Development and Deployment of Document Management Technology Into Rover

EXECUTIVE SUMMARY

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Abstract

Document Management is a technology that allows the input, storage, management and control of an image under the supervision of a computer based system. A document may be an electronically scanned image of a hard copy document or an electronic image such as a word-processed file, sound file, video file, or graphics file. Once the document has entered the system, a full history of that document is maintained throughout its lifecycle.

The author was responsible for the introduction, development and deployment of Document Management technology into Rover Group. The task given to the author was to implement Document Management technology purely as a repository and distribution management system for engineering drawings. However, by adopting an innovative approach to the application of Document Management technology, substantial benefits were realised.

As the author became more conversant with Document Management technology, greater benefits became apparent. Following detailed analysis of Rover's existing 'Engineering drawing release process' the author re-engineered the process to allow electronic paperless release of all engineering drawings. This re-engineering provided Rover with substantial tangible and intangible benefits including cost reduction, improved quality of data, reduced 'time to market', improved access, improved cycle time and reductions in manual labour.

Three projects detailed in the portfolio demonstrate how this technology was applied to existing systems and processes. In particular, the 'Hams Hall' project clearly demonstrates innovation in the way in which the author used the technology to manage working practices and data structure for a multi-disciplined team located in different countries.

With changes implemented by the author, Rover now hold substantially more digital data than before the implementation of Document Management technology. Following research work by the author into both the types of data held and the use to which that data was put, the legality of that data came into question. This prompted a detailed analysis of the legal requirements of digitally stored data that allowed the author to advise Rover Group of their current status and make recommendations to ensure legal admissibility.

The work reported shows how a combination of technical expertise and an appreciation of business issues and drivers, is crucial to the effective and successful implementations of information systems. Other organisations have shown considerable interest in the improved Document Management technology enabled business processes, developed by the author.

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Acknowledgements

The submission of this portfolio would not be complete without an expression of my sincerest gratitude to a number of people who provided help and guidance throughout my studies.

I would like to start with a special thanks to Dr Amanda Dowd who throughout my studies has not only provided exceptional academic guidance but who has also accommodated my requests for time, often at short notice to fit in with my job.

I would also like to thank Peter Vetch who took on the role as my Industrial Mentor, for his time, help and the suggestions he has provided, recognising the fact that as an IT director for Rover Group, his time is precious.

Thanks are also due to Geoff Edwards, Nick Passant and Andrew Bull who as part of my management team have allowed me the time to attend modules and reviews with my mentor, often when workloads have been high. This also extends to David Story who has assisted me in taking my ideas expressed in this portfolio and turning them into the working Document Management system Rover are now using to their benefit.

Finally, could I thank my wife Beverley and my children Adrian, Rachel and Marc who have put up with my absence whilst studying for my Engineering Doctorate.

Declaration

I declare that all work described in this dissertation was undertaken by myself unless otherwise acknowledged and to the best of my knowledge none of the work has been previously submitted for any academic degree.

Although the ideas regarding the release process were totally those of the author, David Storey (a Cimage contractor) assisted in the programming of the system.

Christopher L. R. Smith.

List of Abbreviations

API	Application Programmer Interface
BOM	Bill Of Materials
CAD	Computer Aided Design
COLD	Computer Output on Laser Disk
EDM	Engineering Data Management
EDMS	Electronic Document Management System
FTR	Full Text Retrieval
GPMS	Group Problem Management System
GUI	Graphical User Interface
OCR	Optical Character Recognition
PCR	Product Change Request
PDM	Product Data Management
QC	Quality Control
SDMP	Systems Development Management Policy
SQL	Structured Query Language
TCP/IP	Transport Communications Protocol Internet Protocol
TIFF	Tagged Image File Format
VIN	Vehicle Identification Number
VRML	Virtual Reality Modelling Language
W.M.I	World Manufacturing Identifier
WORM	Write Once Read Many
WWW	World Wide Web

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1. Introduction

This executive summary is designed to provide the reader with an overview of the portfolio contents, which includes Document Management technology and the work carried out by the author to implement this technology into Rover Group.

To introduce the reader to the subject of Document Management, the summary starts with an overview of what Document Management technology includes and where it fits in the IT forum.

The author has, where possible tried to take an innovative approach to Document Management implementation into Rover to ensure maximum benefits are realised.

The work also includes the legal implications of this technology, what trends have been taking place beyond Rover and its supplier of Document Management software over the last four years and analyses how Rover's chosen supplier have responded to those trends.

As Rover are working on a Document Management strategy which aims to provide the company with a planned approach to delivering Document Management solutions to the business over the next five years, this study has also provided valuable background research that will support that strategy.

This study has been compiled from research data gathered during the last 4 years. The data has been obtained from many sources including:

- Seminar attendance
- Journals
- Benchmarking other companies
- Interviewing suppliers & customers of Document Management Systems
- Research Consultants

1.1. Brief Document Management definitions

Prior to looking at how Rover has implemented Document Management technology, it is necessary to define the context in which the report is written and to define the scope of Document Management and its boundaries.

1.1.1. A Document

Probably one of the best definitions of a document as related to 'document management' is proposed by Andrea Wharton [1], who describes it as simply a 'container for information'. Its format could be visual or audio and its media could be paper, electronic file or multimedia. In order for it to be managed by a Document Management system it must be able to be converted to an electronic form that can be stored within that system. This could be for example a scanned document, a native document (created by a wordprocessor, CAD etc.) a digital audio sound file, a digital still or moving video [2].

1.1.2. A Document Management System

A Document Management system not only stores documents, but manages changes to the document over the course of its life span. Document Management systems also include a number of other important services including:

- Document storage management so users do not have to know much about the document or where it is stored in order to view it.

- Document editing, which include:

Viewing either by native application or by universal viewing tools.

Mark-up - Overlaying information over a copy of an original document.

Document deletion.

Maintaining revision control.

- Providing document security and access control.

- Providing query tools to allow flexible document retrieval.

Plus optional tools which include:

- Optical Character recognition (OCR)
- Full Text Retrieval (FTR)
- Workflow

1.1.3. What a Document Management System is NOT

As important as knowing what a Document Management system 'does', is what a Document Management system 'does not do. In a report by **Ovum [3]**, they itemise what a Document Management system 'does not currently do', which includes:

- Provide integrated HSM (hierarchical storage management) i.e. inform the user of how other documents are related to the document under review.
- Help with versioning by telling the user how one version differs from another.
- Provide integrated forms management, in which data inside forms can be used for structured retrieval.
- Provide for document resource dependencies such as fonts.
- Exert control over documents that have been checked out of the system.

1.2. How the Authors View of Document Management has Changed

If one makes a comparison between the views put forward in the first portfolio submission and the views leading up to and including this report, the original view was that Document Management was simply a database for the storage and retrieval of scanned documents. As the author gained knowledge through the 'release process' work and other system integration projects (see portfolio submissions), this view has changed from a simplistic 'image database' to one of a technology that can be applied to business processes within any market sector for both process improvement and automation. The original submission also discussed the implementation of an 'Engineering Drawing' database and its proposed benefits. However, as the author has taken a more academic view that

has been influenced by the Engineering Doctorate programme, he has achieved greater benefits by looking more globally at overall business benefits to be gained by Rover.

1.3. Document Management IT Positioning

When suppliers refer to EDM/PDM, confusion often occurs as to where Document Management fits into this category of IT products. At the time Rover invested in Document Management technology, EDM/PDM was the only other solution to their requirements however it fell short on some major requirements, particularly distribution and storage. Clearly, Document Management data forms part of a company's data whether it be engineering or product data. This section looks at EDM/PDM and attempts to position Document Management within this arena and discusses any overlap between general EDM/PDM data.

1.4. EDM Technology

In a report by CIMdata **[4]**, EDM/PDM is described as a tool that helps engineers and managers to manage both data and the product development process. The system keeps track of the large amounts of data and information required to design, manufacture or build, and then support and maintain a product. In many EDM/PDM systems not all the data is held centrally. Separate systems may hold associated data but the EDM/PDM system must still have some link to that data to allow central management and control. At an EDM/PDM conference 'The Gateway Group' **[5]** described typical EDM/PDM systems and their expansion of links to other system over time. These included external databases located on different sites, all containing information, which formed part of their product data. In a paper by Chris Telfer **[6]**, EDM/PDM is considered as "an infrastructure architecture for business processes" and he then continues, "It stores all the information about all those document entities and manages their lifecycle. These entities need not just be documents themselves, but also an end product, a process or an individual". Telfer concludes by stating that although Engineering historically used EDM/PDM, the products now offer the flexibility to move outside this market.

1.4.1. EDM/PDM Drivers

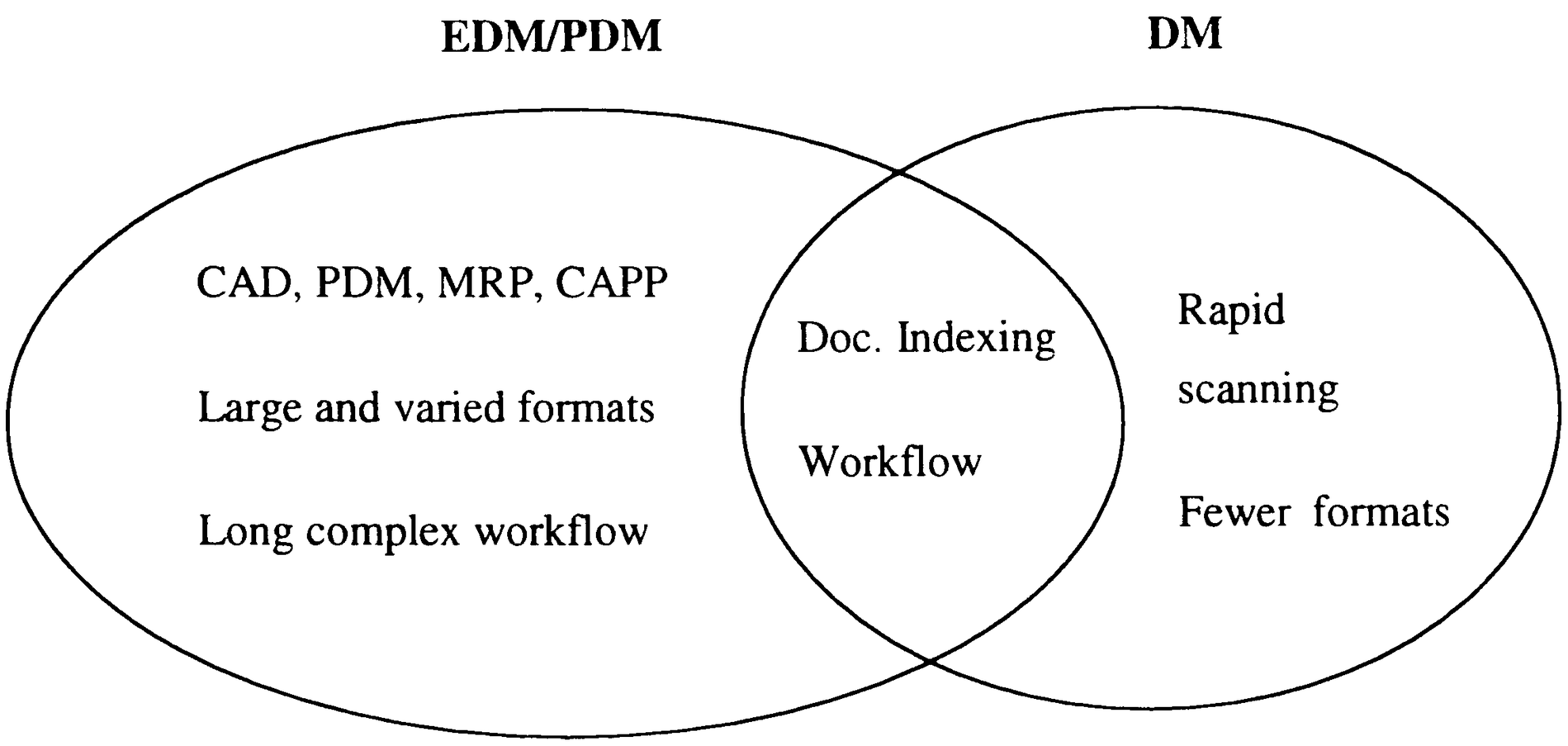
The 'push' for this type of system comes from technology itself. The availability of cheap, powerful computers, global network communication, database applications and peripherals such as scanners all provide the drive for EDM/PDM systems [7].

The 'pull' for this technology comes from user requirements. The amount of documentation alone generated for the design, development and testing of a vehicle now consumes so much storage space, quick and accurate retrieval of that information can be significantly reduced by the use of computer technology. By implementing EDM/PDM, product development can be substantially reduced by providing availability of 'up to date' information throughout an enterprise.

