this approach is concerned with the high level processes at this stage. Later on these processes can be broken down to low level activities. In this case the top enterprise methodology is limited in scope to Manufacturing Engineering.

### *Executive Presentation*

Once the scope of the process improvement has been carried out the activities must be started. This presentation should cover;

- An overview of the process improvement concept
- Sample business process problems currently facing the company, in this case COS.
- A request to approve the concept
- Gain buy in and agreement.

If the scope were enterprise wide the presentation would be made to the main executive board. However in this case since it is on a macro level the key managers in ME will be the audience.

### *Core Business Process Model*

At this stage the core processes are mapped out. The Core functions are then further decomposed into sub processes. These business functions can be mapped out on a flow diagram, with the supporting function mapped on the outside. The supporting processes are functions such as finance, human resources and information systems. These are essential to enable the core activities to be carried out effectively.

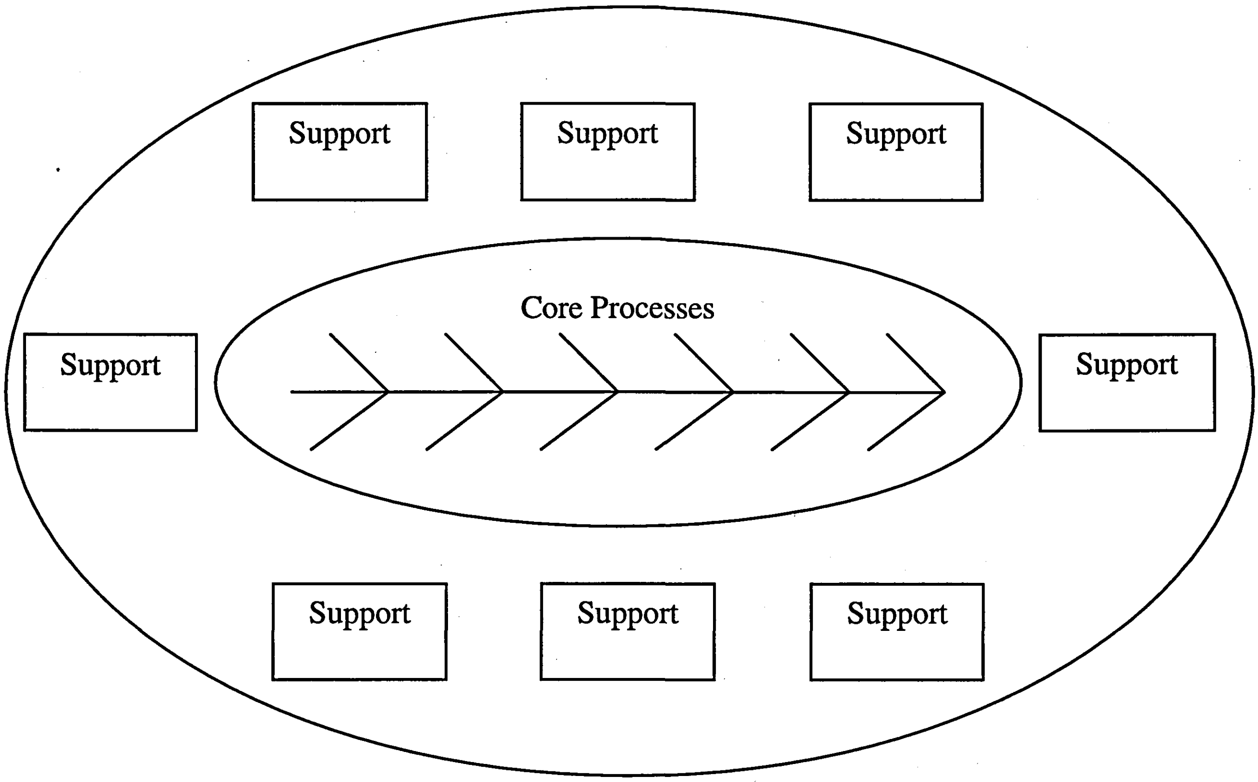



**Figure 12 Core Process Description**

*Brief Process Descriptions*

Once the core business process model has been established, a process description should be transcribed into the following template.

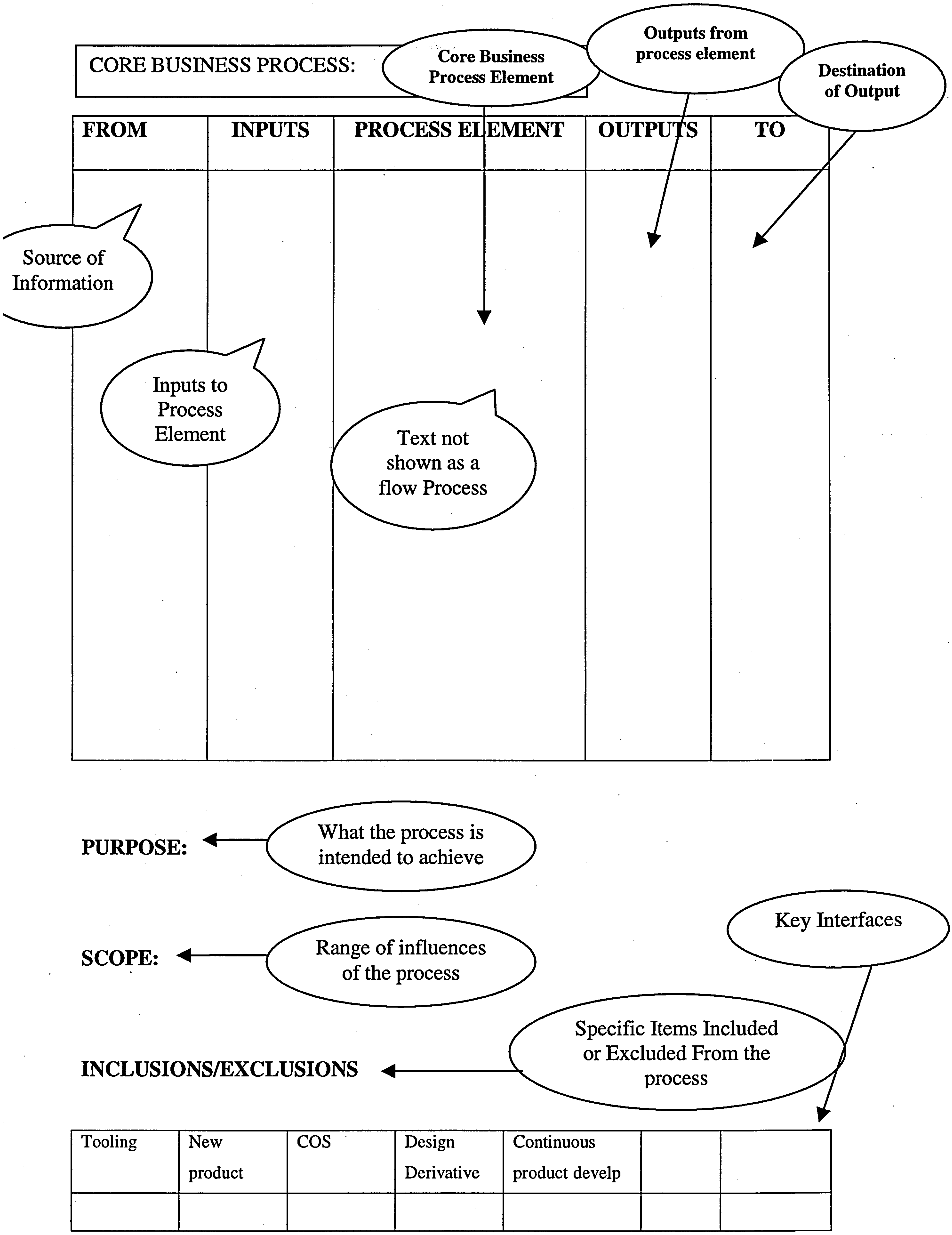



**Figure 13 Core Business Process Framework**

The grid at the foot of the core business template relates to the core business functions. For example it shows graphically if tooling shares process with new product. If it does, a dot is placed in the box to show that the two functions share process.

### *Process Expansion*

This stage expands each box, whilst at the same time keeping the expansion brief, thus not over loading the user with data. A more detailed expansion for each of the items follows on and then is put into a flow chart.

To expand the process requires the use of process mapping. A process map is a graphical representation of the sub processes that support the core process. If the sub process representation does not drill down to a detailed enough level that particular box can be broken down to activity and then further to task level if required. The flow-charting should be kept at a simple understandable level.

### *Process maps*

The process map is used to support the top-level understanding of the process. It has several advantages. The maps give a clearer explanation of a process than words. In this context they are highly usable because they enable the team to clearly see the process involved with the function and identify waste and areas of improvement.

### *The Mapping Process*

Much of the advantage lies not with the maps themselves but the process of actually producing them. Although the output should be an accurate reflection of how and when key points occur. The team works together to produce an end to end map of the processes in which they work they gain an understanding of others' tasks and problems and how they contribute to these.

### *Document*

The next task is to identify what kind of document is required to capture that process. To establish this, the user must ask the question. If the process document were not available what would happen? If the process is critical to the business a procedure or work instruction needs to accompany this part of the process. A procedure is a written regulation in operational process establishing a sequence of events, interfaces and responsibilities that affect *more than one* organisational function. A work instruction fits behind the procedure, it drills down into greater detail. The work instruction is a written regulation in operational process establishing a sequence of events, interfaces and responsibilities that are contained within a *single* organisational function. Procedure is easy to assimilate from a management perspective. A procedure can have a number of work instructions. From this key performance indicators can be developed at a later stage. These key performance indicators will enable the business in measuring themselves and tracking performance improvements within the process. A guideline is written to assist a particular function in identifying the non-critical activities affecting more than on organisational function.

Figure 13 shows a decision table to serve as a guide when writing procedures, work instructions or guidelines.

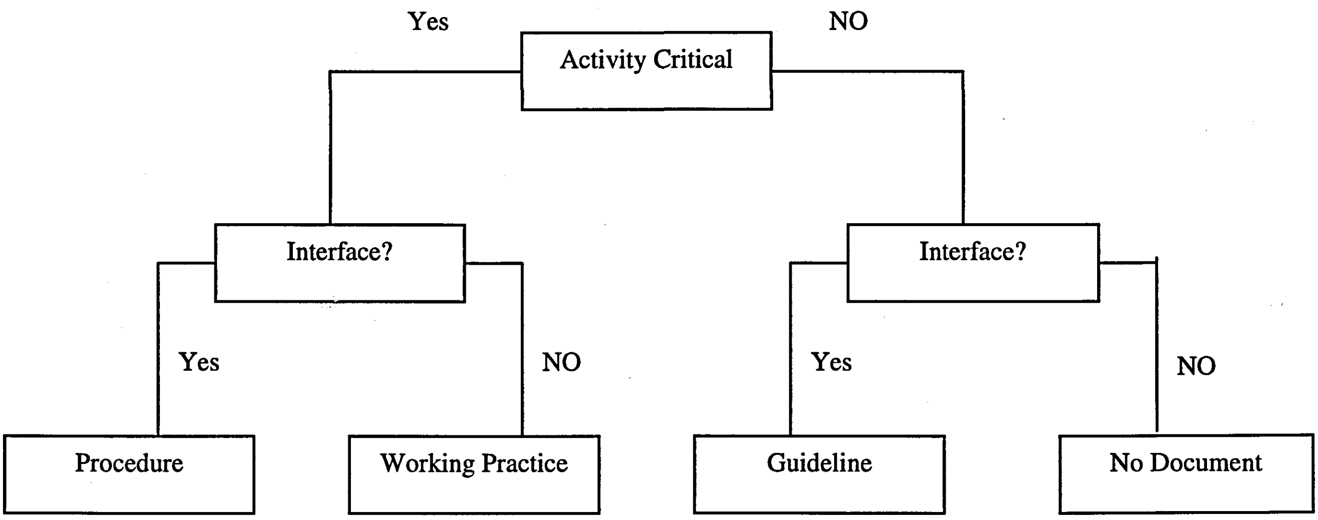



**Figure 14 Decision table for procedures**

## *Measure and Improve*

Figure 15 shows Harrington's[35] five-phase approach to a business process model. The reader will note that the process is ongoing and repeatable.

**The five phase approach**

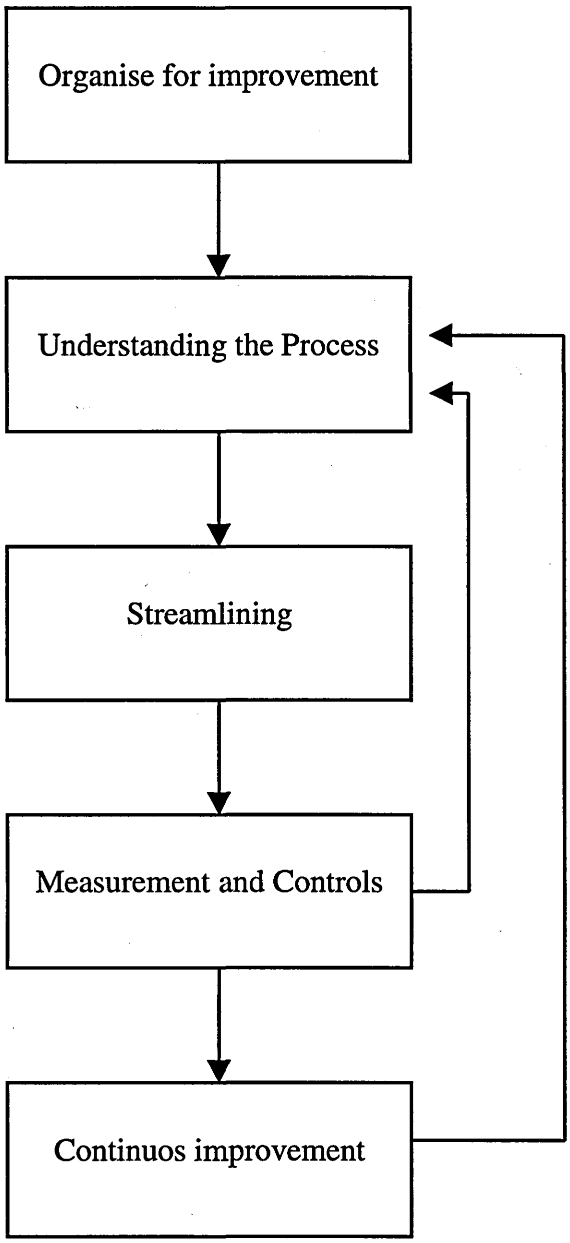



**Figure 15 Five Phase Approach**

From this stage the user can start to monitor trends and devise a set of Key Performance Indicators (KPIs).

*Key message*

The purpose of this methodology is to give top and functional management a top-level view of the processes. Once the basic processes have been noted and understood the users can then review the processes. Consensus is required on the completed diagrams.

## 5.3 Case Studies in Development of Framework

There are two reasons for the case studies:

1. To illustrate the methodology required depicting a robust process overview of the Manufacturing Engineering environment.
2. To validate the framework

COS and Development of New Product where used as an illustration for the development of the framework.

Each process within Manufacturing Engineering will have a current production procedure that can be accessed via the companies Intranet. These documents are authorised by C. Wilcock based in Broughton. The COS is shown as an example to future process modellers on how the process of knowledge capture can be represented.

A COS is an open document that uses the original design drawing, but also might add additional stipulations for the production of an aircraft component. For example, a drawing goes out to an internal/external supplier with the Condition of Supply attached. The drawing might show that the component requires 100 holes, however the manufacturing engineer might only require 75. The condition of supply document provides this information to the supplier of the component in the form of a manufacturing instruction. The official definition can be found in the Appendix The examples given are:

- Manufacture complete to drawing
- Drill holes pilot size
- Omit all holes
- Leave trim allowance on a particular edge(s)
- Manufacture from raw material on a later assembly
- Omit some parts for fitting at a later stage
- Reference only, parts fitted at a later stage.

The departments the are involved in raising a COS are the designers working with the production engineers on the shop floor. Any Manufacturing Engineer can raise a COS. If there is a conflict in the way a COS has been raised. The Manufacturing Engineers will take time to understand each other's build philosophies in solving the conflict between the two main sites (Filton and Broughton). There may be a period of negotiation between the two sites to reach agreement on how a component should be produced. In the worst case one side will have to do all the work and in the best case Filton will do half the work and Broughton the other half. At a more detailed level there is not as much negotiation that takes place. The changes that do occur are between the suppliers and the Manufacturing Engineers.