1.4.2. Where does Document Management fit?

As stated earlier, the design, and development process generates large amounts of data of which a high percentage can be captured and managed by a Document Management system. The Document Management system provides EDM/PDM with functionality that was not present in the early EDM/PDM product as shown below. Figure 1 shows similarities and differences between EDM/PDM and Document Management.

Figure 1 EDM/PDM & DM Product Overlap



Although Document Management has many similarities with EDM/PDM, the EDM/PDM system holds a stronger market position in the overall management of product data. EDM/PDM has the ability to manage data held in many formats across distributed systems throughout the business of which Document Management is one such system.

2. Background

Late 1993, Rover decided to invest in Document Management technology in order to computerise their print room operations and provide a storage, management and electronic distribution system for their engineering drawings. Rover saw this technology as the key to improving the efficiency and effectiveness of their print room facility and a means of streamlining the engineering development programmes.

Prior to any major investment programme in IT, Rover require both financial and business justification. Business justification required the development of two documents; a concurrence paper and a business proposal. The concurrence paper consisted of a brief overview of the proposed system and its potential business and financial benefits. The Business proposal consisted of a detailed breakdown of business requirements, proposed solution, system architecture, training, support model and project plan. The financial justification was usually based on a minimum five-year payback programme that was taken into account during the supplier selection process.

Also, prior to implementing the Document Management system into Rover, a conscious decision was made to keep the project simple and deliver a data repository for Rover's engineering drawings. This decision was based on two factors. The first factor was that from initial research, the author was aware that a Document Management system could offer many potential solutions throughout the company but that if too much was taken on, the project may fail. Secondly, another Document Management system project had been started in the Rover Swindon plant at the same time, which incorporated workflow. Although the system owner had completed a highly technical solution, the development system failed because users could not cope with the complexity and were not involved in any way with the project. The final result was the users refused to use the system.

2.1. Financial Summary

The total project costs were quoted at £409,000 revenue and £20,520 capital, totalling £429,520 over a 5-year period. This expenditure would, it was

anticipated, realise a total cost saving for the project of £657,260, thus providing a net cost saving of £248,260 over a 5-year period.

Table 1 Cost Analysis

DOCUMENT MANAGEMENT COST ANALYSIS (£000's)								
		1993		1994	1995	1996	1997	1998
	2nd Qtr	3rd Qtr	4th Qtr					1st Qtr
Manpower Savings	13	13	13	52	52	52	52	13
Manpower (Natural Wastage)			6.5	45.5	52	52	52	13
Machines	.495	.495	.495	1.98	1.98	30.84	35.58	8.895
Printing/Consumables		2.5	3	26	26	26	26	6.5
Hardware/Software	-14.9	-14.9	-14.9	-59.5	-59.5	-59.5	-59.5	-14.9
Maintenance	90d	-3	-3	-19.1	-25.9	-26.8	-26.9	-6.7
Network	-7	-1.5	-12					
Savings	-8.405	-3.405	-6.905	46.88	46.58	74.54	79.18	19.795

2.1.1. Table breakdown

It can be see that the first line item defines the savings gained from manpower reductions. These include two associates taking redundancy at the initial project justification stage and the savings equate to two salaries of £26k averaged over 1993 per quarter. A further 2 voluntary redundancies are accumulated in 1994 to 1996 into the first quarter 1997. This gives Rover savings in salaries over the 5-year period of four associates. Row two identifies further manpower reductions due to retirement The next row identifies cost savings made by terminating print machine rentals and maintenance contracts by introducing the new Imaging system. In 1994 a maintenance contract was allowed to expire with a saving of £1.98k per annum. Cost savings of £28,860 in 1996 and £33,600 in 1997 are

identified within the cost analysis. Following print machine reduction there are gains to be made by the reduced usage of printer consumables i.e. Paper, toner etc.

The next three rows identify costs to the company to enable the Imaging system to be implemented. Hardware and Software includes the costs of renting computer hardware and the licensing of the Document Management software that runs on the systems.

Maintenance includes the system maintenance and software maintenance (Including consultancy) required to support the system over the 5 year period.

Finally, networking includes the cost of installing the network infrastructure to enable targeted downstream users to access the system. Some areas already had the necessary infrastructure in place prior to installing the system.

It can be seen that initially the system imposes costs to the company but over the 5-year period a total cost saving of £248,260 would be achieved.

2.2. Business Justification

The business justification consisted of a number of proposed benefits that the new system would deliver. A list of those benefits are shown below:

Reduced cycle time

- Images available when required by users within seconds, 24 hours/day, 365 days/year.
- Reduces current reprographics distribution process.
- Leads to reduced procurement preparation time.
- Reduces product cycle time.

Improved quality

- Up to date information simultaneously available to networked users.
- Formalisation of 'unofficial' prints.

- Enhanced graphics quality.

- Provides centralised control of drawings.

- Drawing regeneration/restoration.

As well as the above benefits, the new system also addressed a number of print room processes that were both labour intensive and time consuming. These included:

- Re-scaling of drawings.

- Re-printing modified drawings.

2.3. System Requirements

The system had to fit into the existing Rover IT infrastructure consisting of DOS and Windows 3.1 PC clients, UNIX servers and an Ethernet network structure throughout the business. The system therefore had to conform to client/server architecture [8]. Optical Jukebox technology was required to store the large amount of drawings Rover predicted requiring storage. Large A0 scanners connected to scan stations located in each print room were required to input historic data. A facility for the quality control of the scanned image was also required and a compressed data format would be used to aid data storage.

2.4. System Selection

In order to select a supplier, a survey of possible suppliers was undertaken. Various requirements were assessed including:

- Cost – Purchase and support

- Architecture – Client/server, PC local, enterprise wide.

- Platform – UNIX, PC, DOS, X Terminal.

- Functionality

- User-friendliness

- Support and maintenance
- Supplier stability

2.5. Chosen Supplier

From a short list of five suppliers, the final choice was Cimage. This supplier was well recognised for their support of large drawing management and met the criteria for system architecture, functionality, support and cost.

2.6. System Implementation

When implementing this new technology the author applied techniques learnt whilst attending a Warwick University module on 'Technology Management' to address the human aspects **[9]** in specific, influencing techniques to enrol unwilling associates. Section 3.3 'Human issues' describes the matrix used for this task. Potentially this technology would reduce the labour required in the print rooms throughout Rover. This problem was further compounded by the fact that the author needed the help of the print room operators to understand their processes and get acceptance from those who would be responsible for scanning data into the new system.

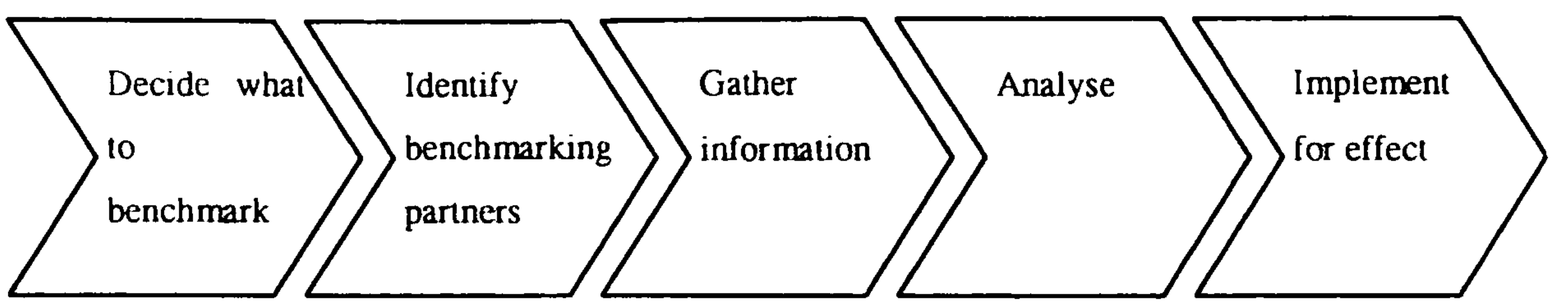
The author approached this problem by being open with the print room staff and giving them involvement with the development and implementation programme. This process was made easier by Rover's 'Job for life' policy which guaranteed that no employee would lose their job through this type of activity. The operators now saw the system as an opportunity for job enrichment and they accepted that new technology had to be introduced to enable Rover to be competitive in the market place. Not only did operators become involved but also some contributed their own ideas for improvement and managed their own working practices.

2.7. Benchmarking

In order to maximise the chances of a successful delivery of the Document Management system a benchmarking exercise was arranged through the supplier with Scottish Nuclear Fuel in Glasgow. The process of benchmarking was already in use at Rover and was based on processes defined by Bengt Karlof & Svante

Ostblom [10] that defined a five stage model for a benchmarking process shown in Figure 2.

Figure 2 Benchmarking Model



Based on this model, a list of areas of interest were identified as shown below:

1. Overall system management
2. System administration
3. System support
4. Database population
5. Drawing control
6. Scanning process
7. Client access - platform/Operating System/time
8. Printing/plotting
9. Archiving
10. Training (user)

During the exercise each area was discussed and both problems and successes were highlighted and documented. Key results achieved by Rover included:

- Reduced scanning process time
- User details, time and date, automatically printed on plots
- Improved understanding of overall system and database
- Ideas for improved administration and system management

The full report is shown in the appendix of the Background portfolio submission.

2.8. Conclusion

As shown above, the Document Management system was successfully justified over a 5-year payback period on both projected cost savings and potential business benefits. A Client/server architecture was chosen to fit neatly into Rover's existing IT environment.

The system's prime objective was to provide a means of providing the business with a data repository for engineering drawings that would enable Rover to replace its manual drawing delivery process with a computerised distribution system. Instead of engineers requesting the delivery of drawings (pull system) the system would provide the facility to 'push' data to customers when available.

Substantial benefits that include reductions in manual labour and cost savings on volume printing were also envisaged following the introduction of this technology.

3. The Document Management Release Process

Following the successful implementation of Document Management in Rover to provide an engineering drawing repository and distribution system, the author was tasked with populating this system with CAD data directly to reduce scanning. At the time no other system was available which would integrate with EDM and manage the release process automatically. ComputerVision (Rover's EDM supplier), were working on modifying their EDM system to allow some control but this was based on the use of their vector data which would impact heavily on Rover's network due to file sizes. Also they could not provide access from the PC platform which formed a major part of Rover's IT infrastructure. This left the author with no alternative but to look at other methods of integrating the Document Management system with the EDM system

When assessing the viability of exporting CAD data from the EDM system to the Document Management system there existed a major problem. The CAD file conversion process was straightforward but the EDM system held the CAD part against a part number i.e. PE.ABC12345, which was useless for users to search upon. The existing engineering drawings were held against the following fields:

- Drawing Number
- Issue Number
- Sheet Number
- Total number of Sheets
- Frame Number
- Total number of Frames

This led the author to study the existing engineering drawing process to assess if there was a stage in the process where the drawing and necessary index data was available.

3.1. Previous Manual Release Process

Figure 12 Existing Manual Release Process' shows the existing manual release process. When a drawing was completed ready for release by the CAD engineer, they would submit the part in EDM from '*Work In Progress*' for review. This process locked the part to stop further modifications and ownership was changed to the specification area. In the print room, a check plot and microfilm were printed. Copies of the microfilm and drawing were temporarily stored and the drawing together with a modification pack (prepared by the engineer describing modifications made by engineering) was posted to the specification area.

The role of the specification area was to check alignment of the part with Rover's BOM (Bill Of Material). Following inspection of the drawing there was one of two outcomes:

1. If the part(s) were correct and hence could be released, the specification engineer would update the part on the EDM system to a status of '*release*' where the part would then be archived in EDM. The drawing would be returned to the print room for copying and distribution to downstream users and the microfilm would be stored as a working copy within the print room.

2. If the part failed for any reason, the specification engineer would update the part on the EDM system back to '*Work In Progress*' status to allow the CAD engineer to make any changes. They would then have to go to the print room to destroy both the drawing and the microfilm. This was often forgotten and caused problems with drawing issue control.

The process described above had many inherent problems including:

1. It was very time consuming i.e. engineers were required to walk to print rooms to destroy microfilm and drawings and at Gaydon users would often have to drive to Longbridge; a 60 mile round trip.

2. It could take up to 17 working days for downstream users to receive copies of the drawing due to delays in the postal system and other print room priorities.

3. It was costly as the process produced a number of hard copy drawings and microfilm, irrespective of the success or failure of a part.

4. If engineers did not destroy the microfilm and drawings upon failure, there was the risk of incorrect data entering the down stream business processes.

5. There were many plot failures due to layering and framing which often entered the business as CAD engineers had no visibility of the final raster drawing when sending plots to the print room and specification engineers were not qualified to recognise geometric errors.

This led the author to re-engineer the whole process through the use of the Document Management system. This potentially allowed substantial benefits to Rover regarding waste reduction, process improvement and quality.