Generically there is only one type of COS, however in effect there are two types; internal/external and intra site. For the external/internal customer the COS is created in PEGS this in turn gets sent on to the factory. When a COS is being raised intra site an interface document is built up with an agreed build philosophy this is done at the start of the project to make sure that both sites understand who is doing what and when the activity occurs in the build sequence. The manufacturing instructions are then based on the COS which is passed through the system on PEGS. When agreement has been reached the relevant manager will sign off the COS.

There is no set format in regards to the layout of the COS it is an open document that the engineer specifies. The only stipulations as to the content are:

- The Aircraft quantity of the part
- The next higher assembly number that the part is required for
- The "Package Code", if the project being worked on requires this.
- The Project, Type, Stage and Sub-Stage where applicable.

If the feedback from the shop floor regarding the COS is incorrect. For example if adding or reducing material would make the product better with a shorter lead-time the COS can be changed.

Once a strategic COS (a component that is out-sourced) is produced, the document is sent to Filton. At Filton the COS is assembled with other documents to produce a product specification. The product specification collates all the technical information necessary to make the component or part. The product specification includes COS, tooling information and engineering manufacturing systems. The sub contractor works to the product specification document. Within the product specification the various sections are:

- Tooling
- Inter-change-ability
- Modification paperwork
- Materials
- COS

A good COS will be one that is easily understood by the recipient and produced in a timely manner. At the present there is not a set time frame that the COS has to be produced in. Errors are not recorded; this has time and cost implications.

Once the process is more fully understood it would be useful to measure the time and quality aspects of COS. An example of advanced condition of supply for A340-600 trailing edge structures can be found in Appendix F.

## 5.4 Condition of Supply in Framework

The following diagram shows the COS in the prescribed framework. This was developed through the interviews. The process flow for COS can be quite complex. It is dependent on what sort of COS has been raised. Filton has different procedures from Broughton. It is also dependent on if the COS is for internal or external (strategic) use.

CORE BUSINESS PROCESS: Condition of Supply

| FROM | INPUTS | PROCESS ELEMENT | OUTPUTS | TO |
|---|---|---|---|---|
| | Cost restraints | | | |
| Manufacturing engineer planning stage | Engineers responsible for parts manufacture | **Compile COS** | Signed off COS | Suppliers |
| | Engineers responsible for higher assembly | | | Assembly Engineers |

PURPOSE: Condition of supply is issued as an instruction from one planning group to another

SCOPE: The procedure applies to all ME teams at Chester, across all projects.

INCLUSIONS/EXCLUSIONS: Filton working practice and sub contract layout for that part excluded

**Figure 16 COS brief process description**

## 5.5 Development of New Product

The second case study used to illustrate the framework is Development of New Product. At present development of new product is represented in IDEF0. It is a complex procedure, which involves the whole organisation. What follows is a demonstration of top-level process of new product development, in the prescribed framework. A flow chart shows the information expansion from the process element (development of new product). This flow chart shows sits behind the module of development of new product. It shows the process required in the development of a new product. If required any of the boxes can be further expanded. The core processes are identifiable by a bolder box. Jim Rowe who is an engineer of many years' experience working on A340-600 aided the construction and validation of the process model.

CORE BUSINESS PROCESS: Development of new products

| FROM | INPUTS | PROCESS ELEMENT | OUTPUTS | TO |
|---|---|---|---|---|
| | Customer requirements | | | |
| Market place | Marketing | Development of new products | Certified Aircraft | Customer |
| | Technology | | | Suppliers |

**PURPOSE:** Design, definition, manufacture and certification of the new product including aircraft prototypes.

**SCOPE:** The establishment of a new market for aircraft

**INCLUSIONS/EXCLUSIONS** ← Specific Items Included or Excluded From the process

**Figure 17 Development of New Product Process Description**

*Process mapping flow chart*

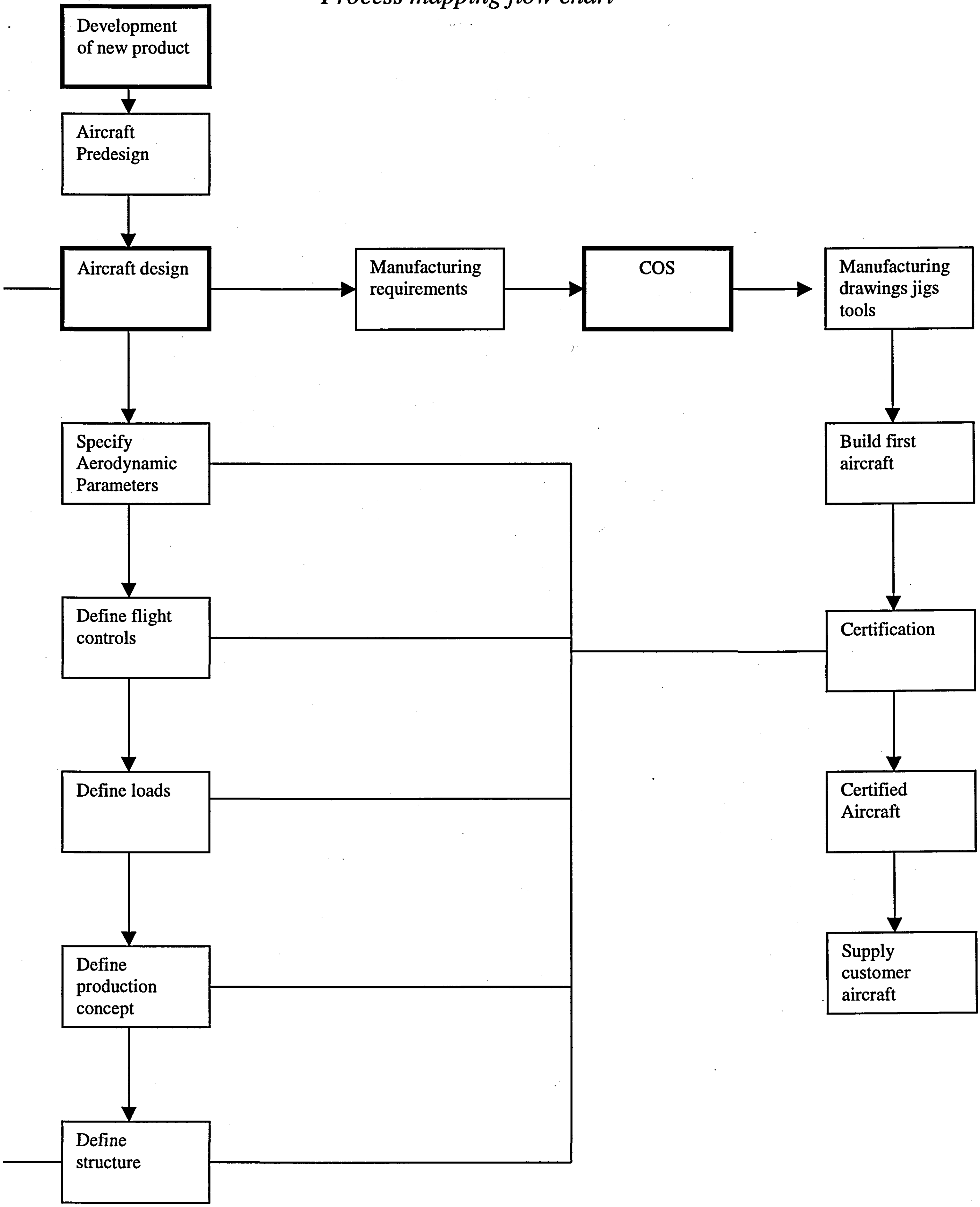



**Figure 18 Process Mapping Flow Chart**

*Validation of results*

After the meetings were held with the staff from around the business. The results from the interview and the process mapping where then checked with these process experts. Any inaccuracies were then addressed until agreement was reached on the correct sequence of events. Furthermore a presentation was given to the industrial supervisor for any additional suggestions for the development of the framework.

*Next steps*

After the core processes have been agreed upon the user can start to review the support processes, such as Human Resources, Finance and Information Technology.

## 5.6 Summary

Once the core processes have been mapped and validated by the experts. The result should be a complete overview of the process from a top level with all the activities contained within the activities behind these main modules. The processes can then be analysed for effectiveness, efficiency and cycle time.

The process framework is designed to capture the top-level processes although it can be utilised to drill down if required. It is modular in its approach because it is concerned with the processes not what occurs behind them. It is the establishment of what actually occurs is important.

# Chapter Six

# Discussion

## 6.1 Introduction

In order for the suggested framework to be implemented a number of factors must be taken into account. What follows is a summary of the points that are poignant in BAe Airbus and ME. The chapter explains a continuation framework in order for ME to map and further understand their processes. The most important next step is implementation of the framework; what follows are recommendations for implementation.

## 6.2 Continuation of framework

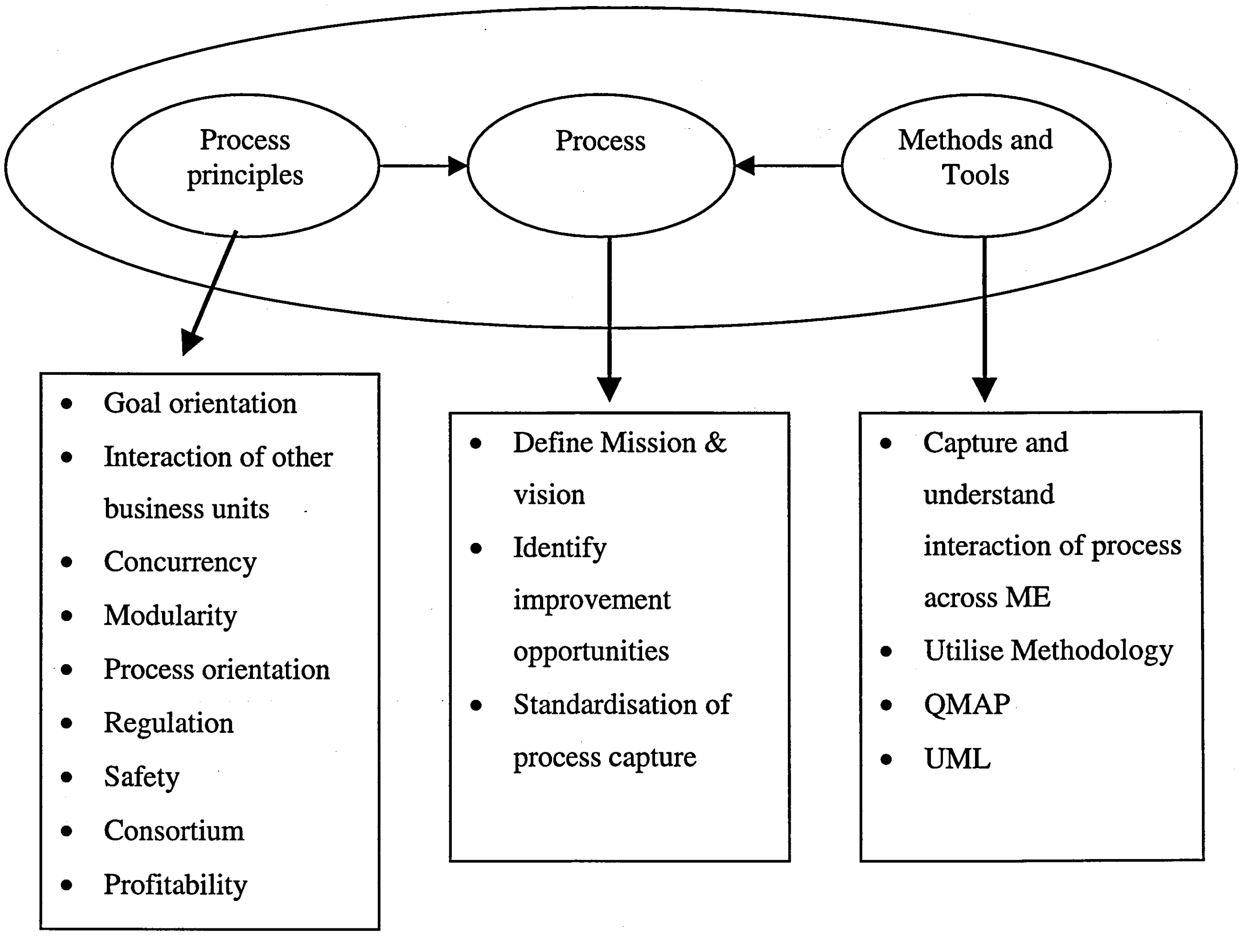



**Figure 19 Continuation of Framework**

Figure 19 represents the framework that ME should adopt in the continuation of the development of process requirements. The process is at the heart of the framework. The box contains a list of considerations for the management of ME. These principals act as foundations at the heart of the framework, the principals have been covered in the thesis. The focus has been on the methods and tools. By ME capturing the process and understanding the interaction that the sub functions play the department can more effective and efficient. Once a full understanding has been gained and process has reached a general consensus the data can be graphically represented either by QMAP (favoured by SCAMP team) or on UML (favoured by PIP and ACE team).

## 6.3 Golden rules to implementation

### *Drive from the top*

Like any other change initiative, it is essential that there is commitment and drive from the top. The senior management must devote a certain amount of resource to the project. The amount will vary dependent on the scope and scale of the task. Clearly within ME this can be kept at a fairly local level. Within the wider organisation this would have to involve a greater proportion of the senior management.

### *Communication*

Before the functional management undertakes the suggested methodology it should be explained to them why a unified approach within ME is necessary. Within the organisation there might be initial reticence to undertake "another" mapping process. Most of the engineers within ME are familiar with IDEF0 and mapping processes. Once these processes have been mapped there is a tendency within the department to shelf the work and get on with the day to day activities. The framework is designed to be simple construct, but more importantly it provides the user with a useful day to day reference document. The completed framework gives all management a greater understanding of ME process.

### *Identify core processes*

This is the first step, as this provides a framework for the process of understanding the underlying and more detailed processes. Once the core processes have been identified and agreed upon, the result is the modules of process.

*Ownership of Processes*

Line managers must be closely involved in the agreement and early testing of the agreed processes. Line managers are critical to successful development. Their input in early design is essential to achieve ownership of the processes. There must be an overall sponsor or champion appointed. This person must have the full support of the management team. There should be representatives from the areas where the process is being reviewed.

*Macro and Micro Politics*

Homa[36] describes Micro politics as;
"interactions required on a one to one basis designed to enrol key influencers inside and outside the organisation". Marco political engagement may be described as a one to many interaction where the objective is to influence a critical mass of discrete populations, for example suppliers, professional groups, trade unions and purchasers. To realise the process culture adopted within ME it is imperative that in time other departments are made aware of how and why ME is process driven.

*Creative use of the Methodology*

When using the methodology strict adherence is not necessary. The methodology is designed for greater process understanding and if necessary entry into modelling tools such as IDEF0 or more usefully in BAe Airbus UML. If the practitioner discovers a more effective way of capturing the process they should feel free to adapt the methodology. It is not the methodology that is important but the results. It is better to measure people on what they produce rather than how they produce it. For example, the worker who can produce one hundred pounds profit in one hour is of greater value than a worker who looks busy for 10 hours, only producing fifty pounds profit. If the user feels that the methodology can be adapted to help their particular situation then the tool can be adapted to ease the solution to a given problem. Other "tools" can be used in conjunction with the suggested methodology.

*Avoid Premature Outsourcing*

It is more useful for integration that the work is carried out in house. The problem with outsourcing the work is once it is finished the knowledge that created the model leaves the organisation.

*Avoid IT department as agent of change*

It will just provide the tool for understanding the process. The framework is simple in its concept. Often people become obsessed by the technology. The process is designed to fit into a certain package. Once the process has been mapped it becomes difficult for the everyday user to gain benefit out of the technology. It must always be remembered that the technology must always be utilised as a tool it does not contain the answers. Initiatives sometimes become bogged down by the over concentration of technical tools at the expense of involvement and leadership. The people who work within a particular function will have ownership and analysis of the process.

## 6.4 Understanding of overall process - Airbus

There is a challenge for SCAMP, PIP and ACE, all three have different ways of gathering and representing the process information. Early in 1999 PIP tried to represent the process flow for all fourteen milestones using IDEF0. The result was two hundred and seventy one pages of A0 paper. Clearly this was of no use to the engineers who required a quick reference point for viewing processes. The processes that were contained within IDEF0 are now being transposed to UML. There should be caution employed when using this method.

- Outside consultants are transposing the processes meaning that they are not in a position to verify maps
- Not to be blinded by technology, the technology should be used as an enabler
- Lack of structured framework. It is better to keep the processes simple and manageable scale
- The technology cannot change or improve the process.

Although SCAMP and PIP share and overlap processes they represent process in two quite different ways. SCAMP favours simple flow diagrams with text written to support and explain each activity within the diagram. It would make greater business sense if these two groups could agree on a common approach. ACE is somewhat controlled by the consortium. The consortium uses IDEF0. If IDEF0 representation appears to complex by drilling down too deep, the framework can be used to represent the top-level processes. The framework is capable of showing process flow right down to the task level.

## 6.5 Understanding of overall process - Manufacturing Engineering

Many of the engineers understand their particular sub processes in great detail. What the majority has difficulty in explaining are the top-level processes and how their particular expertise fits in with other functions in the department. The knowledge already exists in the department. The challenge is to extract the knowledge. Process owners must be appointed. The process owner is the individual appointed by management to be responsible for ensuring that the total process is both effective and efficient. ME need to stop viewing the business as many large functions and start looking at it as many business processes. By using the framework the end result will be a credible map of the core processes. The process owners will feel responsibility and share a greater understanding of their colleges' processes.

It is vital that people in the organisation know why process is important. It should not be used as a threat to expose inefficiencies. It is a tool to make people more effective and the organisation efficient. Once the complete process is understood duplicate processes will start to emerge. These processes can be eliminated so that no two processes are duplicated.

## 6.6 Summary

For effective implementation some consideration will have to be given to a unified approach to process capture and representation. It would be useful for SCAMP PIP and ACE to agree on a common approach to mapping and representing process.

# Chapter Seven

# Conclusions and Future Research

## 7.1 Introduction

This chapter draws on the conclusions that have been made though out this thesis. The chapter also highlights future areas of research.

## 7.2 Conclusions from Thesis

The objective of the project was to establish an approach for the mapping and documentation of ME process. The first part of the study investigated the current practice for process capture in BAe Airbus and ME. The research was carried out at both the Broughton and Filton sites. The research highlights

- The two sites have different processes
- There is no standard methodology for process capture within BAe Airbus or ME
- The three large change teams all adopt a different approach
- Process overload.

The solution to the challenge lies within the suggested framework. The methodology for the framework as demonstrated is able to:

- Easy and simple to understand and requires no software tools
- Captures the core processes
- Capable of drilling down as far as the user requires
- Adaptable for user requirement, top management or at operational level
- Information can be decomposed in to any software environment.

## 7.3 Limitations of research

The main limitation in the research is the sheer size of the organisation. Not only in the number of employees but also because different processes are employed in Filton and Broughton. There are many different departments trying to achieve different objectives. Even if the departments have shared objectives there is a certain amount of a "silo" mentality. The departments all measure process in their own way. Time was a limitation, it was only possible to interview certain people in the time allocated for the project. It would have been useful to gather a cross functional team and to understand how each of them defines process management.

## 7.4 Future research

*Measurement*

When there is a greater understanding of how the process works, the drive will be for greater efficiency through measurement. The department can then start considering appropriate KPIs to put in place. The most important thing about measurement is to measure output and not the effort that goes to produce an output. Measurement is the key to improvement. As Peters famously states "What gets measured gets done". The key processes require effectiveness, efficiency and adaptability measurements.

Effectiveness is concerned with customer or supplier expectations. For example for COS it is important that the document contains everything to deliver the expectation placed upon it. This includes:

- Accuracy
- Timeliness
- Responsive

For COS the measurements might be:

| Expectation | Measurement |
|---|---|
| Accuracy | Number of engineering changes per COS<br>Number of problems found in description<br>Number of complaints regarding notation |
| Timeliness | Time to solve a problem |
| Dependability | Percentage of returned COS<br>Which type of COS are least dependable |
| Responsiveness | Percentage of time with supplier<br>Percentage of time on the manufacturing floor<br>Number of days to correct a problem |

Efficiency measurements reflect the resources that an activity or group of activities consumes to provide an output meeting internal/external customers expectations. An example of this would be throughput, cost reduction and people and tool utilisation. Adaptability measurements reflect how well the process and people react to special customer requests or the changing environment.

### *Elimination of duplicate processes*

Once a unified approach has been agreed and taken, unnecessary processes can be eliminated. ME should concentrate on those activities that are vital in meeting the customer requirements. By doing this it will enable the organisation to refine their overall processes.

### *Organisation*

There is a challenge for the organisation for the business to integrate and align its self. As outlined before all three major organisational improvement groups use different techniques and tools. It is difficult to make a clear distinction where PIP finishes and SCAMP takes over. This distinction would be easy if both groups adopted a unified approach. Research could be conducted on how to best achieve this.

Even within the same functions there is often two processes, one for Filton and another for Broughton. This adds to the confusion over process. It would be beneficial to scrutinise those areas that have different processes for the same function.

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Rupp, R.O and Russell, J. R., "The Golden Rules Of Process Redesign", Quality Progress, December 1994 pp. 85 – 89.

## Online Resources

http://www.reengineering.com/articles/index.htm. Reengineering resource centre

http://www.idef.com/articles/framework/framework_pt1.htm, IDEF Methods

http://spider.dii.osfl.disa.mil/dii/, example of common operating environment for documents

# Appendices

# Appendix A

# People Interviewed

| Person Interviewed | Area of Expertise |
|---|---|
| Alan Lewis | ACE – Design Integrated Build |
| Steve Banks | Process Integration test activity, mapping activities |
| Tim Meddings | Quality systems, Manufacturing Engineering |
| Gareth Williams | Head of Manufacturing Engineering Operations |
| Kenneth Reid | Vision on modular process |
| Sarah Bucknell | ME process data gathering |
| Steve Ash | PIP process Architect |
| Pete Edwards | QMap holder |
| Mark Himpson | ME Scamp Project Manager |
| Allen Wilson | Quality process mapping tools |

# Appendix B

## Questions Asked

**Identification of the interviewee**

NAME:

FUNCTION:

JOB TITLE:

CONTACT NUMBER:

**Identify the area of study.**

Explanation of COS

Which departments are involved?

Which Key personnel are involved with the development of COS?

**Overview of Process**

Purpose of a COS

What are the different types of COS?

Is there a typical COS situation?

Who can raise a COS

What authority do people require to raise a COS

**Inputs to the activity.**

What is the process to develop a COS?

What are the constituents of supply?

Example of COS and what are the key points?

Why are the key points important to the process?

Are there any inputs that you feel are missing?

**Output from COS**

What are the outputs in producing COS

Where do the outputs come from?

When do the outputs occur?

Why do they occur?

Who owns the output?

Are there any outputs that you feel are missing?

## 1. Constraints and Obstacles

Can you categorise the different types of COS?

What are the constraints on the process?

Where and who do the constraints come from?

When do they occur?

Why do they occur?

Who can overcome the constraints?

**2. This phase deals with the mechanisms that are connected to the activity.**

Why is a COS important?

How do you know when you need to raise a COS?

Why do they occur?

Who owns them?

**3. Summarise meeting and check.**

Confirmation of understanding on what has been discussed. Inform the interviewee about the next steps of the project. Confirm that it is acceptable for additional questions at a later period.

**4. Two-way feedback.**

Ask for feedback on method undertaken. Ask the subject if there are any topic areas that have been omitted and whether thy know someone who can supply additional data or has expertise in a complementary area.

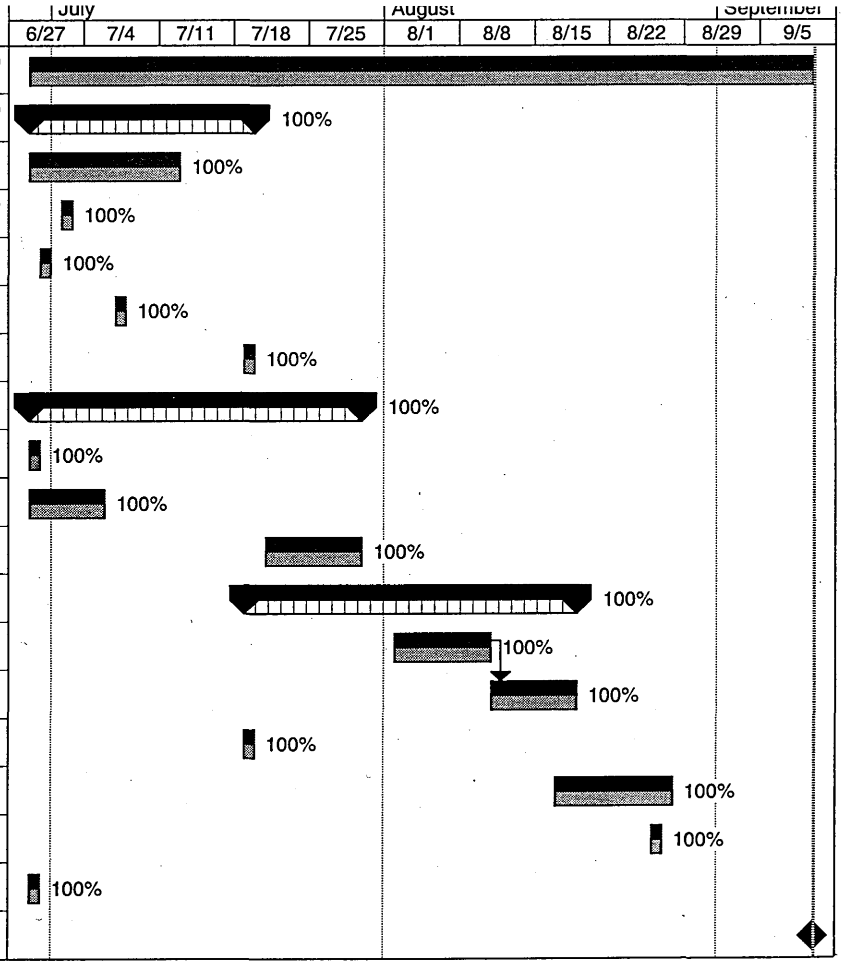
**5. Validation and understanding:**

After interview make sure that all the relevant details have been collected and the tape recording is clear. Produce a summery of the meeting that is subsequently approved and validated by the interviewee.

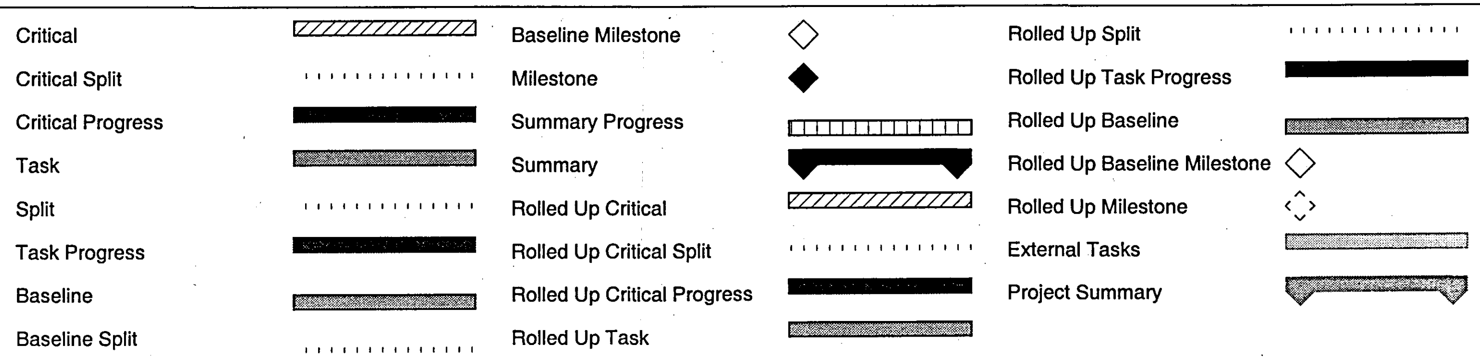
# Appendix C

## Work Plan

| ID | | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 1 | ✓ | Thesis write up | 53 days | Tue 6/29/99 | Thu 9/9/99 |
| 2 | ✓ | **Review existing process capture practice** | **15 days** | **Tue 6/29/99** | **Mon 7/19/99** |
| 3 | ✓ | Literature review | 10 days | Tue 6/29/99 | Mon 7/12/99 |
| 4 | ✓ | British library literature search | 1 day | Fri 7/2/99 | Fri 7/2/99 |
| 5 | ✓ | Meeting to discuss modular approach | 1 day | Wed 6/30/99 | Wed 6/30/99 |
| 6 | ✓ | Meeting on PIP process | 1 day | Wed 7/7/99 | Wed 7/7/99 |
| 7 | ✓ | Review meeting with Raj and Steve | 1 day | Mon 7/19/99 | Mon 7/19/99 |
| 8 | ✓ | **Purpose of modeling process** | **23 days** | **Tue 6/29/99** | **Thu 7/29/99** |
| 9 | ✓ | Identify current holders of information | 1 day | Tue 6/29/99 | Tue 6/29/99 |
| 10 | ✓ | Current best practice filton/Chester | 5 days | Tue 6/29/99 | Mon 7/5/99 |
| 11 | ✓ | Report to identify current model of process across different func | 7 days | Wed 7/21/99 | Thu 7/29/99 |
| 12 | ✓ | **Establish framework process** | **23 days** | **Mon 7/19/99** | **Wed 8/18/99** |
| 13 | ✓ | Creation of process framework | 7 days | Mon 8/2/99 | Tue 8/10/99 |
| 14 | ✓ | Provide demonstration of COS process | 6 days | Wed 8/11/99 | Wed 8/18/99 |
| 15 | ✓ | Meeting with industrial/academic sponsor Chester | 1 day | Mon 7/19/99 | Mon 7/19/99 |
| 16 | ✓ | Write up report | 9 days | Tue 8/17/99 | Fri 8/27/99 |
| 17 | ✓ | Cranfield presentation | 1 day | Thu 8/26/99 | Thu 8/26/99 |
| 18 | ✓ | BAe Airbus presentation S Bryce | 1 day | Tue 6/29/99 | Tue 6/29/99 |
| 19 | ✓ | Thesis hand in | 0 days | Fri 9/10/99 | Fri 9/10/99 |




Project:BAe Airbus
Date: Fri 9/10/99



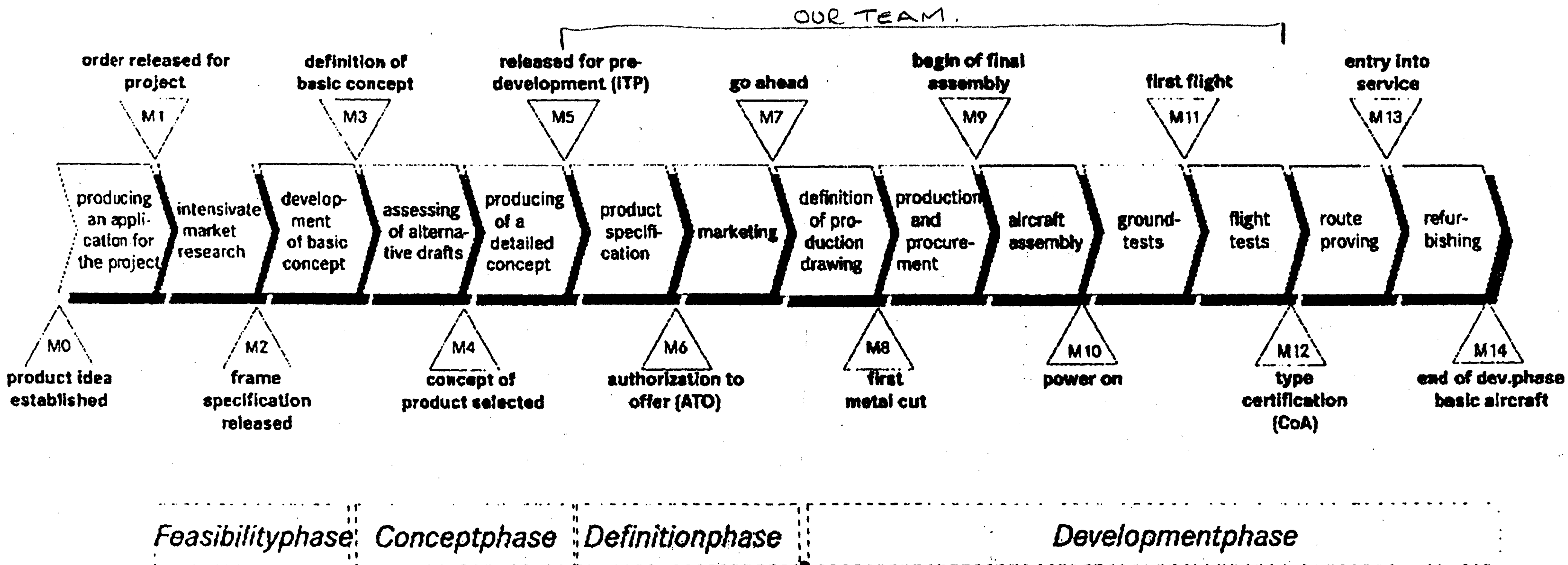
# Appendix D

## Airbus Milestones

# Product-Development
Milestones



Daimler-Benz Aerospace Airbus




**Milestones = Points of Decision**

**Milestones = Target Dates**

**Comprehensive project management is supported by a mandatory milestone structure, by clearly defined project responsibility , by cross-functional teamwork and defined employment of centers of competence.**