3.2. Document Management Release Process

Figure 13 New Document Management Release Process, New Document Management Release Process' shows the re-engineered drawing release process. From a CAD engineering perspective there was little change in the process, as they would submit their part for '*Review*' as before. The only difference was that previously when they submitted a part for 'Review', the CAD engineer never saw the actual data they were submitting. As mentioned above, plotting and microfilm would frequently fail due to layering and framing errors, requiring re-submission or at worst the later raising of a PCR if the errors were not picked up by specification and released into the business. The new process launched an image viewer and displayed exactly what is being submitted, allowing the CAD engineer to cancel and correct prior to submission if necessary. This totally removed layering and plotting errors that existed previously.

The CAD part was then converted from a vector format to a compressed raster file and together with text data extracted from the EDM part submission GUI was sent to a directory located on the Document Management server. Note that this process was not CAD specific and could receive data from any CAD system that can produce a raster image.

The Document Management system had a simple program running which checks the directory for data and if data arrived from the EDM system, the program would run an application which interrogates the text file and indexed the associated image into the Document Management database.

An extra field was added to the Document Management drawings master database table labelled 'Status'. On indexing the drawing into the database, this field was set to 'Review'. Two Oracle views were then created which would control the release mechanism. One Oracle view table called 'Drawings' (by which general users accessed their data) would only allow the display of drawings where the status field was set to 'Released'. The second Oracle view table (by which specification engineers accessed their data) would only display drawings where the status field was set to 'Review'.

Specification engineers accessed the system and viewed the drawing on screen using the Document Management search and view tools. On inspection of the drawing the specification engineer again had two options.

1. If the drawing was correct the specification engineer could select the 'Administration' menu and had the choice to change the drawing status to 'Release'. This initiated a number of actions. First the drawing was now available to be viewed immediately by general users. The Document Management system then logged into the EDM system by SQLNET and synchronised the drawing status to 'Release'. Finally a microfilm was produced from the Image which was stored for legal requirements.

2. If the drawing was incorrect the specification engineer could select the 'Administration' menu and had the choice to change the drawing status to 'Reject'. This again initiated a number of processes. First the drawing was deleted from the system. Then, as before, the Document Management system logged into the EDM system and synchronised the drawing status back to WIP allowing the CAD engineer to modify the CAD data.

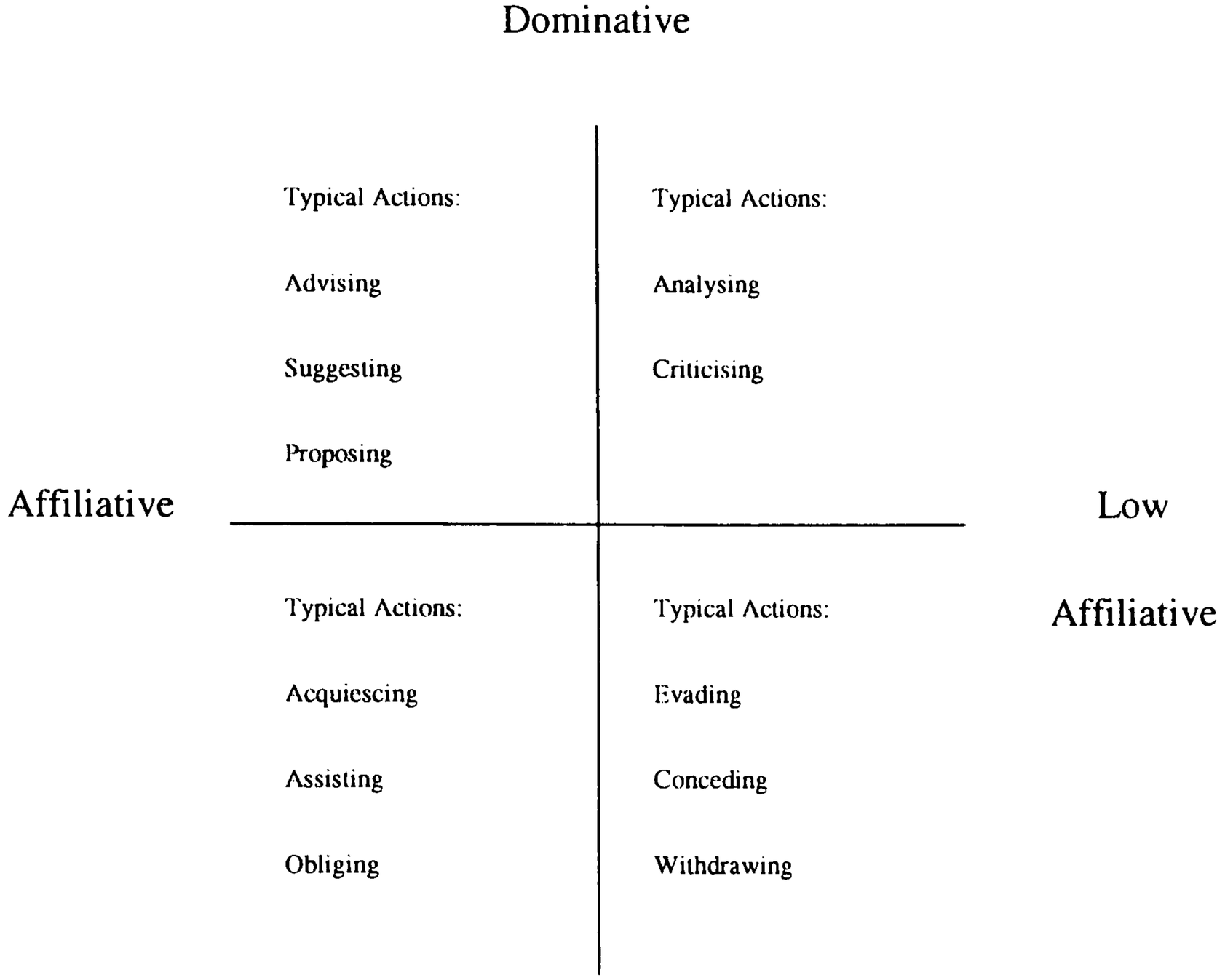
3.3. Human Issues

Another benefit that the pilot allowed was acceptance from those people that would be using the new release process. Learning from knowledge of human factors gained in the 'Technology Management' module **[9]** whilst studying, the author appreciated that this project required a major change in the way the specification department and end users performed their work. Instead of hard copy drawings and signatures the drawings would be electronic only and accountability

would be monitored and managed by the Document Management system. To this end the author involved the specification department from day one. Particular elements used from the module included 'influence and persuasion' techniques to coerce unwilling associates into accepting the changes in their working practices. The approach taken was based on a matrix shown in Figure 3. The matrix was used to determine the best approach to take when presenting the new system, depending upon the type of person one was dealing with.

Figure 3 Matrix of Influencing Styles & Approaches

(Source A Latham, Technology Management Module Human Factors)



User training involved two stages, the first held on a simulation-based system to gain the required knowledge and the second involved working with real data and being hand held throughout the first two days. These people then cascaded both presentations and training to other specification departments thus reducing the fear some engineers showed towards the new system. As the training came from

their colleagues rather than IT people it was accepted well and caused few problems during implementation.

3.4. Implementation Process

As the new processes were in effect IT development projects, linked with other systems and involved people outside the Document Management system it was imperative that the author adopted a structured approach to its implementation. Rover had just introduced an information system development methodology known as Systems Development Management Policy (SDMP) [11], that provided system development engineers with a structured framework for developing and deploying systems into Rover. A detailed overview of the methodology is shown in the portfolio submission entitled 'Document Management Release Process' 1996.

Figure 4 shows those key stages and listed below are the various stages of the methodology.

Project Initiation

Establishes the first definition of the aims, scope and likely structure of the project.

Business Proposal

Produces a clear statement of business requirements, impact and worth, acceptable to both the business sponsor and Rover Systems.

System Proposal

Defines how the business requirements will be delivered and provides sufficient level of cost and timing details for the project to be authorised through to completion.

System Design

Through a process of iterative analysis and refinement, this stage produces a definitive design and specification for the provision of software, hardware and networks.

Construct System

The application is developed, tested and prepared for installation. The user environment is also prepared for the deployment of the system during this stage.

Install System

Procurement, installation and integration of the specified system components, support services and processes occurs.

Commission System

The system components and processes are validated and brought to a state of operational readiness and the user procedures and pre-deployment training are carried out.

Deploy System

Work involved in spreading access to the commissioned system to the end user population to whom it is relevant as defined in the project plan.

Business Planning

The processes, which establish the forward Rover Systems, plan for a business area and identify the need for a system development. These processes are outside of the scope of SDMP, but are shown to provide context.

Service Delivery

During this stage, an ongoing service is delivered through Service Delivery Improvement System SDIS. These processes are outside of the scope of SDMP. They are shown to provide context.

3.4.1. Authors view of Methodology

The above methodology is typical of a 'hard system' methodology which within Rover, tends to be prescriptive in the sense that developers follow the framework until each stage is completed. This does not cater for innovation or creative work as the framework is too ridged.

Although there is user and management involvement at each milestone, having run these key stage events, the view often adopted is to just sign off the event and get back to business. This is generally due to either a lack of the user's technical understanding and interest at the event or frustration over the time taken to complete an event, which is typically half a day.

3.4.2. Comparison with other Methodologies

Although the SDMP methodology was used by the author for both the 'Release Process' and the 'Integration Projects' described later, other techniques were incorporated which the author judged as a major contribution to successful implementation.

When approaching all four projects, the author started by analysing the whole environment, including other system and the people involved in the processes. The people using the existing systems, whether manual or computerised, were encouraged to input their suggestions and identify problems they were encountering, through consultation. This identified bottlenecks and existing problems that needed addressing with the new system. The final design thus addressed the broader issues of the whole process and resulted in major benefits to the company.

This approach borrows from the 'Soft Systems Methodology' (SSM) Checkland **[28]** as this also focuses on environment analysis whereas hard systems tend to focus on design, development and implementation. SSM adopts the approach that one should look at 'the system' in terms of the wider system that includes the 'human activities' such as the people involved with the system. SSM suggests also the construction of what is described as a 'rich picture' which provides a pictorial view of the wider system and the human interactions both internal and external to the system. Although the author did not use this pictorial chart, the

traditional system boundaries were identified and a view was taken beyond those boundaries in the initial analysis work.

Another method adopted by the author that contributed to the successful delivery of the projects was that of a participative approach. This method follows closely work identified by Enid Mumford's 'Effective Technical and Human Implementation of Computer-based Systems (ETHICS) methodology [**28**].

In order to sell the ideas of the author to the system users, there had to be some benefits to the users as well as those benefits identified to the business. First the benefits to both the users and the business were communicated allowing time for questioning and comments. The benefits to the users relating to each project are shown below.

Release Process

Users are no longer responsible for travelling to the print room and destroying hard copies and microfilm.

They can now release or reject a part by clicking a box on screen.

Hams Hall

Users may now share common data irrespective of their location, but not be responsible for its filing, storage or its revision control.

Vehicle History Build Integration Project

Screens catered for all users irrespective of their experience.

Secure data was now available throughout Rover Group

GPMS Integration Project

Full graphical mark-up capability was now available to users.

Manufacturing assembly data and engineering drawings were now available to GPMS users.

In order to convince the user that these benefits were now available, a pilot scheme was set-up as a prototype. This was not to address such issues as screen layouts etc, as users were already conversant with the Document Management system, but to demonstrate the user benefits offered by the system and to assess if a sufficient understanding of the operating environment had been gained in the analysis phase. These benefits directly addressed the user's quality of work and enhanced job satisfaction by removing the risk of poor workmanship due to inadequacies in the previous system or processes.

Mumford defines the socio-technical approach of ETHICS methodology as

'one which recognises the interaction of technology and people and produces work systems which are both technically efficient and have social characteristics which lead to high job satisfaction'.

By adopting some of the ETHICS methodology approaches, the users of the new system accepted the changes to the extent that they themselves drove the migration of other similar areas to the new system. The ETHICS methodology takes this one stage further by involving the users in the system design stage. The users had involvement in the above systems design stage but only at key stages for awareness, ideas and buy-in to its acceptance.