# Appendix E

## Simplified Process Map and PIP Interaction with Functions

## PRODUCT INTRODUCTION PROCESS (PIP)

# BAe Airbus Simplified Process Map

the Business

Introduction
Process
(PIP)

Supply Cha
Manufacturing Pro
(SCAMP)

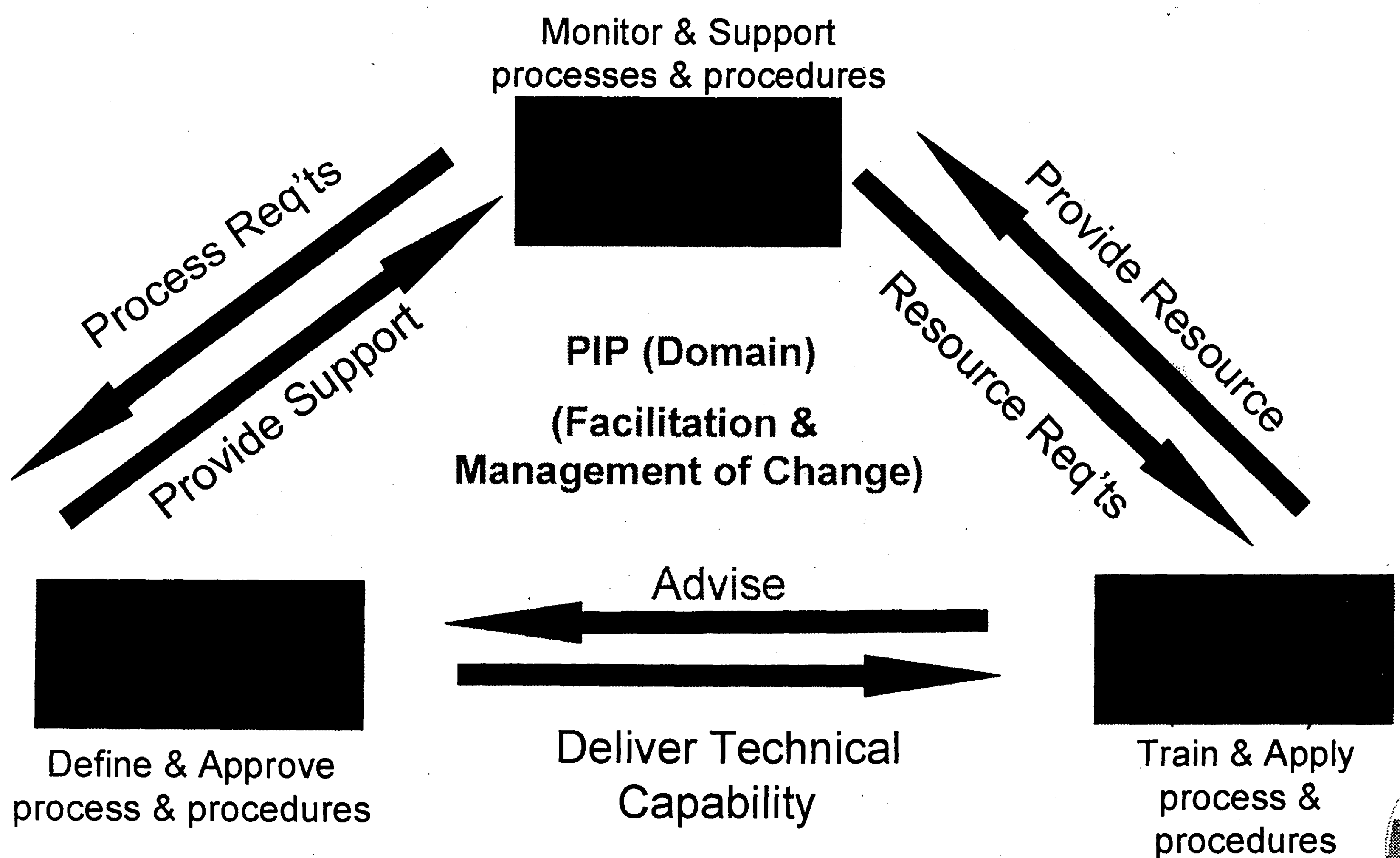
Customer (STAC)

Develop People

BRITISH AEROSPACE
Airbus

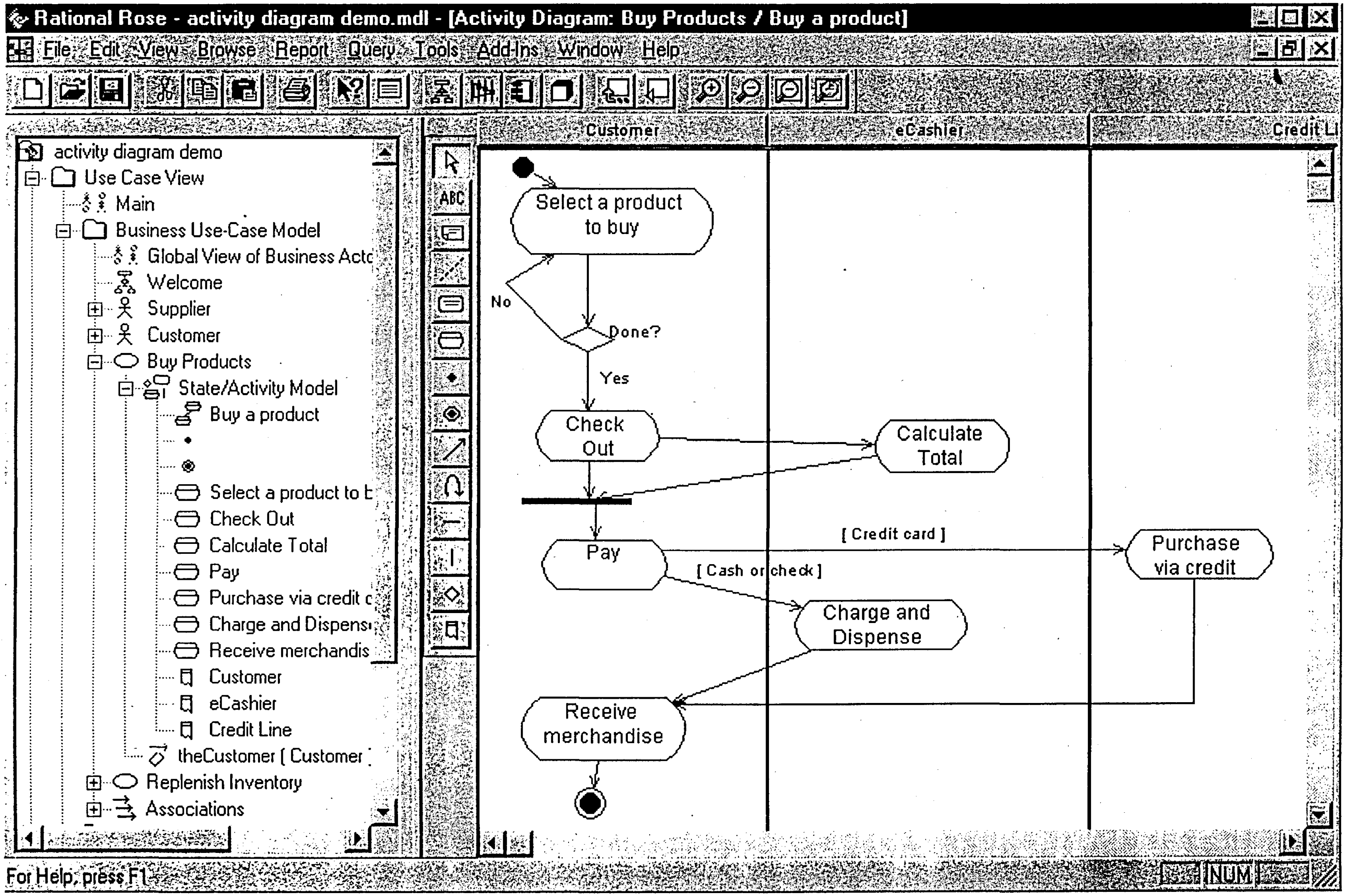
# PRODUCT INTRODUCTION PROCESS (PIP)

## PIP INTERACTION WITH FUNCTIONS AND TECHNOLOGISTS

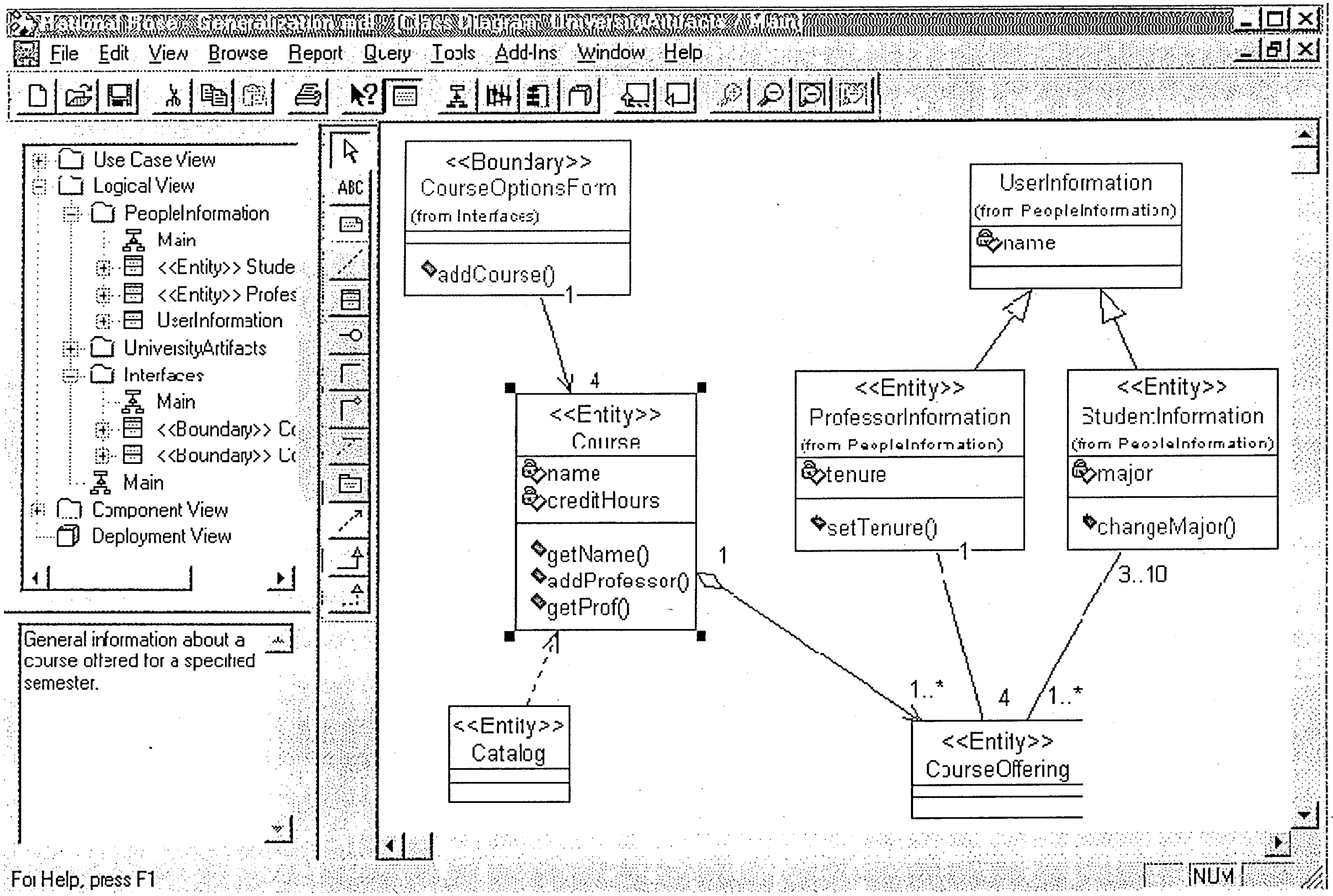


# Appendix F

## UML Diagrams



Rational Rose - activity diagram demo.mdl - [Activity Diagram: Buy Products / Buy a product]
File Edit View Browse Report Query Tools Add-Ins Window Help
activity diagram demo
Use Case View
Main
Business Use-Case Model
Global View of Business Actc
Welcome
Supplier
Customer
Buy Products
State/Activity Model
Buy a product
Select a product to b
Check Out
Calculate Total
Pay
Purchase via credit c
Charge and Dispens
Receive merchandis
Customer
eCashier
Credit Line
theCustomer [ Customer
Replenish Inventory
Associations
Customer
eCashier
Credit Li
Select a product to buy
No
Done?
Yes
Check Out
Calculate Total
Pay
[ Credit card ]
[ Cash or check ]
Purchase via credit
Charge and Dispense
Receive merchandise
For Help, press F1
NUM



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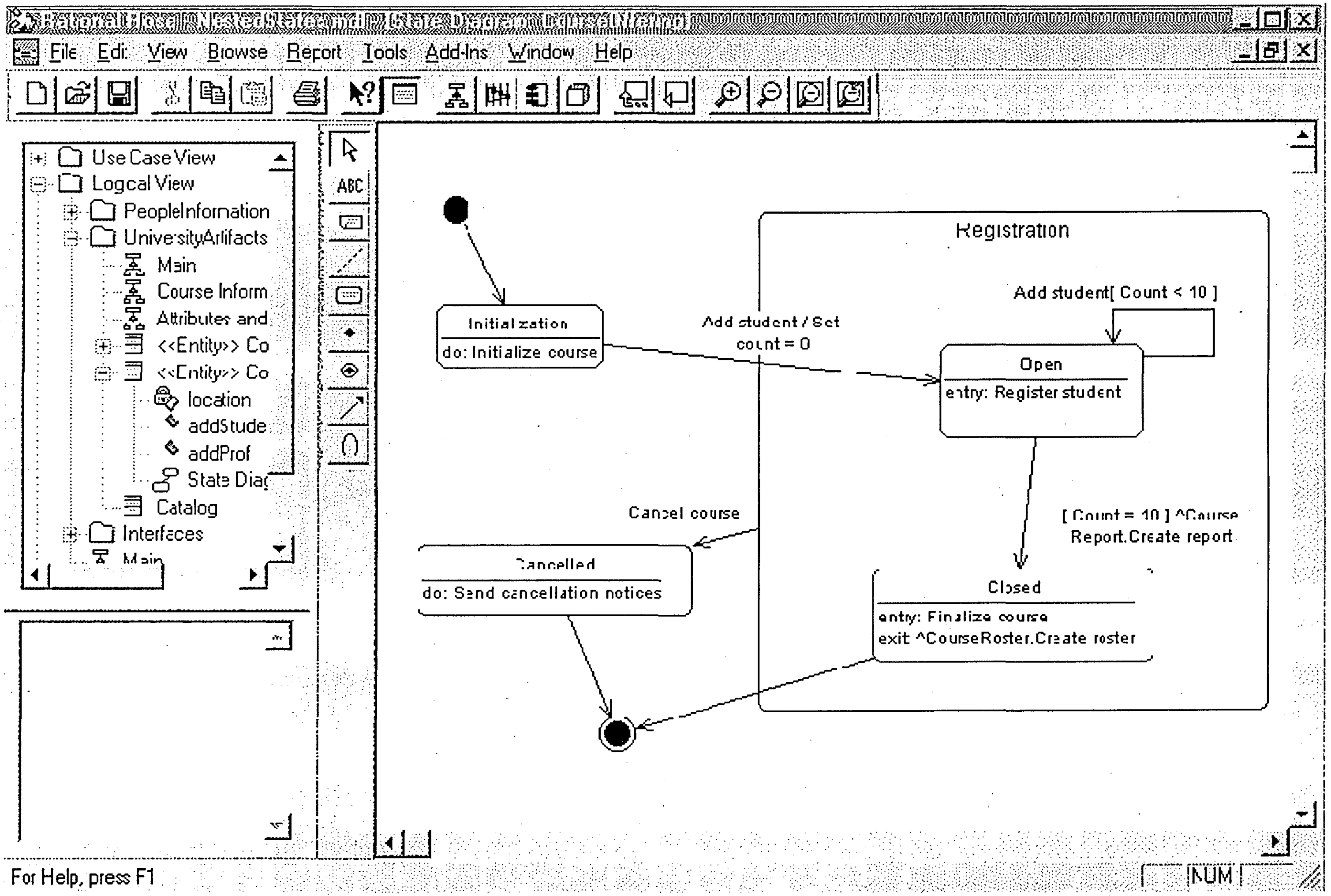
Use Case View
Logical View
PeopleInformation
Main
<<Entity>> Stude
<<Entity>> Profes
UserInformation
UniversityArtifacts
Interfaces
Main
<<Boundary>> Cc
<<Boundary>> Lc
Main
Component View
Deployment View
General information about a course offered for a specified semester.
<<Boundary>>
CourseOptionsForm
(from Interfaces)
addCourse()
1
4
<<Entity>>
Course
name
creditHours
getName()
addProfessor()
getProf()
1
<<Entity>>
Catalog
UserInformation
(from PeopleInformation)
name
<<Entity>>
ProfessorInformation
(from PeopleInformation)
tenure
setTenure()
1
<<Entity>>
StudentInformation
(from PeopleInformation)
major
changeMajor()
3..10
1..*
4
1..*
<<Entity>>
CourseOffering
For Help, press F1
NUM


8/18/00



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Use Case View
Logcal View
PeopleInformation
UniversityArtifacts
Main
Course Inform
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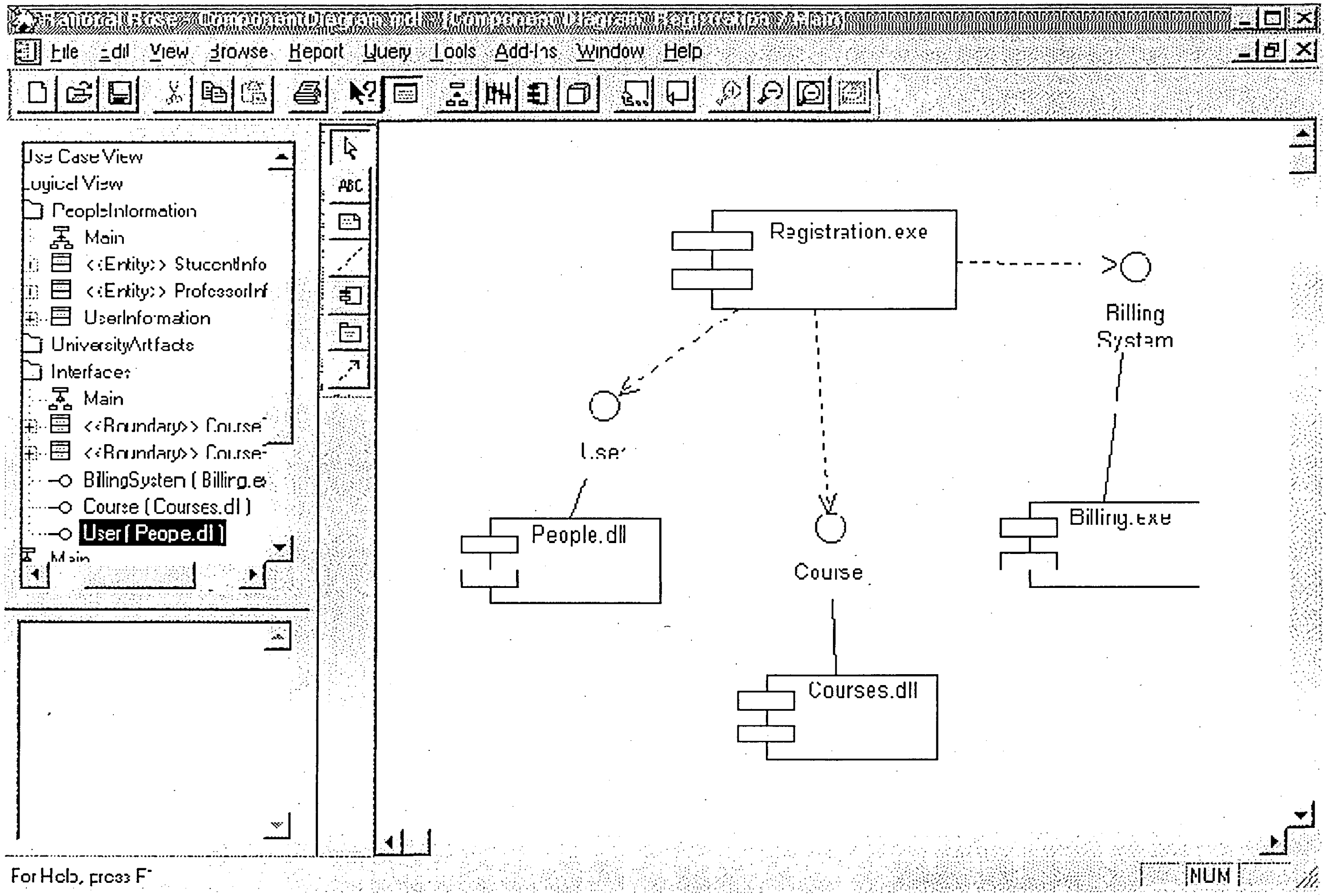
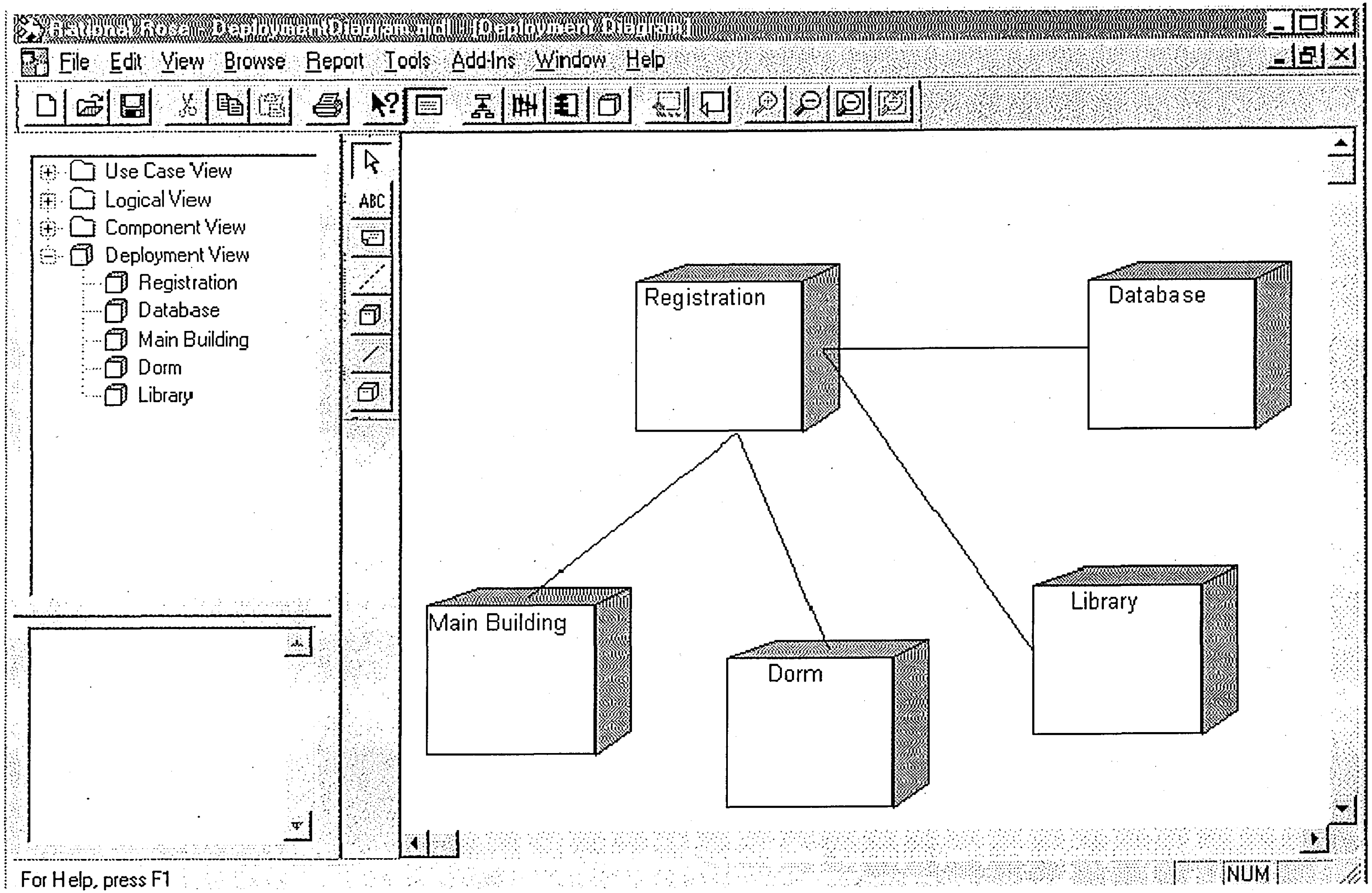
<<Entity>> Co
location
addStude
addProf
State Diag
Catalog
Interfaces
Registration
Initialization
do: Initialize course
Add student / Set
count = 0
Add student[ Count < 10 ]
Open
entry: Register student
Cancel course
Cancelled
do: Send cancellation notices
[ Count = 10 ] ^Course
Report.Create report
Closed
entry: Finalize course
exit ^CourseRoster.Create roster
For Help, press F1
NUM


File Edit View Browse Report Query Tools Add-Ins Window Help
Use Case View
Logical View
PeopleInformation
Main
<<Entity>> StudentInfo
<<Entity>> ProfessorInf
UserInformation
UniversityArtifacts
Interfaces
Main
<<Boundary>> Course
<<Boundary>> Course
BillingSystem ( Billing.e
Course ( Courses.dll )
User ( Peope.dll )
Registration.exe
Billing System
User
People.dll
Course
Billing.exe
Courses.dll
For Help, press F
NUM


File
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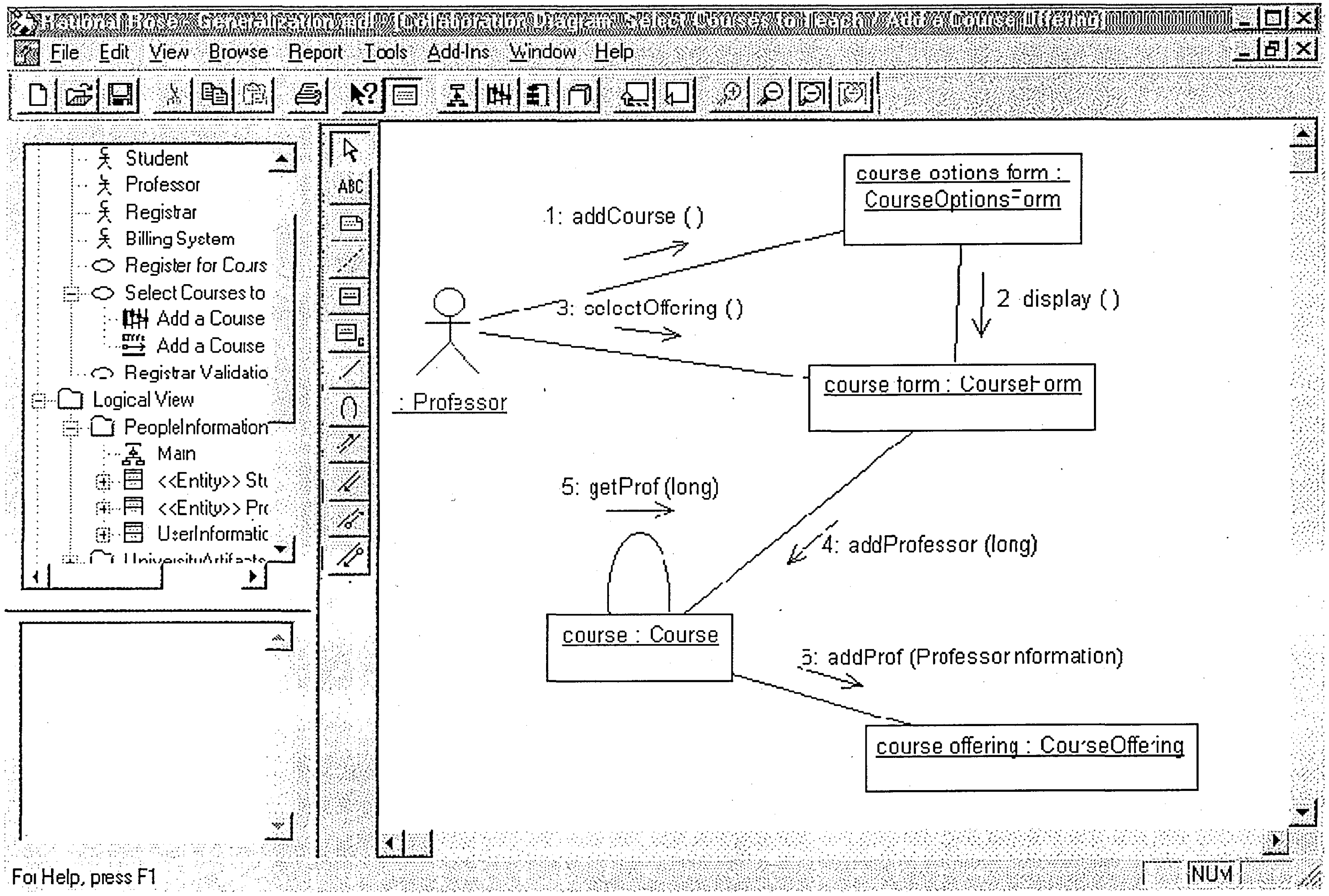
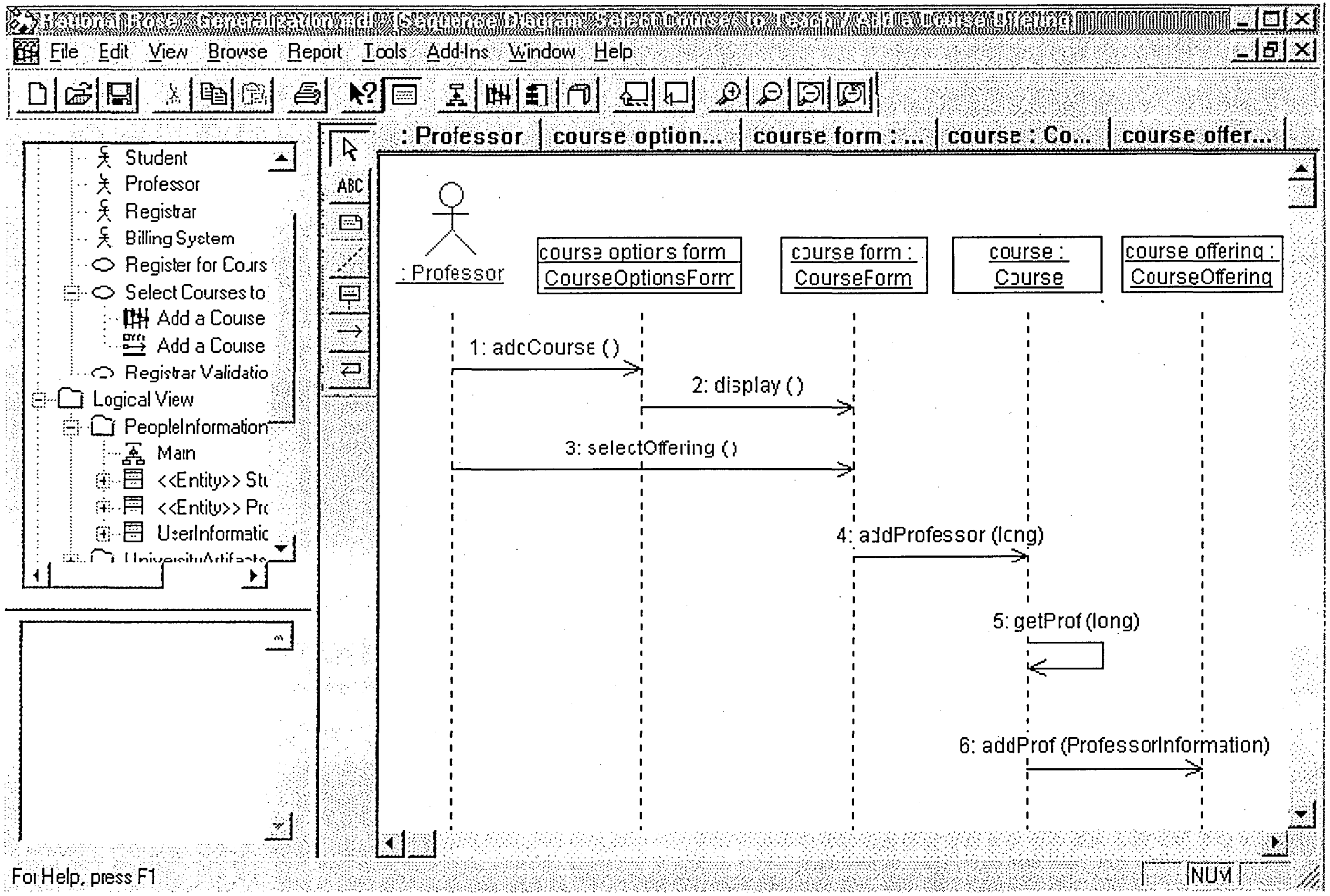
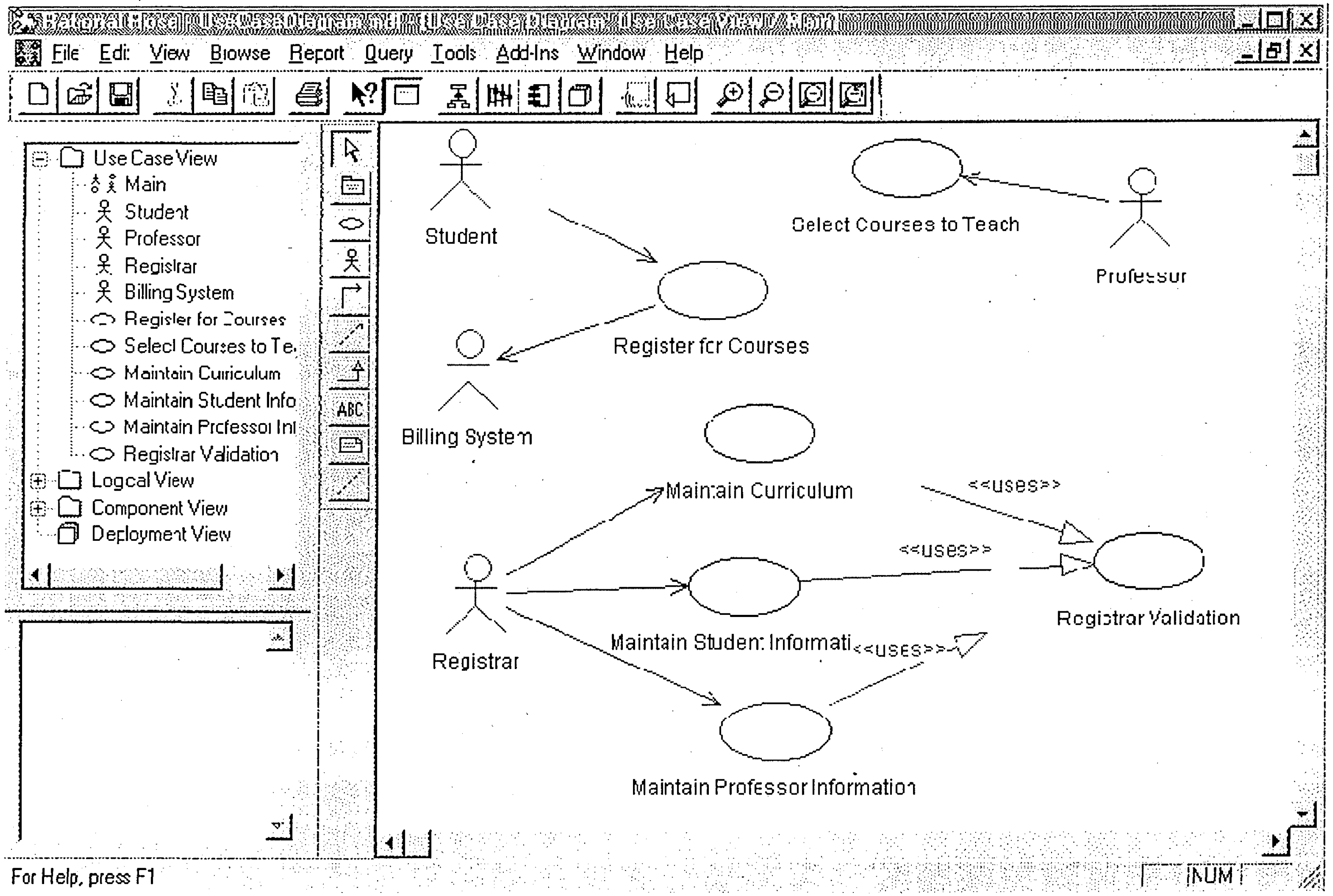
View
Browse
Report
Tools
Add-Ins
Window
Help
Use Case View
Logical View
Component View
Deployment View
Registration
Database
Main Building
Dorm
Library
ABC
Registration
Database
Main Building
Dorm
Library
For Help, press F1
NUM