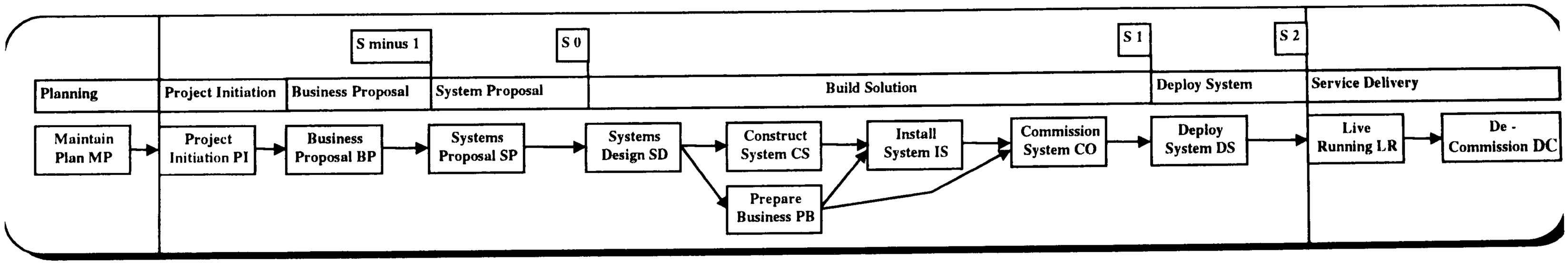
3.4.3. Techniques and Tools

Whilst adopting the above methodology, a number of tools and techniques were used. The two main techniques used included 'Entity Modelling' when designing the database index tables for all the projects and 'Data Flow Diagramming' for analysing the flow of data to/from other systems and processes. Both of these techniques allowed the author to communicate his ideas to users and management, and demonstrate how the new systems would integrate into the existing systems. The main tool used was a project management tool that was used to manage the project life cycle from feasibility, through design and development, to implementation.

3.4.4. Conclusion

The hybrid methodology developed by the author is closest in philosophy to Multiview [28]. This approach also addresses both the human and technical aspects of systems development. Whilst the 'hard systems' methodology provides a good framework for implementing IT systems, the 'soft systems' approach addresses the wider system and includes the human systems which the author feels is equally important to successful delivery of information technology systems.

Figure 4 System Development Management Policy Key Stages

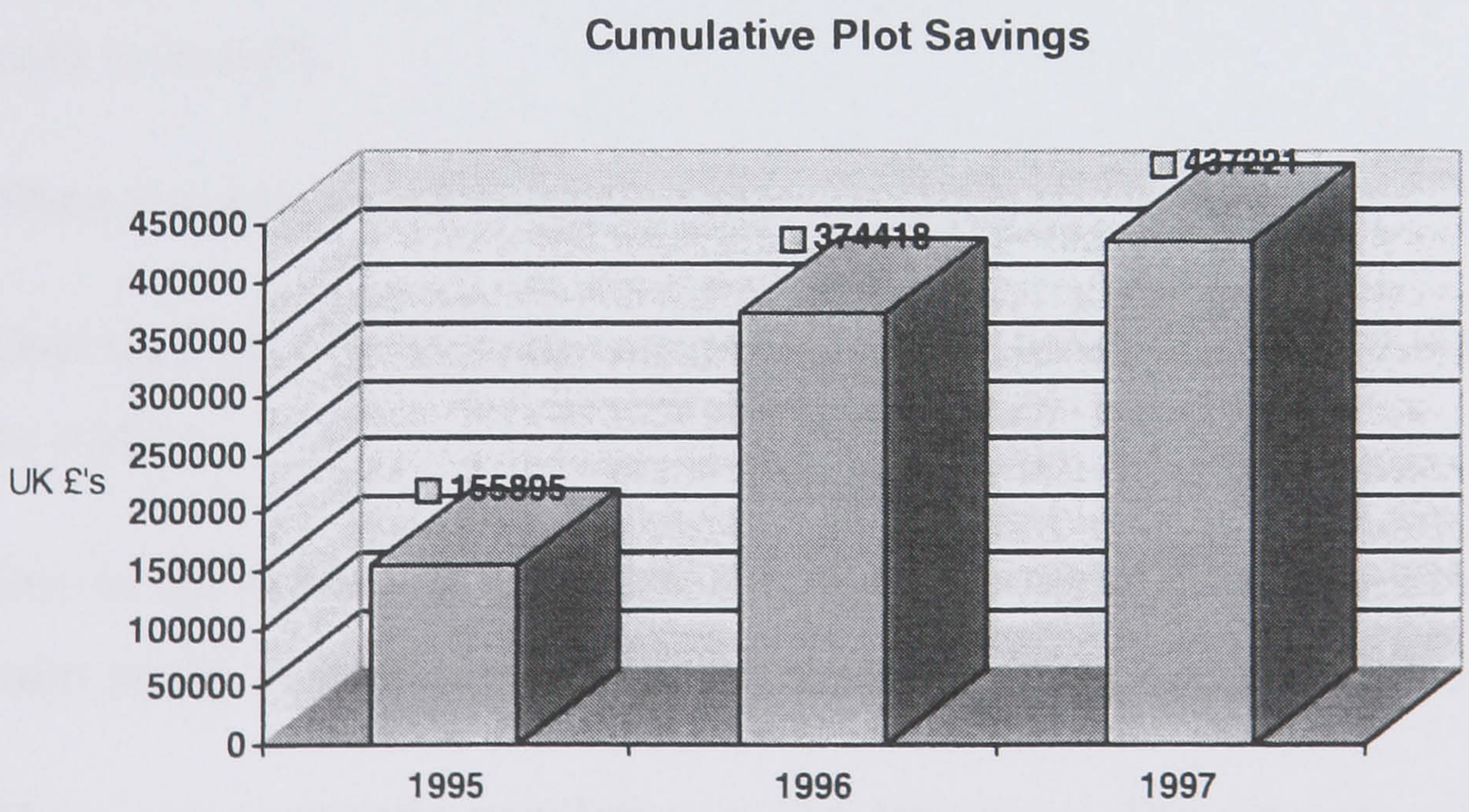


3.5. Tangible Benefits

In order to provide accurate savings information, the audit logs held within the Document Management system were used to monitor the new release process. The system monitored all drawings entering the system and as these would normally be processed manually the system could account for all data flowing through the new process. Prior to the implementation of the new process, costs were calculated for the manual process that included manpower and materials that equated to approximately £1.50 per drawing. These costs were concurred by Rank Xerox who provided additional support for Rover's reprographic function.

Costs saving from implementing the Document Management system and reducing the need for hard copy drawings were already being monitored but the effect of the new release process was already impacting on those figures due to the fact that all current CAD drawings were now available. Figure 5 below shows the cumulative cost savings up until the end of 1997.

Figure 5 Cumulative Plot Savings



Additional to these savings were the savings made by reduced microfilm. The new process eliminated the production of microfilm when a part was rejected (see Document Management Release Process submission). Also the old process

required both working copies and archive copies of plots and microfilm but the new process only requires a single archive copy of the microfilm.

Taking cost savings from above which include both reductions in copying drawings and reductions in microfilm (includes duplicards, silvers and aperture card which are different types of microfilm) printing, a total cost saving to the end of 1997 is shown below:

Microfilm Savings	£117762
Drawing prints	£696988

TOTAL SAVINGS	**£814750**

3.6. Intangible Benefits

Although it is difficult to identify actual monetary savings the intangible benefits were estimated to out weigh the tangible benefits. Amongst the many intangible measures gained by the computerised release process the main benefits included:

- Development cycle time reduction due to data availability, reductions from 17 days to seconds.
- There was now a single Release/Reject process and system.
- Drawings were immediately available to all users throughout Rover and BMW on release.
- Due to the quality of data gained from importing data instead of scanning, users could, and did, plot to a smaller size in preference to large A1/A0 plots.
- There was automatic population of the Document Management engineering drawing database.
- The CAD engineer now viewed his plot data prior to 'Request Review' thus eliminating layering and plotting problems

- Elimination of wasted time by engineers walking to print rooms for drawings and specification engineers walking to destroy failed microfilm and drawings.

- Reduction in wasted engineering activities from working with incorrect or out of date drawing data.

- The Reprographics function has now been removed from the critical path.

- Reduction in print consumables gained from printing to A3/A4 instead of A0/A1/A2 due to vast improvements in data quality.

3.7. Conclusion

From the initial requirement of transferring CAD data to the Document Management system, Rover now benefited from improved process efficiency, shorter cycle time and reduced costs by process re-engineering and by the innovative use of Document Management technology to integrate it with Rover's EDM system.

By including the creation of microfilm within the Document Management system, further waste was removed from the existing process and enabled the reduction of microfilm archives from five sites to one.

By piloting the new process within a live project specifications area, Rover had been able to test the process fully prior to deployment throughout the business. A Document Management audit process running in the background through which work passing through the system can be tracked has also measured cost savings. The cost savings measured so far have justified the release process and added to the payback of the Document Management system itself.

Finally, following a presentation at a Document Management user forum by the author, interest has been shown by other companies and in particular Lucas Industries who requested a visit to Rover with the intent to duplicate the electronic release process within their own company. This was mainly due to the fact that there was no alternative on the market, which would provide them with the same

functionality, and they were also using both Document Management and the same EDM system as Rover.

Rover's supplier of Document Management had suggested that there was a possibility that the new process could be patented and sold jointly as a completely integrated solution. Rover however, declined this offer as it was not part of their core business and it also gave them potential business advantages over their competitors.

There had also been a strong interest shown by Rover's parent company BMW and following a visit by BMW's equivalent system developers, work was started on the integration between both BMW and Rover Document Management systems to take advantage of the release process.

4. Document Management Integration

With the successful implementation of the Document Management based part release process the author's attention was turned towards a number of projects requested by Rover Engineering. Each project required the type of functionality offered by Document Management but also needed integrating into existing systems or processes. Three of these projects have been used to demonstrate how the author has applied this technology in an innovative approach to meet business requirements. The three projects include:

The 'Hams Hall' project whose problems were providing a large multi-disciplined team located across two countries with a common system for the management of all data generated by the team.

A manufacturing project that required a method of inputting large amounts of data quickly and simply and providing two user interfaces to allow access to that data by both internal experienced users and non-experienced external users.

A closely coupled integration project requiring an existing system known as GPMS (Group Problem Management System) to be 'Image enabled' by Document Management technology.

4.1. Hams Hall Project

Rover and their parent company BMW were involved in a major joint project to build a new engine plant located at Hams Hall in Warwickshire England. The plant would build both BMW and Rover power units and transmission units for their prospective range of vehicles. The Hams Hall project management team responsible for the delivery of the new plant consisted of both BMW and Rover personnel plus a major contractor. The team members were located on various Rover and BMW sites within Europe and also outside the company boundary as regards the contractor. It was requested that the project management be controlled by Rover's Document Management system as the project had a number of inherent problems that need addressing in order to deliver the project successfully and on time.

The problems included:

- Large project teams dispersed across the BMW/Rover enterprise with varying IT skills.
- No common filing methodology, security or working practices.
- No common document formats.
- No ability to share data globally.
- No traceability.
- Integration into applications, i.e. wordprocessors etc.

4.1.1. Analysis

The first task was to analyse in detail the problems and determine how Document Management could address each problem. The analysis showed that Document Management could address all the problems either by system functionality or application functionality.

System functionality is that which exists within the basic system as supplied by the vendor and is generally fixed until a new release of software. This includes functionality like data sharing, security, database communications, infrastructure etc. and could be used to solve some of the problems.

The application is the front-end software that allows the user to communicate with the Document Management system when storing, retrieving and viewing data. This is more flexible regarding user preferences and allows the developer to be creative when building the application. The properties include what the user sees on his screen i.e. layout, colour, search facilities, form definitions etc. This could be used when limiting data entries or presenting relevant data to the user.

4.1.2. Problems addressed by system functionality

Large project teams dispersed across the BMW/Rover enterprise, all requiring shared 'up to data' information was addressed by the system functionality as

Document Management systems support global networking and allowed the sharing of common data. As users requested data the latest revision was provided and system security allowed different levels of access and functionality to be defined at user level.

Document Management systems allow multiple document format including scanned images, native documents (Word, Excel, PowerPoint documents) and multimedia formats such as video and sound. This allowed all the Hams Hall data to be catered for and the editing functionality allowed maintenance of that data.

Traceability was required as this was an externally contracted project and Rover needed to know when invoices and contracts were both received and supplied and that one could track time and data of the document life cycle for legal purposes.

In order to provide integration with existing applications, an API tool-set was used. This tool-set allows Document Management menu commands to be inserted into other application menus thus providing the facility to index a document. Within Microsoft Office, when a user needs to save a document they select 'File' on the pull down menu system and instead of using the 'save' option there is an extra command below 'save' labelled 'Index'. This called up the application index table and when completed allowed a document to be indexed into the database. The API allowed the Document Management commands to be integrated into the Microsoft Office menu facilities.

4.1.3. Problems addressed by application functionality

As stated earlier, this is the creative part of the system where the specific needs of the user can be met. A major problem the Hams Hall project team were facing was that there was no common filing format, which resulted in difficulties when trying to find information when working in other locations of the project. This was solved by first agreeing a common filing structure throughout the team. Then index tables were constructed that would only allow documents to be indexed in that agreed format. This was further improved by disallowing data to be indexed unless mandatory fields were completed. To remove the risk of different

definitions of the same object such as a Rover 600 being filed as R600, SK1, R620 etc. lookup tables were adopted. These allowed certain fields to provide a drop down menu and a pick list was presented to the user. An administrator maintained the list and users could only choose from the list.