File Edit View Browse Report Tools Add-Ins Window Help
Student
Professor
Registrar
Billing System
Register for Cours
Select Courses to
Add a Course
Add a Course
Registrar Validatio
Logical View
PeopleInformation
Main
<<Entity>> Stu
<<Entity>> Pro
UserInformatic
1: addCourse ( )
3: selectOffering ( )
: Professor
course options form :
CourseOptionsForm
2 display ( )
course form : CourseForm
5: getProf (long)
4: addProfessor (long)
course : Course
5: addProf (ProfessorInformation)
course offering : CourseOffering
For Help, press F1
NUM


File Edit View Browse Report Tools Add-Ins Window Help
: Professor
course option...
course form : ...
course : Co...
course offer...
Student
Professor
Registrar
Billing System
Register for Cours
Select Courses to
Add a Course
Add a Course
Registrar Validatio
Logical View
PeopleInformation
Main
<<Entity>> Stu
<<Entity>> Pro
UserInformatic
: Professor
course options form
CourseOptionsForm
course form :
CourseForm
course :
Course
course offering :
CourseOffering
1: addCourse ()
2: display ()
3: selectOffering ()
4: addProfessor (long)
5: getProf (long)
6: addProf (ProfessorInformation)
For Help, press F1
NUM


File Edit View Browse Report Query Tools Add-Ins Window Help
Use Case View
Main
Student
Professor
Registrar
Billing System
Register for Courses
Select Courses to Te
Maintain Curriculum
Maintain Student Info
Maintain Professor Inf
Registrar Validation
Logical View
Component View
Deployment View
Student
Select Courses to Teach
Professor
Register for Courses
Billing System
Maintain Curriculum
<<uses>>
<<uses>>
Registrar
Maintain Student Informati
<<uses>>
Registrar Validation
Maintain Professor Information
For Help, press F1
NUM

# Appendix G

# SCAMP Release Process Descriptions

1.2.2.6 - Identify / Create BOM/Part requirements.

Define the BOM structure, Parents, Children, As drawn parts, Synthetic parts, AGS, Etc.
Ensure "Identifiable" parts are marked as such.
Consider Engineering Build Sequence and Condition of Supply (COS) implications.
How do changes impact the BOM.
For internal manufacture create/modify the BOM in PEGS, ( PEGS BOMs (process parts lists) form the basis of the configured BOMs passed into SAP by the Legacy / SAP interface ).

1.2.2.7 - Identify advance requirements.

Are there any new or obscure material, part or equipment requirements that may prove difficult to obtain in the time available. If so, inform "procure parts" via SAP Office.

1.2.2.8 - Identify/Define documents required.

What documents are required to fully define the requirements of the change and how it is to be implemented and proven in the production environment (Documents required are transferred into the SAP master recipe (in house manufacture) or the SAP material master "COS document" (sub contract supply) for the part concerned).
"SSC" component documents required are defined external to SAP.

1.2.2.9 - Create C.O.S (Condition of Supply) "Internal", "Tactical" , "Strategic"

In what state does a Bom item and/or assembly need to be when it is delivered to the next stage and /or customer.
A C.O.S is always required, if "As drawn" then COS must state "Complete to Drawing" , but if not "As drawn" then the COS must specify the standard of the item to be supplied, eg: All holes pilot size, Leave 3mm extra land around flange, Supply item xxx slave bolted, etc.
C.O.S definitions for internal & external (Tactical) manufacture are incorporated within the PEGS method.

For internal "manufacturing processes" the C.O.S. contained within the PEGS method is transferred to SAP directly as part of the "Master Recipe" for the part concerned.

The C.O.S. defined within the PEGS C.O.S screen is for use between Engineers and remains within PEGS.

For externally procured items the COS contained within the PEGS method is separated from the rest of the PEGS Routing information by the Legacy/SAP interface and stored as a "Document" in SAP separately from the "Master Recipe" , but linked to the "Material master" for the part..
C.O.S is also defined in support of Strategic Sub contract requirements sub process "Define SSC supplied component reqmts".

For "Strategic" requirements this sub process provides COS directly to sub process "Define SSC (Strategic sub Contract) supplied component reqmts".

1.2.2.10 - Identify Tooling requirements.

What type of Tools are required to manufacture and/or assemble the product, identify the need and produce a PEGS TDF and/or other document to inform Tooling of the need. Tools required are called up on PEGS processes for the parts concerned.

Also consider kit box requirements from "Define Packaging & Transportation", creating requirement documentation as above.

(For in house manufactured components, Tools required are transferred into the SAP master recipe for the part concerned ).

1.2.2.11 - Define logistics mechanisms.

First stab for a new part, Is it a Kan-Ban supply, Two bin supply, etc.
Consider Engineering parameters such as Design class (Trace ability requirements), Shelf life, special storage requirements, etc, not just cost and/or frequency of use.

| Source | INPUT | ACTIVITY | OUTPUT | Destination |
|---|---|---|---|---|
| •Sub process 1.2.1 | All 1.2.1.1 inputs | **1.2.2.9** | BOM condition of supply | Sub process 1.2.2.5 |
| | **Identified actions** | | Part condition of supply | Sub process 1.2.2.6 |
| •Sub process 1.2.2.13 | Available facilities | | | Sub process 1.2.2.7 |
| •Sub process 1.2.2.7 | Advance requirements | | | Sub process 1.2.2.4 |
| •Sub process 1.2.2.15 | **Preferred manufacturing method** | | | Sub process 1.2.2.10 |
| •Sub process 1.2.2.5 | Preferred Manf Sys philosophy | | | Sub process 1.2.2.11 |
| •Sub process 1.2.2.10 | **Tooling requirements** | | | Sub process 1.2.2.12 |
| •Sub process 1.2.2.11 | Logistics mechanisms | | | Sub process 1.2.2.13 |
| •Sub process 1.2.2.16 | **Inspection/Test requirements** | | | Sub process 1.2.2.14 |
| •Sub process 1.2.2.17 | **Packaging/Transportation** | Create C.O.S | | Sub process 1.2.2.15 |
| •Sub process 1.2.2.18 | Skill & competency reqmts | "Internal" | | Sub process 1.2.2.16 |
| •Sub process 1.2.2.6 | **Configured BOM** | "Tactical" | | Sub process 1.2.2.17 |
| •Sub process 1.2.2.6 | **Identified part** | "Strategic" | | Sub process 1.2.2.18 |
| •Sub process 1.2.2.8 | All documentation necessary to allow completion of the "Manufacturing" requirement definition | | | Sub process 1.2.2.19 |
| | | | | Sub process 1.2.2.29 |
| •Sub process 1.2.2.20 thru 1.2.2.26 | Queries on Tooling requirements | | | |
| Sub process 1.2.2.19 | **Electrical "Looming" definitions** | | | |

# Appendix H

## Example of Advanced COS

| BRITISH AEROSPACE<br>AIRBUS LIMITED<br>MANUFACTURING ENGINEERING | DEPT REF :C/204/AF/00017<br>DATE: 09/10/1998<br>SHEET: 01 OF11 |
|---|---|

# MANUFACTURING ENGINEERING MEMORANDUM

| CLASSIFICATION INFORMATION | PROJECT AIRBUS A340-600 |
|---|---|

**TITLE:**
**ADVANCED CONDITION OF SUPPLY FOR A340-600 TRAILING EDGE STRUCTURES**

## A340-600 TRAILING EDGE

The trailing edge structure will be supplied as eight deliverable items.

1. INNER REAR SPAR TRAILING EDGE ASSEMBLY.

2. MID REAR SPAR TRAILING EDGE ASSEMBLY.

3. OUTER REAR SPAR TRAILING EDGE ASSEMBLY.

4. INBOARD FIXED SHROUD (T/EDGE RIB 0-1).

5. RFS BUILD DOOR ASSEMBLY (T/EDGE RIB 2-4).

6. INBOARD FALSEWORK (T/EDGE RIB 6-10).

7. OUTBOARD FALSEWORK (SPOILER/AILERON @ RIB 27).

8. WING TIP FALSEWORK (AILERON/WING TIP @ RIB 39-41).

THE SPAR JOINTS AT RIB 9 AND 27 SHALL BE CONTROLLED TO MAINTAIN THE RELATIONSHIP OF MASTER DATUM POSITIONS BETWEEN EACH OF THE ABOVE ASSEMBLIES.

**PROJECT NO.**

DISTRIBUTION:

COMPILED BY: JIM ROWE

APPROVED:------------------------------------------

| ISSUE: | 01 | | | |
|---|---|---|---|---|
| APPROVED: | | | | |
| DATE: | 09/10/1998 | | | |

**INNER REAR SPAR TRAILING EDGE ASSEMBLY.**

CONDITION OF SUPPLY WILL BE SIMILAR TO THAT OF A340-300

SPAR LOCATION WILL BE VIA A TOOLING HOLE IN SPAR MACHINING AT INBD END CO-ORDINATED IN BOTH FILTON AND CHESTER JIGS.
SPAR WILL BE HELD NOMINAL TO TOP SKIN POSITION AND CLAMPED TO REAR SPAR DATUM IN THE UN-TWISTED DESIGN CONDITION.
SPAR SUPPORT AND CLAMP POSITIONS ARE TO BE CO-ORDINATED WITH CHESTER STAGE 01 JIGS.

CORNER FITTINGS DRILLING AND FETTLING REQUIREMENTS TO BE CONFIRMED WITH PARTNERS AT INTERFACE MEETING (MR D. NOBLE).

GEAR RIB 6, PINTLE FITTING, SIDE STAY FITTING SHALL BE CONTROLLED TO DESIGN GEOMETRY IN THE UN-TWISTED DESIGN CONDITION.
LOCATION AND SETTING METHOD TO BE CO-ORDINATED WITH CHESTER STAGE 01 JIGS.

GEAR RIB 6 WILL BE PRODUCED WITH THE FOLLOWING CONTOROLLED DATUMS.
PRIMARY DATUM: - THE PINTLE AXIS
SECONDARY DATUM: - THE GEAR RIB / SPAR WEB INTERFACE SURFACE.
TERTIARY DATUM: - THE GEAR RIB / FIXED STRUCTURE RIB 0 INTERFACE.
THESE DATUMS WILL BE USED TO SET AND CONTROL THE GEAR RIB POSITION TO THE SPAR.
TOP AND BTM SURFACES WILL BE PRODUCED WITH A FETLING ALLOWANCE TO ALLOW FOR THESE SURFACES TO BE MATCHED TO SPAR FLANGE PROFILES ON ASSEMBLY.

GEAR RIB WILL BE SUPPLIED WITH 4 OFF PILOT HOLES IN TOP AND BTM SURFACES IWO MAIN SKIN DRILLING (INFORMATION SUPPLIED TO PETE MONK BASED ON CURRENT A340 CHESTER PRACTICE)

INNER REAR SPAR WILL BE SUPPLIED WITH PILOT HOLES DRILLED IN TOP AND BTM FLANGES IWO MAIN SKIN DRILLING (APPROXIMATELY 2 PER RIB BAY INFORMATION SUPPLIED TO MARTIN TUDGAY BASED ON CURRENT A340 CHESTER BUILD PRACTICE (NOT CONFIRMED BY SUPPLIERS))

FIXED FITTING SIMILAR TO CURRENT A340 -300 BUILD SUBJECT TO SYSTEM DESIGN REQUIREMENTS.

VERTICAL STIFFENER SIMILAR TO CURRENT A340-300 BUILD.

BACKING ANGLES SIMILAR TO CURRENT A340-300 BUILD.

SPOILER 1 T/EDGE STRUCTURE

SPOILER 1 STRUCTURE WILL BE SUPPLIED TO ALLOW FOR MINIMUM FINAL BUILDS IN CHESTER STAGE 01 AND 03.

INBOARD FIXED SHROUD.

C.O.S. SIMILAR TO A340-300.

FIXED SHROUD SHALL BE LOCATED AND SET TO DESIGN GEOMETRY
LOCATING ON SPOILER HINGE POSITION AT T/EDGE RIB 1.
EDGE OF PART IS TO BE CONTROLLED IN RELATIONSHIP TO INBD FALSEWORK TO ACHIEVE ICY REQUIREMENTS OF SPOILER 1 APERTURE.
DRILL STRUCTURE TO GEAR RIB. SUPPLY AS A LOOSE DELIVERABLE ITEM TO CHESTER STAGE 01.

HINGE RIB/BUILD DOOR ASSEMBLY.

LOCATE AND SET SPOILER 1 HINGE RIBS 2,3 & 4 TO REAR FALSE SPAR BUILD DOOR TO DESIGN GEOMETRY POSITIONS AND ICY REQUREMENTS.
HINGE LINE IS TO BE CONTROLLED IN RELATIONSHIP WITH HINGE POSITIONS ON FIXED SHROUD T/EDGE RIB 1 AND INBD FALSEWORK T/EDGE RIB 6.
HINGE RIBS TO BE FULLY BOLTED TO BUILD DOOR.
BUILD DOOR IS TO BE FULLY DRILLED TO REAR FALSE SPAR.

ASSEMBLE COMPLETE TO DRAWING REQUIREMENTS SPOILER 1 T/EDGE RIB INTERCOSTALS EXCEPT:
AFT INTERCOSTAL RIB 1-2 TO BE FULLY DRILLED TO STRUCTURES AND SUPPLIED SECURED TO RIB 2 FOR FINAL FIT IN CHESTER STAGE 03.

AFT INTERCOSTAL RIB 4-5B TO BE FULLY DRILLED TO STRUCTURE AND SLAVED TO RIB 4 AND 5B FOR FINAL FIT IN CHESTER STAGE 01.

AFT INTERCOSTAL RIB 5B-6 TO BE FULLY DRILLED TO STRUCTURE AND SUPPLIED SECURED TO RIB 5B FOR FINAL FIT IN CHESTER STAGE 01.

PANEL SUPPORT STRUCTURE WILL BE SUPPLIED TO CHESTER STAGE03
C.O.S. SIMILAR TO A340-300.

THIS SPOILER HINGE/BUILD DOOR STRUCTURE IS TO BE SUPPLIED AS A SEPERATE SUB ASSEMBLY TO CHESTER STAGE 01.

*LOWER FWD INTERCOSTAL AND BRACKETS T/E RIB 3-4 TO BE SUPPLIED LOOSE FOR FINAL FIT AT CHESTER STAGE 01.*

*LOWER FWD INTERCOSTALS T/E RIB 4-5A AND 5B-6 TO BE SUPPLIED LOOSE FOR FINAL FIT AT CHESTER STAGE 01. LOWER ATTACHMENT BRACKET AT T/E RIB 6 TO BE FULLY DRILLED AND BOLTED TO RIB, PILOT HOLES IN BRKT IWO ATTACHMENT TO INTERCOSTAL.*

*UPPER FWD INTERCOSTALS T/E RIB 4-5B AND 5B-6 TO BE SUPPIED LOOSE FOR FINAL FIT AT CHESTER STAGE 01 UPPER ATTACHMENT BRACKET AT T/E RIB 6 TO BE FULLY DRILLED AND BOLTED TO RIB, PILOT HOLES IN BRKT IWO ATTACHMENT TO INTERCOSTAL.*

*ATTACHMENT ANGLE FOR FWD INTERCOSTAL TO T/E RIB 5A SUPPLIED LOOSE FOR FINAL FIT IN CHESTER STAGE 01.*
*ATTACHMENT PLATE FOR FWD INTERCOSTAL TO T/E RIB 4 SUPPILED LOOSE FOR FINAL FIT IN CHESTER STAGE 01.*

**STRUCTURE INSATLLATION FLAP TRACK 2:**

C.O.S. SIMILAR TO A340-300.

FLAP TRACK 2 SUPPORT STRUCTURE IS TO BE SUPPLIED FITTED TO INNER REAR SPAR TO DRAWING REQUIREMENTS.
POSITION OF FLAP TRACK 2 AFT MTG. STRUCTURE IS TO BE SET TO DESIGN GEOMETRY AND CONTROLLED TO ICY REQUIREMENTS AND IN RELATION TO C/L OF FLAP ROLLER ON INBD FALSEWORK T/EDGE RIBS 6-10. THE SETTING OF THE AFT PICKUP IN 'Z' IS TO BE CONTROLLED USING A 10mm BUILD SILP.

SPOILER 1 HINGE AT T/EDGE RIB 5B IS TO BE SET TO DESIGN GEOMETRY AND CONTROLLED TO ICY REQUIREMENTS IN RELATION TO SPOILER 1 HINGE POSITIONS AT T/EDGE RIBS 1-4 & 6. THE 5B HINGE ASSEMBLE STRUCTURE IS TO BE SET AND DRILLED OFF COMPLETE TO THE 5A/5B FLAPTRACK 2 SUPPORT STRUCTURE AT THE INNER TO MID SPAR ASSEMBLE STAGE.

RIBS 5A AND 5B TO BE FULLY DRILLED TO BOX BRACKET AND ASSEMBLED COMPLETE EXCEPT PANEL SUPPORT TEE BRKTS TO BE SLAVED ONLY. ***(CAN THESE BE FULLY FITTED? CHECK WITH KEITH FOR STAGE 03 REQUIREMENT.)***

TOP INTERCOSTAL ATTACHMENT BRACKETS AT RIB 5B SLAVED TO RIB **(CAN THESE BE FULLY FITTED? (CHECK WITH KEITH FOR STAGE 03 REQUIREMENT.)**

DRILLING IWO MAIN SKIN PANELS TOP AND BTM THRU RIB 5A AND 5B (INCLUDING TOP AND BTM ANGLES TO BE OMITTED EXCEPT FOR PILOT HOLES SIMILAR TO
A340-300

SPOILER 1 HINGE LINE AND FLAP TRACK 2 AFT POSITION IS TO BE CHECKED AT FILTON FINAL ASSEMBLY STAGE TO DRAWING GEOMETRY POSITIONS AND ICY REQUIREMENTS, WITH JOINT SLAVED TO MID SPAR AND INNER SPAR SUPPORTS RELEASED. THE INNER T/EDGE BEING HELD ON RIB 1 SUPPORT SHELF, SIDE STAY FITTING AND GEAR RIB.

**INSTN FLAP TRK 2 AFT MTG**

c.o.s. SIMILAR TO A340-300

BTM PANEL FIXED SIMILAR TO A340-300.
SLAVE ASSEMBLED TO STRUCTURE (INCLUDING BUTTSTRAP).

**SPAR JOINT RIB 9(IN CONJUNCTION WITH MID T/EDGE ASSY)**

SIMILAR TO CURRENT A340-300.
JOINT PLATE FULLY DRILLED TO SPAR. SETTING OF PLATE TO BE CO-ORDINATED TO INBD FIXED STRUCTURE T/EDGE RIB 6 BY USE OF SHIM PACKERS. TOP AND BTM JOINT STRAPS TO BE ASSEMBLED TO SPAR FLANGES AND FETLED TO FLANGE PROFILES.
DRILL AND TAP 6 OFF PILOT HOLES IWO SPAR DRILLING IN EACH STRAP FOR SECURING STRAPS TO INNER AND MID SPARS AT CHESTER STAGE 01

**MID REAR SPAR TRAING EDGE ASSEMBLY**

CONDITION OF SUPPLY SIMILAR TO A340-300 EXCEPT:

SPAR ASSEMBLY TO BE BUILT IN THE UN-TWISTED CONDITION.

SPOILER RIBS TO BE CLAIMED AND POSITIONS CONTROLLED TO DESIGN GEOMETRY AND ICY REQUIREMENTS BY USE OF JIG FLAGS AND PINS, UTILISING 5MM BUILD SLIPS TO SET AND CLAMP RIBS TO DATUM POSITIONS. THIS PHILOSOPHY WILL BE ADOPTED IN FILTON AND CHESTER STAGE ASSEMBLY JIGS.

*MID REAR SPAR WILL BE SUPPLIED WITH PILOT HOLES DRILLED IN TOP AND BTM FLANGES IWO MAIN SKIN DRILLING (APPROXIMATELY 2 PER RIB BAY INFORMATION SUPPLIED TO MARTIN TUDGAY BASED ON CURRENT A340 CHESTER BUILD PRACTICE (NOT CONFIRMED BY SUPPLIERS)).*

**RIB 9 JOINT PLATE AND STRAPS** DRILLED IN CONJUNCTION WITH INNER REAR SPAR ASSEMBLY, SIMILAR TO A340-300.

**INSTALLATION JACKING BRACKET** SIMILAR TO A340-300

**SPAR JOINT RIB 27 (IN CONJUNCTION WITH OUTER T/EDGE ASSY)**

*JOINT PLATE FULLY DRILLED TO SPAR AND SLAVED BOLTED TO MID SPAR.*

*JOINT PLATE DRILLED 4.8mm IWO HOLES THRU TOP AND BTM SKIN PANELS.*

*TOP AND BTM JOINT STRAPS TO BE ASSEMBLED TO SPAR FLANGES AND FETLED TO FLANGE PROFILES.*

*DRILL AND TAP 4 OFF PILOT HOLES IWO SPAR DRILLING IN EACH STRAP FOR SECURING STRAPS TO INNER AND MID SPARS AT CHESTER STAGE 01.*

*STRAPS TO BE IDENTIFIED TO A/C AND SUPPLIED LOOSE SECURED TO MID T/EDGE ASSEMBLY*

**INBD FALSEWORK T/EDGE RIBS 6-10**

INBOARD FALSEWORK WILL BE SUPPLIED AS A LOOSE ITEM TO CHESTER STAGE 01

FALSEWORK TO BE ASSEMBLED COMPLETE TO DRAWING REQUIREMENTS EXCEPT:

TOP SKIN PANEL WILL BE FINALLY LOCATED AND DRILLED OFF COMPLETE TO DRAWING BUT DRY SLAVE BOLTED IN POSITION TO STRUCTURE. *(CAN THIS BE FULLY FITTED AT FILTON)*

LOWER SURFACE AFT CURVED PANEL WILL BE FINALLY LOCATED AND DRILLED OFF BUT DRY SLAVE BOLTED IN POSITION TO STRUCTURE.

FALSEWORK IS TO BE LOCATED AND DRILLED TO SPAR STRUCTURE IN FILTON INNER/MID ASSEMBLY JIG.
POSITION OF FALSE WORK TO BE CONTROLLED AT SPOILER 1 HINGE LINE ON T/EDGE RIB 6 IN RELATION TO SPOILER 1 HINGE POSITIONS ON T/EDGE RIBS 1-5 TO SATISFY ICY REQUIREMENTS.
CONTROL CENTRELINE OF FLAP ROLLER OBD OF RIB 9A IN RELATION TO FLAP TRACK 2 AFT PICKUP.

SET FALSEWORK RELATIVE TO MAIN TOP SKIN BY CONTROL OF SPAR/RIB STEPS TO DESIGN INSTALLATION REQUIREMENTS.

JIG LOCATE FALSEWORK T/EDGE TO SET TRAILING EDGE POSITION IN THE DEFLECTED DESIGN GEOMETRY POSITION. (UN-TWISTED)

CONTROL FALSEWORK BOUNDARIES AT RIB 6 AND 10 TO SATISFY SPOILER 1 AND 2 ICY APERTURE REQUIREMENTS.

DRILL FALSEWORK STRUCTURE IWO ATTACHMENT TO REAR SPAR COMPLETE TO DRAWING EXCEPT, WHERE RIB BOLTS DIRECT TO SPAR OMIT FASTENERS. WHERE RIB ATTACHES TO SPAR VIA FIXING BRACKETS, FASTEN BRACKETS TO SPAR COMPLETE TO DRAWING, OMIT FASTENERS ATTACHING RIB TO FIXING BRACKET.

WHERE T/EDGE RIB 6 ATTACHES TO SPAR JOINT PLATE AT RIB 9 FIT PACKERS AS REQUIRED TO ACHIEVE LOCATION OF RIB TO SATISFY ICY REQUIREMENTS AND CONTROL CRITERIA STATED.
DRILL COMPLETE TO DRAWING REQUIREMENT, OMIT FASTENERS, SECURE PACKERS TO RIB.

GUSSET PLATES, BUTTSTRAPS AND LANDINGS SIMILAR TO A340-300.

**ACTUATOR BRACKETS SPOILER 2 TO 6.**

SIMILAR TO A340-300, INSTALL COMPLETE TO DRAWING OMIT HOLES FROM UPPER AND LOWER FLANGES IWO TOP AND BTM SKIN PANELS.

**INTERMEDIATE RIBS INBOARD SPOILER 2 TO 6.**

SIMILAR TO A340-300, INSTALL COMPLETE TO DRAWING EXCEPT:

DRILL 1 X 4.0mm PILOT HOLE IN TOP FLANGE OF EACH RIB IWO TOP SKIN PANEL.

WET ASSEMBLE AND FULLY BOLT LOWER GUSSET PLATES TO RIBS, DRILL FOR AND INSTALL 3.2mm dia ALLOY RIVETS IN LIEU OF BOLTS FOR CLAMP OUT AT RIB/SKIN INTERFACE. DRILL 2 X 4.0mm PILOT HOLES IN EACH GUSSET PLATE IWO BOTTOM SKIN PANEL.

**INTERMEDIATE RIBS OUTBOARD SPOILER 2 TO 5.**

SIMILAR TO A340-300, INSTALL COMPLETE TO DRAWING EXCEPT:

***NOTE SPOILER 2 INTERMEDIATE RIB MAY BE FULLY BOLTED SUBJECT TO MOVING OF WING REMOVAL SUPPORT PLATE OUTBD TO RIB 15 (TO BE AGREED WITH DESIGN/STRESS).***

TOP SURFACE, WET ASSEMBLE AND FULLY BOLT GUSSET PLATES TO RIBS, DRILL FOR AND INSTALL 3.2mm dia ALLOY RIVETS IN LIEU OF BOLTS FOR CLAMP OUT AT RIB/SKIN INTERFACE. DRILL 1 X 4.0mm PILOT HOLES IN EACH GUSSET PLATE IWO TOP SKIN PANEL.

WET ASSEMBLE AND FULLY BOLT LOWER GUSSET PLATES TO RIBS, DRILL FOR AND INSTALL 3.2mm dia ALLOY RIVETS IN LIEU OF BOLTS FOR CLAMP OUT AT RIB/SKIN INTERFACE. DRILL 2 X 4.0mm PILOT HOLES IN EACH GUSSET PLATE IWO BOTTOM SKIN PANEL.

**MACHINED RIB/ANGLE ASSEMBLY.**

SIMILAR TO A340-300, ***(CAN THESE BE DELIVERED DIRECT TO CHESTER STAGE 03 INSTEAD OF SLAVED TO INTERMEDIATE RIB.)***

**ACTUATOR RIBS INBOARD AND OUTBOARD SPOILER 2 TO 6.**

SIMILAR TO A340-300, INSTALL COMPLETE TO DRAWING EXCEPT:

TOP SURFACE, WET ASSEMBLE AND FULLY BOLT GUSSET PLATES TO RIBS, DRILL FOR AND INSTALL 3.2mm dia ALLOY RIVETS IN LIEU OF BOLTS FOR CLAMP OUT AT RIB/SKIN INTERFACE. DRILL OUTER HOLES 2 X 3.2mm PILOT HOLES IN EACH GUSSET PLATE IWO TOP SKIN PANEL.

BOTTOM SURFACE, DRILL 1 X 4.0mm PILOT HOLE IN LOWER FLANGE OF EACH RIB OMIT ALL OTHE HOLES IWO BTM SKIN PANEL.

**HINGE RIBS SPOILER 2 TO 6.**

SIMILAR TO A340-300, INSTALL COMPLETE TO DRAWING EXCEPT:

HINGE RIB INBOARD SP2.

TOP SURFACE, WET ASSEMBLE AND FULLY BOLT GUSSET PLATES TO RIB, DRILL FOR AND INSTALL 3.2mm dia ALLOY RIVET IN LIEU OF BOLT FOR CLAMP OUT AT RIB/SKIN INTERFACE. DRILL OUTER HOLES 2 X 4.0mm PILOT HOLES IN GUSSET PLATE IWO TOP SKIN PANEL.

DRILL 2 X 4.0mm PILOT HOLES IN LOWER FLANGE IWO BTM SKIN PANEL.

COMMON HINGE RIB SP2-3, 3-4, 4-5 & 5-6.

DRILL 4 X 4.0mm PILOT HOLES IN LOWER FLANGES IWO BTM SKIN PANELS. (NOT APPLICABLE TO RIB5-6)

DRILL 2 X 4.0mm PILOT IN UPPER FLANGE IWO TOP SKIN PANEL.