In order to address differing skills across the project team two levels of search were provided. 'Query by example' provided users with the ability to type in parts of the information they knew and the system would search for documents that matched that information but for more advanced users Structured Query Language (SQL) was provided.

4.1.4. Conclusion

The implementation of the Hams Hall project application not only addressed business requirements but through an innovative approach, users have benefited from Document Management IT in a number of ways to improve working practice.

By using Document Management, users were no longer responsible for maintaining a rigid filing system because the Document Management system now had that responsibility. Users were only required to select a number of lookup fields and click on the index button to store their data. By limiting index field data entry, the system imposed discipline on users indexing data thus allowing easy retrieval of data stored by other users.

Inexperienced users requiring access to data were presented with simple menu screens and only required to select data from the lookup tables to navigate the filing system; thus ambiguity was eliminated by using common field data between users inputting data and users retrieving data.

Project management was also improved by centralising data and making it available concurrently to all users. This ensured all users were working with up to date data at all times.

4.2. Manufacturing Build Card Project

During the vehicle assembly process, all vehicles carry a vehicle history build document consisting of about 30 pages. The purpose of this document is to capture data appertaining to the assembly process such as paint defects, fitment problems, test data results etc., which was historically archived onto microfilm. Two main types of user accessed this data. The internal Rover engineers who were conversant with the VIN format and mainly used the system for warranty data and process monitoring. The second type of user was the external user such as the Police who accessed the data for accident assessment and stolen or ringed vehicle identification. They were not conversant with the VIN format and therefore need assistance when searching for build card information.

4.2.1. Build Card Problems

This project was initiated to replace a manual system that was getting progressively worse day by day to the effect that users of the system were unable to use the data effectively. The main problems of the system in use included:

- The speed at which vehicles were being built was quicker than the microfilm based system could cope with, thus building a backlog of work.
- Data was held on microfilm that was difficult to search and access.
- There were two main users of the system with different levels of skill, the lower of which was not catered for.
- Data was only available in one location.
- There was a high risk of data loss.

4.2.2. Analysis

To allow a complete understanding by the vehicle build project team, a data model was constructed from techniques gained in the 'Information Systems' module **[12]** allowing identification of all fields, lookups and their relationships. The 'entity model' allows the designer to graphically show all key fields and their

individual relationship with other fields. The actual data model used is in the appendix of the 'Integration' portfolio submission. This also required an understanding of the existing process in order to produce a model on which the application would be designed. The data entity model once completed allowed both the vehicle build project team and the author to agree on the final specification of the application prior to the build process.

4.2.3. Build Card Solution

In order to address the problem of the speed of data input, a high speed, double-sided document scanner was purchased. As the documents had barcodes located on the front cover, a barcode reader was provided to allow quick and accurate inputting of data into the Document Management system. The accuracy was important because if an incorrect character were typed, the document would effectively be lost in the system. On receiving a vehicle history document the operator would guillotine the binder off the document and insert the pages into the scanner. The barcodes would be scanned into the correct fields of the application and on selection of the index button the document would be captured.

4.2.4. The Application

The main issue regarding the application was the problem of catering for those users not conversant with the V.I.N. (Vehicle identification Number) format. This was the key field used for searching and retrieving documents. Rover users knew the format but users like the police who often used the system required help.

In designing the application, the author took an innovative approach by attempting to incorporate a method of catering for both levels of user. The VIN format is shown below:

Figure 6 VIN Format Layout

W.M.I.	MODEL	CLASS	BODY	ENGINE	TRANS/ STEER	MODEL CHANGE	ASSY PLANT	SERIAL No

This format consists of a series of characters that represent a unique vehicle identity and also describe the vehicle build. The experienced users know what

characters represent for instance a 3 door coupe with power steering but inexperienced users need to refer to a lookup sheet that is updated regularly and was often out of date.

To solve the problem the author laid out the index and search screen as shown in Figure 7 but behind each VIN box constructed a double lookup table.

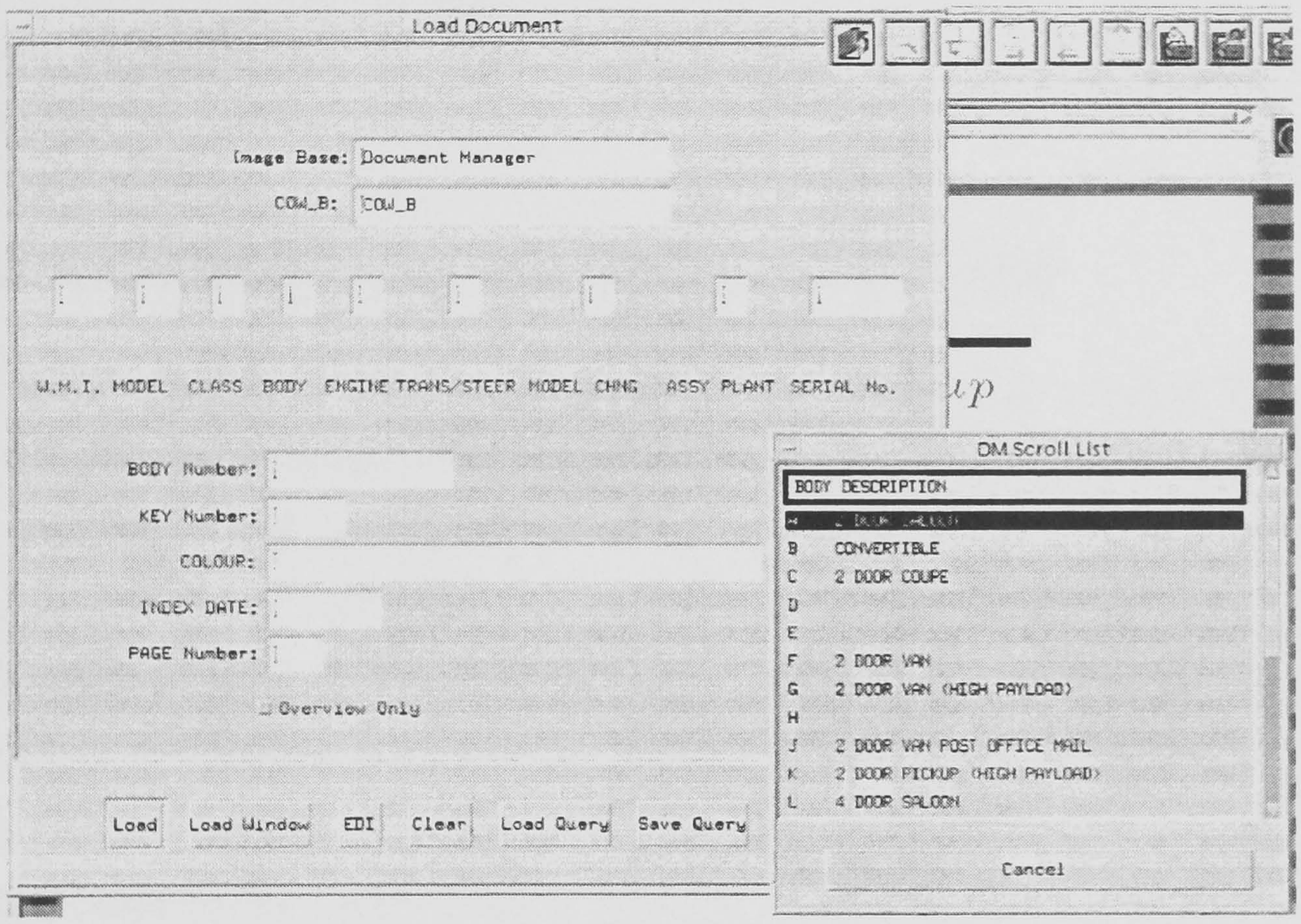


Figure 7 Document Search Screen with VIN Layout

An experienced user could enter all or parts of the VIN directly into the fields and search for the document. Inexperienced users could double click into the 'MODEL' box for instance, and a list of models will appear. The user can select a model and the lookup table will put the codes relating to that selection back into the field. This negates the need for VIN reference sheets and caters for both levels of user.

The system also addressed the other problems identified, by providing access throughout Rover and BMW, and removing the risk of data loss by providing optical storage and backup.

4.2.5. Conclusion

Not only had a manual system been automated in order to keep up with increasing generated data volumes but also by innovative use of data presentation, non-experienced users could now use the system with ease. By innovative use of lookup tables, inexperienced users only needed to double click on the VIN field and were presented with data they understood such as vehicle and engine types, instead of associated VIN codes. On selection the appropriate codes are returned to the VIN field and used to search the database. This allowed any person who could describe a vehicle by part breakdown to be able to find the relevant vehicle history document held on the system. The data was now also secure and accessible throughout Rover and BMW.

4.3. Group Problem Management System (G.P.M.S.) Project

The GPMS system was responsible for managing problems such as those found in service through re-design and re-engineering and back to problem rectification. The original system was based on a text database management package and although the system was heavily utilised, it required enhancing to allow graphical information to be used. The GPMS project team looked at a replacement system but due to cost and data migration problems an enhancement was opted for. This was the stage where the Document Management system was involved. The request made by the GPMS project team was, 'could the existing GPMS system be integrated with the Document Management system closely enough to provide its users with the ability to incorporate graphical data together with its textual data already in use'. Below describes how the Document Management system was integrated into the GPMS system.

4.3.1. GPMS Project Problems

The GPMS project team identified a number of issues that required addressing before the integration process could be attempted. These included:

- The solution must be able to handle existing engineering drawing data formats.
- The solution must provide close integration between applications.

- The solution must enable the graphical data to be marked up and managed throughout the GPMS process.

- Access must be provided to other existing engineering data.

- All platforms supported by the GPMS system must be supported by the solution.

- For future work the solution must be able to support other images such as photographs.

4.3.2. Analysis

The GPMS team required a method by which digital photographs could be associated with a problem and displayed and edited on-screen. Typical digital photographic formats included JPEG, GIF and TIFF, all of which could be catered for by the Document Management system. To view all formats together a universal view was incorporated as the current Document Management system only displayed GIF format but could store and retrieve all formats.

GPMS was currently available on X Terminal and PC. This was not a problem as the Document Management system was available across all platforms within Rover and BMW.

The 'Mark-up and Facility Management' requirements included the requirement of overlaying text and arrows over the image to show points of interest. The Document Management system had full mark-up facilities and although it was not in use, it was available.

To enable close integration to the required level, it was proposed to use Application Programmer Interface (API) tools provided by Rover's Document Management system supplier. These tools allowed Document Management menu commands to be displayed or substituted within the GPMS screen menus.

4.3.3. Close Integration Solution

The GPMS team stated the importance of close integration, as they did not want their existing users to have to run both the GPMS system and the chosen graphical application as two separate applications on one screen. This issue was addressed by the use of the API tool set. The API tool set allowed the Document Management system and/or its internal functions such as viewing and mark-up to be accessed from within other applications.

The API tool set had already been used to integrate the Document Management system into 'Microsoft Office' to allow secretaries working on the 'Hams Hall' project to index their documents directly into the Document Management system. (See section 4.1.2)

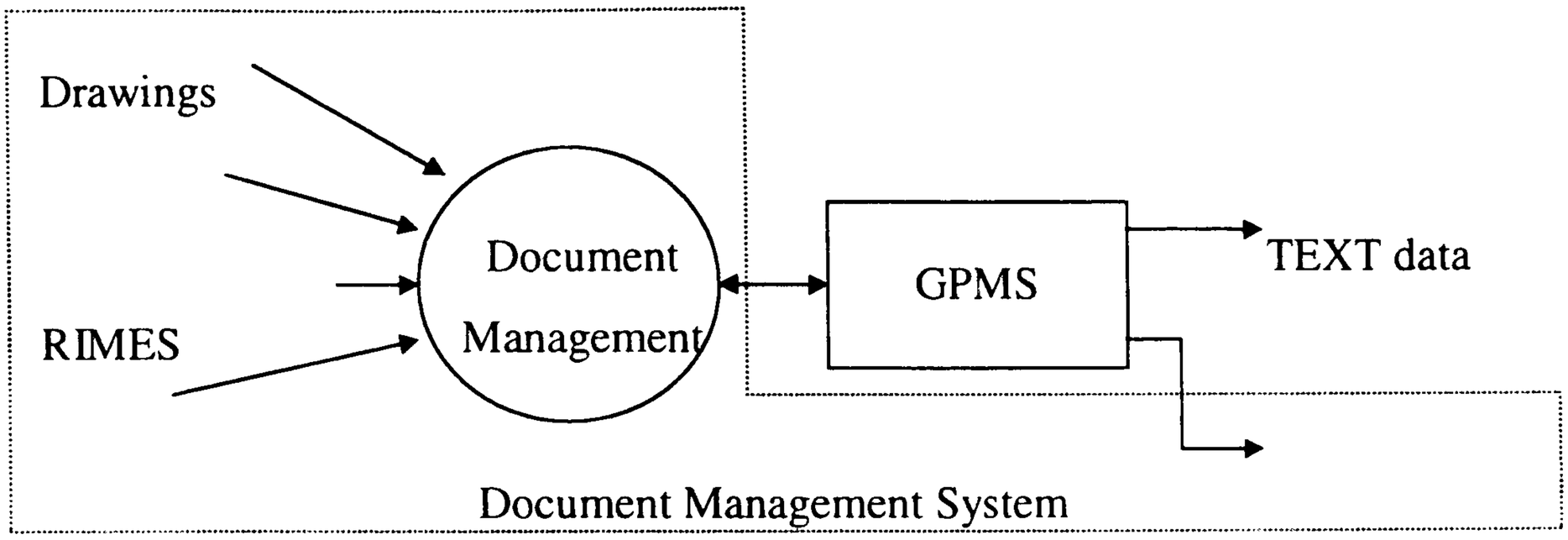
In the GPMS system a button within the GPMS application menu launched the image viewer and passes a problem reference query that immediately loaded the corresponding images relating to the problem being worked on. The Document Management system managed the graphical data and mark-up data and communicated with the GPMS application at a record level providing documents for viewing and editing when the GPMS system passed a query to the Document Management system. The only extra training required for the GPMS team was for the viewing commands such as zooming etc. and adding mark-ups to the master image.