HINGE RIB OUTBOARD SP6. ***(SUBJECT TO DESIGN CHANGES IN SPOILER 6 AREA).***

DRILL 4.0mm PILOT HOLES IN UPPER AND LOWER FLANGES IWO TOP AND BOTTOM SKIN PANELS. ***(4B HOLE POSITIONS)***

DRILL 1 X 3.2mm PILOT HOLE IN UPPER FLANGE IWO TOP SKIN PANEL. ***(3B HOLE POSITION)***

**TOP PANEL STRUCTURE DRILLING.**

DRILL STRUCTURE TO ICY REQUIREMENTS IWO TOP SPOILER PANELS 1-5 COMPLETE TO DRAWING IWO 5.1mm and 6.7mm holes.
***(ARE M/C ANGLE ASSEMBLIES DRILLED IWO PANEL ATACHMENTS CHECK WITH STAGE 03). WHAT ABOUT 5.6mm HOLES IN RIBS AT MRSX 1738, 3425, 5616, 7816, 10016, 12233 POSITIONS.***

TOP BUTTSTRAPS TO BE SUPPLIED DRILLED COMPLETE TO DRAWING AND ICY REQUIREMENTS IWO TOP PANEL ATTACHMENTS AND ***3.2MM PILOT HOLES IWO TOP WING BOX SKIN PANEL, (KIT SUPPLY TO CHESTER STAGE 01)***

***BUTTSTRAPS WILL BE SET AND DRILLED TO WING BOX SKINS IN CHESTER STAGE 01 BY MEANS OF A DUMMY DOOR LOCATING ON PRE DRILLED STRUCTURE.***

PANELS TO BE SUPPLIED COMPLETE TO DRAWING AND ICY REQUIREMNETS SIMILAR TO A340-300for FOR FINAL FIT AT CHESTER STAGE 03.

**BTM PANEL STRUCTURE DRILLING.**
SIMILAR TO A340-300.

DRILL STRUCTURE TO ICY REQIUREMENTS IWO BTOTTOM SPOILER PANELS

BTM BUTTSTRAPS TO BE SUPPLIED DRILLED COMPLETE TO DRAWING AND ICY REQUIREMENTS IWO BTM PANEL ATTACHMENTS AND 3.2mm PILOT HOLES IWO BTM WING BOX SKIN PANEL ***(KIT SUPPLY TO CHESTER STAGE 01)***

BUTTSTRAPS WILL BE SET AND DRILLED TO WING BOX SKINS IN CHESTER STAGE 01 BY MEANS OF A PARTIAL DUMMY DOOR LOCATING ON PRE DRILLED STRUCTURE.

PANELS TO BE SUPPLIED COMPLETE TO DRAWING AND ICY REQUIREMNETS SIMILAR TO A340-300 FOR FINAL FIT AT CHESTER STAGE 03.
BTM PANEL STRUT ASSEMBLIES TO BE SUPPLIED SIMILAR TO A340-300 FOR FINAL FIT AT CHESTER STAGE 03.

**FLAP TRACK BRACKETS FT3, 4 AND 5**

SIMILAR TO A340-300.

**OUTBOARD FALSEWORK (SPOLIER/AILERON @ RIB27) IN CONJUNCTION WITH OUTER T/EDGE ASSY.**

SIMILAR TO A340-300 EXCEPT:

FALSEWORK IS TO BE SET TO AERODYNAMIC PROFILE IN RELATION TO SPAR AND THEORETICAL TOP SKIN PROFILE.
T/EDGE POSITION IS TO BE SET AND CONTROLLED AT A PREDETERMINED RIGGING POINT DEFINED BY DESIGN.
INBOARD AND OUTBOARD BOUNDARIES ARE TO BE CONTROLLED AND SET TO ACHIEVE SATISFACTORY CLEARENCES TO SPOILER, FLAP, AND ALIERON BOUNDARIES.
LOCATE STUB RIBS TO SPAR COMPLETE TO DRAWING EXCEPT:
DRILL 2.4mm PILOT HOLES IWO ATTACHMENTS THRU TOP AND BTM WING BOX SKIN PANELS.
DRILL FALSEWORK RIBS TO STUB RIBS PILOT SIZE SIMILAR TO A340-300 THIS IS TO BE REVIEWED OVER THE FIRST 5 A/C SET TO ESTABLISH AN ACCEPTABLE STANDARD WITH A VIEW TO DRILLING ATTACHMENTS COMPLETE TO DRAWING.

**TRANSPORTATION BRACKETS.**

SIMILAR TO A340-300.

**SIGHTING ROD BRACKET.**

SIMILAR TO A340-300.

**SYSTEM BRACKETS AND FIXED FITTINGS.**

SIMILAR TO A340-300 SUBJECT TO FINAL DESIGN DEFINITIONS.

## OUTER REAR SPAR TRAILING EDGE ASSEMBLY.

CONDITION OF SUPPLY SIMILAR TO A340-300 FOR FILTON OUTER WINGBOX

SPAR ASSEMBLY TO BE BUILT IN THE UN-TWISTED DESIGN GEOMETRY.

AILERON RIBS TO BE CLAIMED AND POSITIONS CONTROLLED TO DESIGN GEOMETRY AND ICY REQUIREMENTS BY USE OF JIG FLAGS AND PINS, UTILISING 5MM BUILD SLIPS TO SET AND CLAMP RIBS TO DATUM POSITIONS. THIS PHILOSOPHY WILL BE ADOPTED IN FILTON AND CHESTER STAGE ASSEMBLY JIGS.

RIB 27 JOINT TO BE DRILLED IN CONJUNCTION WITH MID REAR SPAR TRAILING EDGE ASSEMBLY.

## AILERON HINGE RIBS.

### HINGE RIB 1(inner and outer aileron)

ASSEMBLE HINGE RIBS TO SPAR COMPLETE TO DRAWING.
***DRILL PILOT HOLES IWO ATACHMENTS TO TOP AND BTM WING BOX SKIN PANELS.***

### HINGE RIB 2(inner and outer aileron)

ASSEMBLE HINGE RIBS TO SPAR COMPLETE TO DRAWING.
***DRILL PILOT HOLES IWO ATTACHMENTS TO BTM WING BOX SKIN PANEL.***
***ASSEMBLE TOPSKIN SPREADER PLATE COMPLETE TO DRAWING EXCEPT:***
***DRILL FOR AND FIT CLAMP OUT RIVETS AT 3.2 mm DIA IWO ATTACHMENTS THRU TOP WING BOX SKIN AND RIB.***
***DRILL 2 OFF PILOT HOLES IWO REMAINING HOLES IN SPREADER PLATE FOR ATTACHMENT THRU TOP WING BOX SKIN.***

### HINGE RIB 3(inner and outer aileron)

ASSEMBLE HINGE RIBS TO SPAR COMPLETE TO DRAWING..
***ASSEMBLE TOP AND BTM SKIN SPREADER PLATE COMPLETE TO DRAWING EXCEPT:***
***DRILL FOR AND FIT CLAMP OUT RIVETS AT 3.2 mm DIA IWO ATTACHMENTS THRU TOP WING BOX SKIN AND RIB.***
***DRILL 2 OFF PILOT HOLES IWO REMAINING HOLES IN SPREADER PLATE FOR ATTACHMENT THRU TOP WING BOX SKIN.***

***NOTE HOLES IN SPAREADER PLATES ARE TO BE DRILLED AS A PATERN GROUP TO ENSURE DRILL OUT OF CLAMP RIVETS WHEN DRILLING THRU MAIN WING SKINS.***

### JACK RIBS (inner and outer aileron)

ASSEMBLE JACK RIBS TO SPAR COMPLETE TO DRAWING.
***DRILL PILOT HOLES IN RIB FLANGES IWO TOP AND BTM MAIN WING BOX SKINS SIMILAR TO CURRENT FILTON EIS WING BOX REQUIREMENTS?***

### HINGE POSTS ('A' Frame Hinge attachment)

ASSEMBLE HINGE POSTS COMPLETE TO DRAWING.
*DRILL PILOT HOLES IN POST FLANGES IWO TOP AND BTM MAIN WING BOX SKINS SIMILAR TO CURRENT FILTON EIS WING BOX REQUIREMENTS?*
***'A' FRAMES WILL BE SUPPLIED SEPERATELY TO CHESTER STAGE 03 FOR FINAL FIT.***

## FABRICATED INTERMEDIATE RIBS.

SIMILAR TO A340-300.
FULLY ASSEMBLE TO SPAR INCLUDING TEE –BRACKETS IWO TOP AND BTM WING BOX SKINS. DRILL 2.4mm PILOT HOLES IN TEE-BRACKETS IWO SKIN ATTACHMENTS.

## WING TIP FALSEWORK (AILERON/WING TIP @ RIB 39-41)

***FALSEWORK IS TO BE SUPPLIED COMPLETE TO DRAWING***

FALSEWORK IS TO BE SET TO AERODYNAMIC PROFILE IN RELATION TO SPAR AND THEORETICAL TOP SKIN PROFILE.
T/EDGE POSITION IS TO BE SET AND CONTROLLED AT A PREDETERMINED RIGGING POINT DEFINED BY DESIGN.
INBOARD AND OUTBOARD BOUNDARIES ARE TO BE CONTROLLED AND SET TO ACHIEVE SATISFACTORY CLEARENCES TO ALIERON AND WING TIP BOUNDARIES.
LOCATE CORNER ATTACHMENT BRKTS TO SPAR COMPLETE TO DRAWING EXCEPT:
DRILL 2.4mm PILOT HOLES IWO ATTACHMENTS THRU TOP AND BTM WING BOX SKIN PANELS.
***DRILL FALSEWORK RIBS TO CORNER BRKTS PILOT SIZE ,THIS IS TO BE REVIEWED OVER THE FIRST 5 A/C SET TO ESTABLISH AN ACCEPTABLE STANDARD WITH A VIEW TO DRILLING ATTACHMENTS COMPLETE TO DRAWING.***

***ACCESS PANELS AND BUTTSTRAPS TO BE SUPPLIED COMPLETE EXCEPT:
PILOT HOLES IN BUTTSTRAPS IWO ATTACHMENT TO WING BOX PANELS.
PAUL TO CONFIRM REQUIREMENTS FOR CHESTER STAGE 03.***

***OUTER REAR SPAR WILL BE SUPPLIED WITH PILOT HOLES DRILLED IN TOP AND BTM FLANGES IWO MAIN SKIN DRILLING (APPROXIMATELY 2 PER RIB BAY.)***

**TOP PANELS.**
DRILL STRUCTURE COMPLETE TO DRAWING AND ICY REQUIREMENTS.
BUTTSTRAPS WILL BE DRILLED OFF COMPLETE IWO PANELS AND 2 OFF PILOT HOLES IWO ATTACHMENTS TO WING BOX SKIN. OMIT ALL OTHER HOLES IWO WING BOX SKIN.

PANELS WILL BE SUPPLIED TO CHESTER STAGE 03 FOR FINAL FIT.

BUTTSTRAPS WILL BE SUPPLIED TO CHESTER STAGE 01 FOR DRILLING TO WING BOX SKIN AND FINAL FIT.

**BOTTOM PANELS.**

DRILL STRUCTURE COMPLETE TO DRAWING AND ICY REQUIREMENTS.
BUTTSTRAPS WILL BE DRILLED OFF COMPLETE IWO PANELS AND 2 OFF PILOT HOLES IWO ATTACHMENTS TO WING BOX SKIN. OMIT ALL OTHER HOLES IWO WING BOX SKIN.

PANELS WILL BE SUPPLIED TO CHESTER STAGE 03 FOR FINAL FIT.

BUTTSTRAPS WILL BE SUPPLIED TO CHESTER STAGE 01 FOR DRILLING TO WING BOX SKIN AND FINAL FIT.

SYSTEM BRACKETS,FIXED FITTINGS SIMILAR TO A340-300 SUBJECT TO FINAL DESIGN DEFINITION.

SIGHTING ROD BRACKET TO BE SUPPLIED FULLY DRILLED TO DRAWING REQUIREMENTS AND SLAVE BOLTED IN POSITION TO SPAR.

## FABRICATED INTERMEDIATE RIBS.

SIMILAR TO A340-300.
FULLY ASSEMBLE TO SPAR INCLUDING TEE –BRACKETS IWO TOP AND BTM WING BOX SKINS. DRILL 2.4mm PILOT HOLES IN TEE-BRACKETS IWO SKIN ATTACHMENTS.

## WING TIP FALSEWORK (AILERON/WING TIP @ RIB 39-41)

***FALSEWORK IS TO BE SUPPLIED COMPLETE TO DRAWING***

FALSEWORK IS TO BE SET TO AERODYNAMIC PROFILE IN RELATION TO SPAR AND THEORETICAL TOP SKIN PROFILE.
T/EDGE POSITION IS TO BE SET AND CONTROLLED AT A PREDETERMINED RIGGING POINT DEFINED BY DESIGN.
INBOARD AND OUTBOARD BOUNDARIES ARE TO BE CONTROLLED AND SET TO ACHIEVE SATISFACTORY CLEARENCES TO ALIERON AND WING TIP BOUNDARIES.
LOCATE CORNER ATTACHMENT BRKTS TO SPAR COMPLETE TO DRAWING EXCEPT:
DRILL 2.4mm PILOT HOLES IWO ATTACHMENTS THRU TOP AND BTM WING BOX SKIN PANELS.
***DRILL FALSEWORK RIBS TO CORNER BRKTS PILOT SIZE ,THIS IS TO BE REVIEWED OVER THE FIRST 5 A/C SET TO ESTABLISH AN ACCEPTABLE STANDARD WITH A VIEW TO DRILLING ATTACHMENTS COMPLETE TO DRAWING.***

***ACCESS PANELS AND BUTTSTRAPS TO BE SUPPLIED COMPLETE EXCEPT:
PILOT HOLES IN BUTTSTRAPS IWO ATTACHMENT TO WING BOX PANELS.
PAUL TO CONFIRM REQUIREMENTS FOR CHESTER STAGE 03.***

***OUTER REAR SPAR WILL BE SUPPLIED WITH PILOT HOLES DRILLED IN TOP AND BTM FLANGES IWO MAIN SKIN DRILLING (APPROXIMATELY 2 PER RIB BAY.)***

**TOP PANELS.**

DRILL STRUCTURE COMPLETE TO DRAWING AND ICY REQUIREMENTS.
BUTTSTRAPS WILL BE DRILLED OFF COMPLETE IWO PANELS AND 2 OFF PILOT HOLES IWO ATTACHMENTS TO WING BOX SKIN. OMIT ALL OTHER HOLES IWO WING BOX SKIN.

PANELS WILL BE SUPPLIED TO CHESTER STAGE 03 FOR FINAL FIT.

BUTTSTRAPS WILL BE SUPPLIED TO CHESTER STAGE 01 FOR DRILLING TO WING BOX SKIN AND FINAL FIT.

**BOTTOM PANELS.**

DRILL STRUCTURE COMPLETE TO DRAWING AND ICY REQUIREMENTS.
BUTTSTRAPS WILL BE DRILLED OFF COMPLETE IWO PANELS AND 2 OFF PILOT HOLES IWO ATTACHMENTS TO WING BOX SKIN. OMIT ALL OTHER HOLES IWO WING BOX SKIN.

PANELS WILL BE SUPPLIED TO CHESTER STAGE 03 FOR FINAL FIT.

BUTTSTRAPS WILL BE SUPPLIED TO CHESTER STAGE 01 FOR DRILLING TO WING BOX SKIN AND FINAL FIT.

SYSTEM BRACKETS,FIXED FITTINGS SIMILAR TO A340-300 SUBJECT TO FINAL DESIGN DEFINITION.

SIGHTING ROD BRACKET TO BE SUPPLIED FULLY DRILLED TO DRAWING REQUIREMENTS AND SLAVE BOLTED IN POSITION TO SPAR.

## TOOLING CASCADE

FILTON TOOLING WILL BE MANUFACTURED USING CADS 5 DESIGN GEOMETRY IN THE UN-TWISTED CONFIGURATION.

CHESTER TOOLING WILL BE MANUFACTURES USING CADS 5 DESIGN GEOMETRY IN THE TWIST DEFLECTED CONFIGURATION.

PARTNER INTERFACE COMPONENT TOOLS WILL USE CADS 5 DESIGN GEOMETRY IN THE UN-TWISTED CONFIGURATION.

MANUFACTURE / BUILD TOLERANCING WIL BE AS DEFINED IN THE PARTENER INTERFACE DRAWINGS AND ICY DRAWINGS.