As regards security, the GPMS application passed the user's ID to the Document Management system when launching thus the logon is transparent to the user. This user ID also defined what tasks the user is able to perform within the Document Management system.

4.3.4. System Integration Boundaries

Figure 8 is a system layout showing how the Document Management system image enabled the GPMS system.

Figure 8 System Integration Boundary



The area in the box shows the Document Management system with two links to GPMS. The first queried the DM database for the relevant document and the second launched the image viewer to display the document on the screen along side the GPMS window.

4.3.5. Conclusion

By the use of Application Programmer Interface (API) tools an existing text based system was image enabled allowing graphical data to be viewed with text data and removing the need to totally replace an existing system which users were conversant with.

As the Document Management system was responsible for holding data that is generally referenced for problem management resolution, access to that data was now available to GPMS users via the Document Management system allowing improved problem description and solution.

By using multiple layers on the drawing data, users could now provide designers with multiple problem/solution visualisation. A number of problem solutions

could be over-laid onto the master drawing and designers could switch between potential solutions.

The above approach has improved the communication loop between problem identification and final solution due to multiple graphical layers allowing a number of ideas to be evaluated prior to selection of a resolution.

Finally, by system integration, substantial cost savings have been made rather than designing, developing and implementing a complete new system. Also the impact of a new system on the users and the re-training issues have been avoided.

5. Legal Admissibility of Digital Data

The storage of documents on a computer based system in digital format provides businesses with many advantages including improved quality, access, retrieval and storage but unlike a hard copy, the legal admissibility of the electronic document comes into question and it is more difficult to prove its integrity in a court of law.

As companies migrate from paper format to computer generated documentation they need to ensure that they can prove the documents integrity, especially when dealing with information that may be called upon in a court of law to defend their product or service in a liability claim against the company. This document compares the legal aspects and recommendations taken from references against work completed by the author for the Rover Group Document Management system. It is intended to provide an insight as to where Rover are at this moment in time and provide guidance to ensure their compliance to British Standards recommendations.

5.1. Definition of Legal Admissibility

Before one can assess its ability to meet legal requirements one must be able to define what makes a document legally admissible in a court of law. The general requirements defined by the British Standards **[13]** include the need to prove:

- That the electronic document is a faithful representation of the original document.

- That the electronic document has not been altered in any way during its life cycle.

- If the document has been altered, what alterations have been made, by whom and when.

Other considerations to assess include the level of proof required which is dependent upon that court of law by which the documents may be requested. If it

is a civil court the defendant will need to prove 'on the balance of probability' but in a criminal court the defendant will require to prove 'beyond reasonable doubt'.

5.2. Assessment of Data against Code of Practice

An assessment of all data currently held within the Document Management system was performed to understand the type of data and whether it was likely to be requested by a court of law in any claims against Rover Group. The outcome of the assessment showed that all data held might be requested as the data related to either commercial documentation or design and safety documentation.

5.3. Basic requirements to meet legal admissibility

From reading referenced material such as the British Standards, there is an underlying requirement that underpins the whole process of ensuring legal admissibility of data in a court of law and that is by use of procedures and responsibility. Every process, starting from document creation or document scanning to the storage and original document destruction must have a formal documented procedure that identifies step by step how the process is performed. Secondly, there is the need to prove that the procedure has been adhered to at all times and finally that one can prove responsibility for that process i.e. that the person responsible for scanning, indexing etc. the document can be identified.

5.4. Business Processes

As Rover have implemented BS EN ISO 9000, there already exists a complete set of documented processes covering scanning, indexing, and quality control for operators who are responsible for these tasks. Also, a background process that is running constantly on the Document Manager server provides an audit facility. This logs anything that happens to a document whilst under the control of the system including who views what and when etc. This audit also tracks which operator indexed a document into the system and if any changes are made, who was responsible for those changes thereby providing a means of tracing responsibility back to an individual. As well as the audit logs, all scan station

operators keep a manual log of their indexing process which includes batches, dates, problems and quality control (QC).

5.5. Other British Standards Recommendations

5.5.1. Security

Security is also a requirement **[14]**, and includes single user login identification, passwords, frequency of password changes, etc. Rover's IT Security Handbook **[15]** to which the Document Management system conforms, amply covers British Standards recommendations.

5.5.2. Document Retention

The British Standard recommends that a Document retention policy is adopted which defined the type of documentation and its length of retention. Again Rover have a Record Retention Policy **[16]** which is well within the recommendations.

5.5.3. Bureau Services

British Standard recommendations for use of bureaus include the need for processes that control the management, security, format and responsibilities of any bureau a company might use. British Standard recommendations also states that the processes used by the bureau must link to those in use by the company and the processes must provide traceability, even if the bureau ceases trading.

Rover use bureaus extensively; however, the assessment showed that Rover failed to meet the requirements adequately. The reasons include:

- Rover had no bureau processes.
- There was no management of data to and from the bureau.
- There was no security.
- There was no traceability.

5.5.4. Optical Storage Issues

The British Standards address the issue of the types of storage medium used for Document Management data [17]. They recommend the use of optical media, specifically 'Write Once Read Many' (WORM) as once written to, the data cannot be changed. Rover adopted optical technology as part of their Document Management system however they failed to understand the requirements for WORM media and chose 'Read/Write' media to allow incorrect data to be modified. To address this issue all future data needs to be written to WORM but current data will now be under question.

5.6. Recommendations

The outcome of this assessment is a list of recommendations that each area needs to address in order to meet legal requirements in a court of law. These recommendations include:

5.6.1. Bureau Outsourced Work

1. A bureau site assessment visit.

2. Duplication of Rover processes introduced within bureau for Rover work.

3. A formalised Rover process for general bureau work.

4. Documentation requirements from bureau.

5. An audit procedure and timing plan to check process traceability.

5.6.2. Optical Storage

1. Type of media in use needs certification.

2. A process and policy for optical storage needs implementing.

3. A process and Policy owner is required.

5.6.3. General

1. Review of all existing internal processes.

2. Data integrity process and documentation.

3. Data format documentation/Policy.

5.7. Conclusion

The assessment showed that Rover need to address a number of issues regarding their compliance with British Standards recommendations, in order to ensure legal admissibility of their Documents Management data. The main area of non-compliance was the lack of processes and control when outsourcing work to bureaus. Clearly, Rover would be unable to prove that any data processed by the bureau was performed correctly and indexed accurately. Following this assessment Rover planned a visit to their bureaus to look at ensuring they adhered to Rover's existing processes.

The general processes used internally met most of the recommendations, however a complete review of all processes used had now been planned following this assessment.

As regards security, Rover exceeded the British Standards recommendations with their IT Security Handbook Document **[15]** except for the optical storage recommendations. As the policy was due for review, the systems security group would be including optical storage policies with reference to concerns raised in this assessment.

6. The Changing Role of Document Management

6.1. Introduction

During the author's involvement with Document Management technology, many changes had taken place and technology such as the Intranet and Microsoft were still influencing this change. From work and research undertaken over the last 4 years, the author compiled information into the trends and changes that have or are effecting Document Management technology.

The aim of this section is to understand what is happening beyond Rover and its supplier of Document Management software and also to allow a comparison to be made between the development work currently in progress and direction of planned future work, with general Document Management market trends

The section also attempts to analyse how Rover's chosen supplier have responded to these trends and also assesses if Rover's approach to Document Management and its choice of supplier would differ, given the chance again, but 5 years on.

6.2. Document Management Infrastructure

Over the past 3 years the target platform for Document Management systems has changed. This change has been driven by the changes in the 'office desktop' market and the influence of Microsoft. When the author began Document Management work for Rover, the platform available from most suppliers was predominantly client/server (see Background portfolio submission). This basically consisted of a UNIX type server (Sun, HP etc.), a database again running under UNIX and the client which was generally PC based. This architecture was used because the server end of the system required high processing ability but the client only needed limited power to display the image.

Two major changes have affected this approach. The first is that more functionality has been required at the client such as annotation, more graphical information, multi-page manipulation etc. Secondly, the PC has improved in power so much that both the client and the server can be kept in the same

environment and at a much-reduced cost **[18]**. This view is supported by Wharton **[19]** who also sees the Windows NT platform as the preferred platform due to its scalability, a major factor of importance to large enterprises.

6.3. Document Management Market Segments

In order to understand the markets outside the Engineering and Manufacturing sector, a study of general Document Management marketing was sought in order to explore 3 market trends.

1. What major markets are targeted by Document Management suppliers/vendors?

2. What are the particular areas of importance to these market sectors?

3. What are the overall generic areas of importance of the sectors that invest in Document Management?

In studies by iTX Marketing Services **[20]** and BTC **[21]** the top 10 major Document Management market segments were surveyed. A matrix was built up showing all major market segments, suppliers that currently support the sectors and key services they provide.

The 10 market sectors included:

- Banking, Finance and Insurance
- Government
- Other Public Services/Healthcare/Education
- Engineering & Manufacturing
- Utilities, Oil & Gas and Construction
- Chemical/Pharmaceuticals
- Transport/Distribution

- Communications/Media
- Business Services/Professional Practices/Charities
- Retail

The Study also includes the type of services required by these market sectors which are listed below:

A. Managing paper as electronic images

B. Scanning, viewing & storage hardware

C. Managing technical documentation

D. Process automation and workflow

E. Office automation & electronic file management

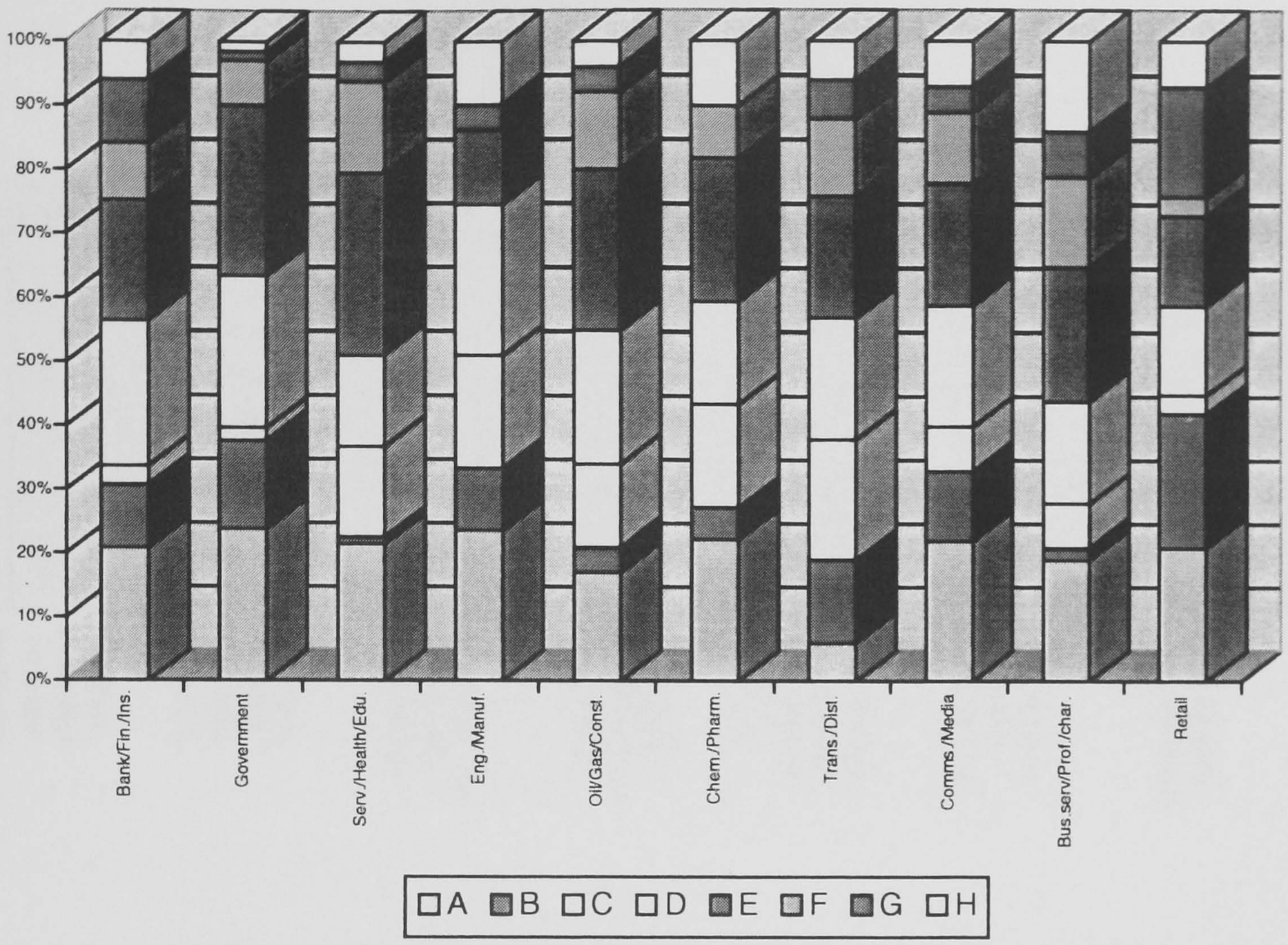
F. Recognition & forms processing

G. Computer print management

H. Internet and information distribution

By analysis of the study data, the following graphs show what is important to the individual sectors, and what are the major areas of interest to the overall Document Management market. Table key A,B,C etc. refers to previous page list.

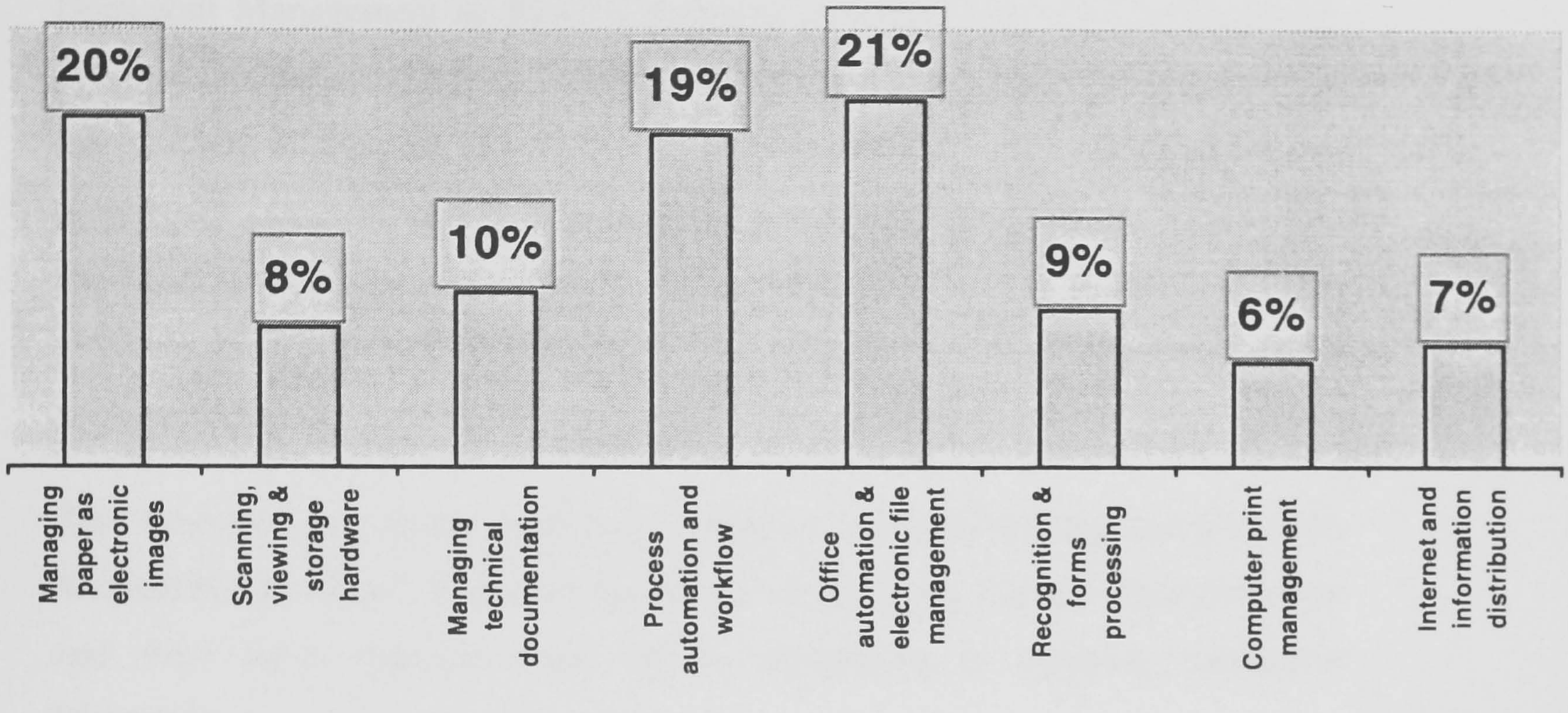
Figure 9 Results of Market Trend Analysis



One major issue that is continually being referred to by Document Management suppliers for their lack of sales and which is discussed in depth in a market research report by CATN/Cambashi **[22]** is that of education in Document Management. Not only do many companies not understand what benefits Document Management systems can provide but they also fail to justify the need for this technology to their board members.

Figure 10 below show the overall levels of interest being shown in the various fields within the Document Management arena.

Figure 10 Generic % importance of Document Management



The data for Figure 9 was compiled from both the Ovum Report **[23]** and the iTX Marketing Services **[20].**

Most Document Management users tend to apply this technology in order to address particular requirements. The two most popular requirements are:

1. Office automation and electronic file management

2. Management of paper as electronic images

6.3.1. Where Rover Sit in Market Sectors

As Rover sit commercially in the Manufacturing and Engineering sector, one would assume that they also fit into that category in the Document Management market sector as described in section 6.3. If one takes a generalists view this assumption was probably true; however, the view of the author is that as a company gains experience and knowledge in the application of Document

Management, the focus changes. Rover initially invested in Document Management to address a specific problem, that of a repository for engineering drawings. The company focused on that task ignoring other requirements to ensure success. Once that task was completed, knowledge gained on that task allowed the author to change focus from the product to the process i.e. instead of using a product (Document Management) to store documents, the author applied Document Management to Rover's business processes which is fundamentally different and returned higher benefits. Once this task was complete, the author then looked at how the many facets of Document Management described in section 6.3 could be applied to processes to benefit the company. Taking this approach it is difficult to fit Rover into a typical sector as the type services generally associated with manufacturing and engineering (see Figure 9) no longer apply to Rover.

This situation was again supported following a benchmarking exercise with Scottish Nuclear Fuel. They also had moved on from their initial implementation and their focus changed from Office automation to applying Document Management to process re-engineering.

6.3.2. Top Supplier Survey

A Survey was carried out and analysed in order to understand the Document Management market. **Figure** 11 lists the major suppliers and their market position at the end of 1997. (See 'The Changing Role of Document Management' portfolio submission for a full supplier breakdown)

6.3.3. 'If Rover Could Choose Again'

At the time Rover was planning to invest in Document Management technology back in 1994, focus was purely on providing a repository for engineering drawings. This led Rover towards suppliers who focused mainly on the Manufacturing and Engineering sectors. Looking back, the choice made then was correct as the system now installed in Rover has been very successful and the criteria on which the product was chosen have been met. However, since then Rover have changed their focus from just engineering drawings to more complex

multi-format documents such as native documents (Word, excel etc.), scanned documents, multi-page documents etc. At this moment in time (August 98), Cimage do provide some of the level of support Rover require for this level of document but as this is not their core business, many other suppliers perform this task better.

With Rover's move towards multi-page documents as well as engineering drawings, if the choice was made today, a more suitable supplier would be Documentum or PCDocs as they have a more mature product focused towards multi-page documents. Also their Web client is fully functional unlike the Cimage client that at present is unable to support mark-up and indexing.

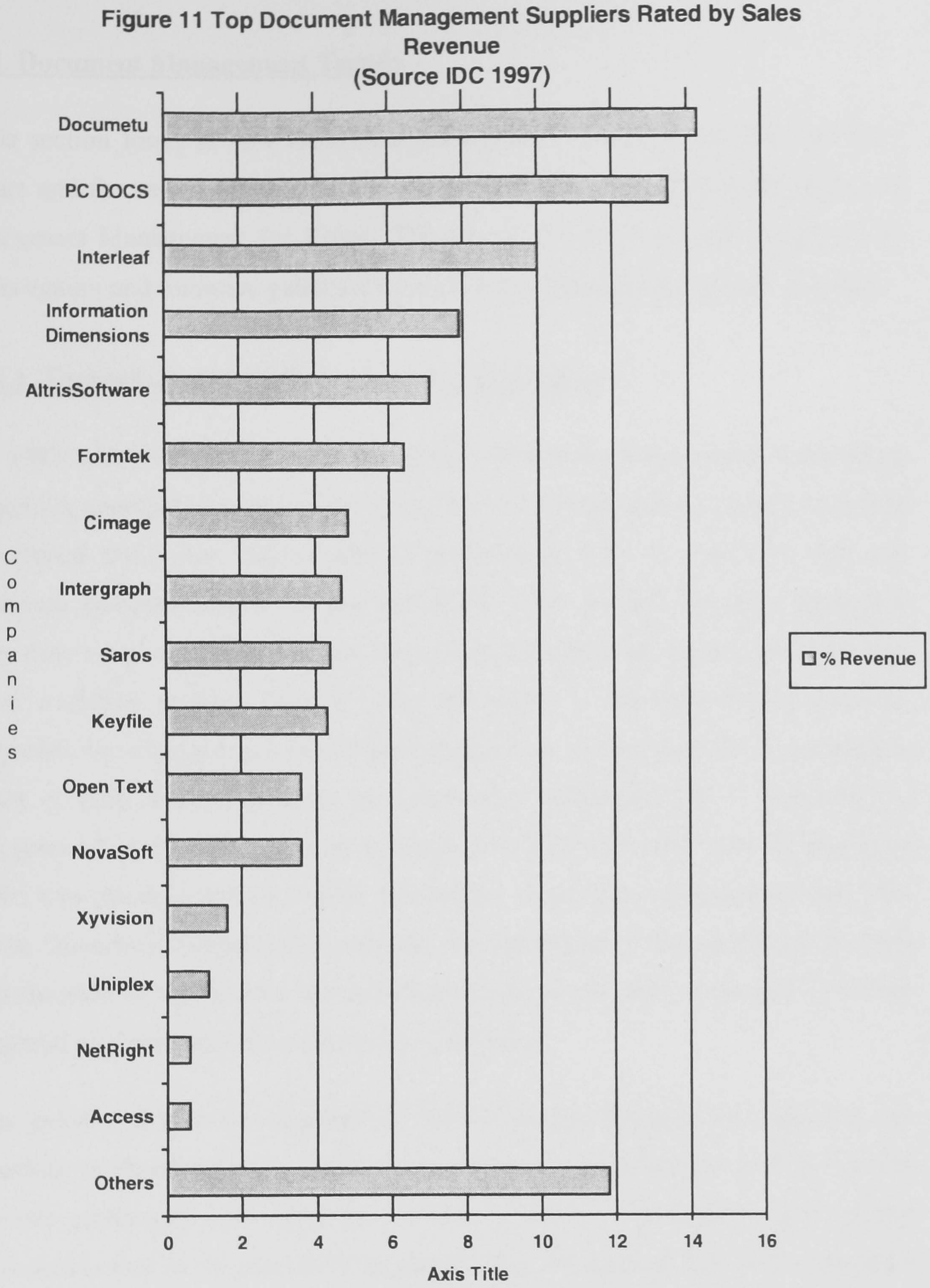


Figure 11 Top Ten Suppliers

6.4. Document Management Trends

This section looks at how Document management has changed over the last 5 years and the trends encountered by the author whilst developing and deploying Document Management for Rover. The trends discussed are also supported by information and literature gathered from journals, seminars and general research.

6.4.1. Technology Acquisitions (companies/partners)

In 1993 when the author started studying Document Management technology, suppliers generally produced their core Document Management system and then developed their own various add-on applications such as workflow, full text retrieval, computer output on laser disk (COLD) etc. Rover's supplier, Cimage at that time were no different in that they produced their core product and had their own workflow product. Over the past few years, it has been evident that this approach has changed and Document Management system suppliers now acquire most of their add-on products from specialist companies **[18]**. This trend is supported in a report by Wharton Systems **[19], [24]** who stated that the market in 1995 was characterised by a series of mergers, acquisitions and partnerships. This gives Document Management suppliers the advantage of incorporating the high functionality of specifically developed products, produced by companies with the required expertise into their own suite of software.

The positive side to this approach is that Document Management suppliers can continue to develop their core products and leave the specialist add-on's to the various companies who specialise in these products. The negative side to this approach is that as the process of migration from the original add-on's to the third party products has taken place, customers have been faced with a number of problems. Not only is there discontinued support for the original products they purchased but they now have to purchase new licenses and maintenance for the replacement products, as they are not part of the Document Management supplier's software suite.

6.4.2. How to Limit Effect

Unfortunately, it is difficult for a customer to limit the effects of a supplier dropping a product in order to take advantage of a 3rd party product. One method is to undertake a partnership agreement as Rover has now done with Cimage. This entails the customer signing an agreement of commercial confidentiality with the supplier and working with them in their product development by beta testing etc. and in return gaining knowledge of future strategy and product development.

6.5. Document Management and the Internet

The one area of IT that has impacted the most on Document Management has to be the Internet. All major Document Management companies have or are developing some level of Web technology into their products. As the main uses of Document Management include a repository, management system and means of distribution of information throughout a business, then enabling that access to be extended world-wide has to be of major interest to international businesses. In an article 'Logging onto the Net – DM connects to the super highway' **[23]** a number of major drivers of this trend are highlighted as well as global access.

- Open Architecture' which allows it to run on almost any platform.
- Web Clients can be used freely without licensing.
- Control, security and configuration is managed from the Server.
- WWW architecture uses only one network protocol; TCP/IP thus reducing the level of network support required and as it is well-established technology, it is robust.

6.5.1. Inherent Weaknesses in this Technology

There are however, still some issues that have deterred many companies from implementing this technology and are well documented in an independent survey carried out by 'The Wall Street Journal Europe' **[25]**. This survey highlights the risk of security of the Internet, as their area of work is money related and early

access to changing share data by hackers could be catastrophic to their business and very attractive to potential criminals.

There are other inherent weaknesses in current WWW technology that will need addressing according to T Carroll **[26]** and include:

- Standard browsers have difficulty in managing large documents.

- Hyper links require managing otherwise links become broken.

- Full text retrieval searches from a thin client are not yet available.

- Document standardisation is not yet agreed

6.5.2. How Rover Intend to utilise this Technology

Due to the benefits described above such as a single client support and a common look and feel, Rover have already started development into Web technology for their Document Management system. At present this development has been limited to the Rover/BMW Intranet (a company wide Internet with no access to or from the external Internet) mainly for security reasons. An Internet web server has been installed which provides a link between the Intranet and the Document management server and allows access from Rover/BMW based Web browsers running on PC and UNIX clients. At present this access is limited to document search, retrieval and viewing which is dictated by the current functionality of the Cimage software, but Cimage aim to release full functionality by the end of the year.

6.6. Conclusion

From this report and supporting literature **[27]** is clear that the Document Management market has still not reached its full potential. From experience, the author feels this is mainly due to the lack of education into exactly what is Document Management, how it differs from general database technology and what it can do for a business. In the first few years the author was continually presenting talks to higher IT management within Rover Group on how this technology differed from our existing EDM/PDM database and how this could be

used to re-engineer processes to improve efficiency. It took 3 years before Rover took full advantage of Document Management technology and eventually re-engineered their release process (see portfolio submissions), gaining substantial benefits.

With regard to trends in Document Management, the author sees the Internet and Intranet as having the greatest affect on new product development. All major Document management suppliers now offer some form of Web client thus potentially providing global access to their corporate data. Although Document Management suppliers have implemented Web technology into their product with differing levels of functionality, the author feels that even greater functionality will be available over the next 12 months by the use of Java and VRML.

Another major trend highlighted in this report is that all Document Management suppliers are moving to a Windows environment and reducing support for the UNIX environment. This is being driven by influences outside Document Management but it still has a major impact on its development.

Finally Document Management suppliers themselves have changed their approach to new product development over the last 5 years. Instead of maintaining a complete product range, they now tend to enter partnerships with suppliers of special products such as workflow and FTR and just provide integration with their partners.

7. Conclusion and Future Work

7.1. Portfolio Conclusion

From both the literature survey and the author's experience, a number of key factors have been identified when adopting Document Management technology.

In particular, the 'Hams Hall' project clearly demonstrates innovation in the way in which the author used the technology to manage working practices and data structure for a multi-disciplined team located in different countries by exploiting the attributes of Document Management technology.

A major factor gained from the author's work but not widely reported is the application of Document Management technology to business processes. From attendance at a Document management user forum twice yearly and many seminars, most case studies involve the use of Document Management for a data repository and a means of management and distribution throughout an enterprise. Whilst this is a key use for Document Management technology, the author has gained far more benefits from applying the technology to business processes, improving efficiency and effectiveness. This has allowed the automation, control and simplification of existing processes and improves the overall process as described in the release process submission. Improved functionality of existing systems can also be gained from integrating Document management technology as described in section 4. The success of the author's release process within Rover has led a number of other companies to adopt this process including, Lucas, Ford, GEC and BOBST.

When introducing Document Management technology a simple project with defined boundaries should be chosen and focus should be on the successful delivery of that project. This will provide both the level of knowledge required by the developers to then apply the technology to other more ambitious projects and more importantly introduce the users of the system to the use of digital data rather than hard copy data. The change from hard copy to digital data should not be underestimated and required a culture change and involvement by users to be successful. With reference to the use of a simple project for its introduction, at the

time of the author's initial project, a similar project was started in Rover's Swindon plant. The difference between the two projects was the Swindon project used workflow from day one. The result was failure as the users refused to adopt the technology due to complexity as well as a major change in working practices.

When introducing Document Management technology it is imperative that users of the system have involvement. Firstly the users have to cope with the technology and culture changes and secondly the technologies will almost certainly result in reduced manpower and by involving users these changes will be accepted more easily.

Understanding of legal issues must also be addressed by a business when introducing Document Management technology. Many businesses focus on the technology but ignore legal admissibility of the stored data and fail to understand the processes that need to be in place to provide accountability and traceability of that data.

The effect that the Internet is having on Document Management technology is enormous and with thin client technology, access to Document management system will expand rapidly. Although global access to these systems provides major business benefits the issue of data security must be addressed. Also the functionality provided by thin client access must be available in order to realise maximum benefits. This includes workflow, F.T.R., mark-up and editing etc.

7.2. Future Work

7.2.1. Automation of Specification

Rover's BOM system's underlying database is Oracle, the same as that used by Rover's EDM and Document Management system. The Document Management system already queries and updates EDM via SQLNET (an Oracle database language) to maintain alignment of the Document Management system with the CAD EDM system. As the drawing index tables contain Drawing Number, Issue and Page Numbers, a process of initiating an automatic login process by the Document Management system into GBOM using SQLNET and querying GBOM

with the EDM part number, a comparison of the GBOM and part data could be performed. If they align correctly the drawing could be released but if incorrect the drawing could be rejected.

This process would eliminate human error in comparing alphanumeric strings and would perform the process quicker, 24 hours a day. On the down side 50 specifications engineers would no longer be required for that function; however through Rover's 'job for life' policy they would be re-deployed within the business.

7.2.2. Supplier Drawings

Many engineering drawings are still provided by suppliers and therefore cannot be managed by the 'Document Management Release Process'. By extending access outside Rover, this limitation could be removed. By the use of the Internet and once security and functionality issues have been addressed, these suppliers could be integrated into the release process and allow all drawings to be managed by a single process.

7.2.3. BMW Integration

From a business point of view Both Rover and BMW have their own Document Management system. At present although the data format is compatible, the underlying databases are different and cannot communicate. Interest has been shown by BMW in the Rover Document Management system, particularly the 'release process', which is something they are eager to implement themselves however in order to benefit from the author's work they must change their database to be SQL compliant. BMW have identified the need for this work to be undertaken.

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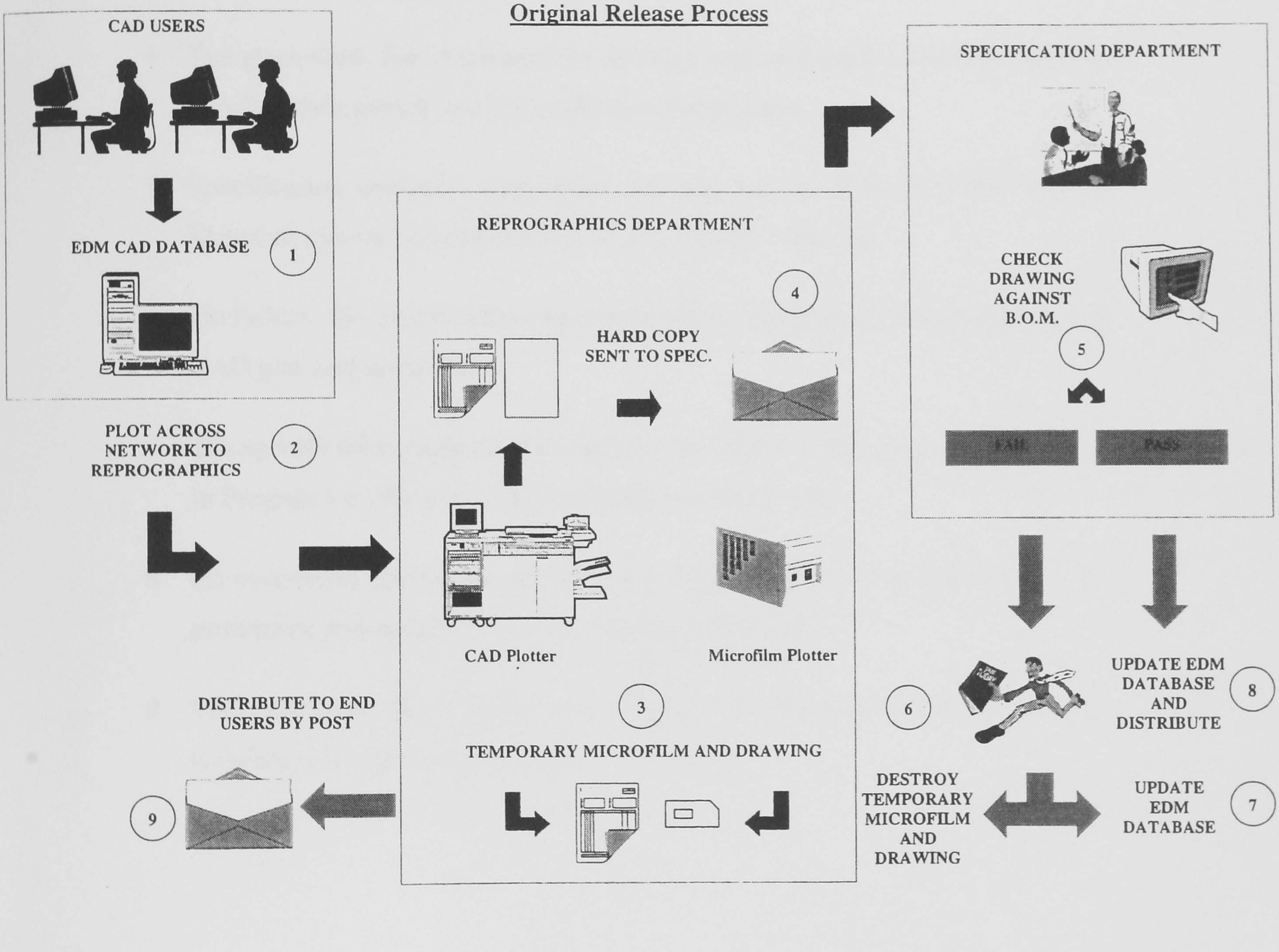
9. Appendix

Figure 12 Existing Manual Release Process



Existing Manual Release Process Description

1. On completion of the CAD part, the engineer files the part for '*REVIEW*' in Rover's EDM (Engineering Data Management) system.

2. The EDM system then sends a plot file across the network to the print room.

3. In the print room a plot and microfilm is produced. These are stored temporarily until the part is *RELEASED* or *REJECTED* by the specification department.

4. The print room then packages the drawing and mod-pack (drawing changes), which is then posted to the specification department.

5. Specification engineers then check the part against Rover's BOM (Bill Of Material) system and either *RELEASE* or *REJECT* the part.

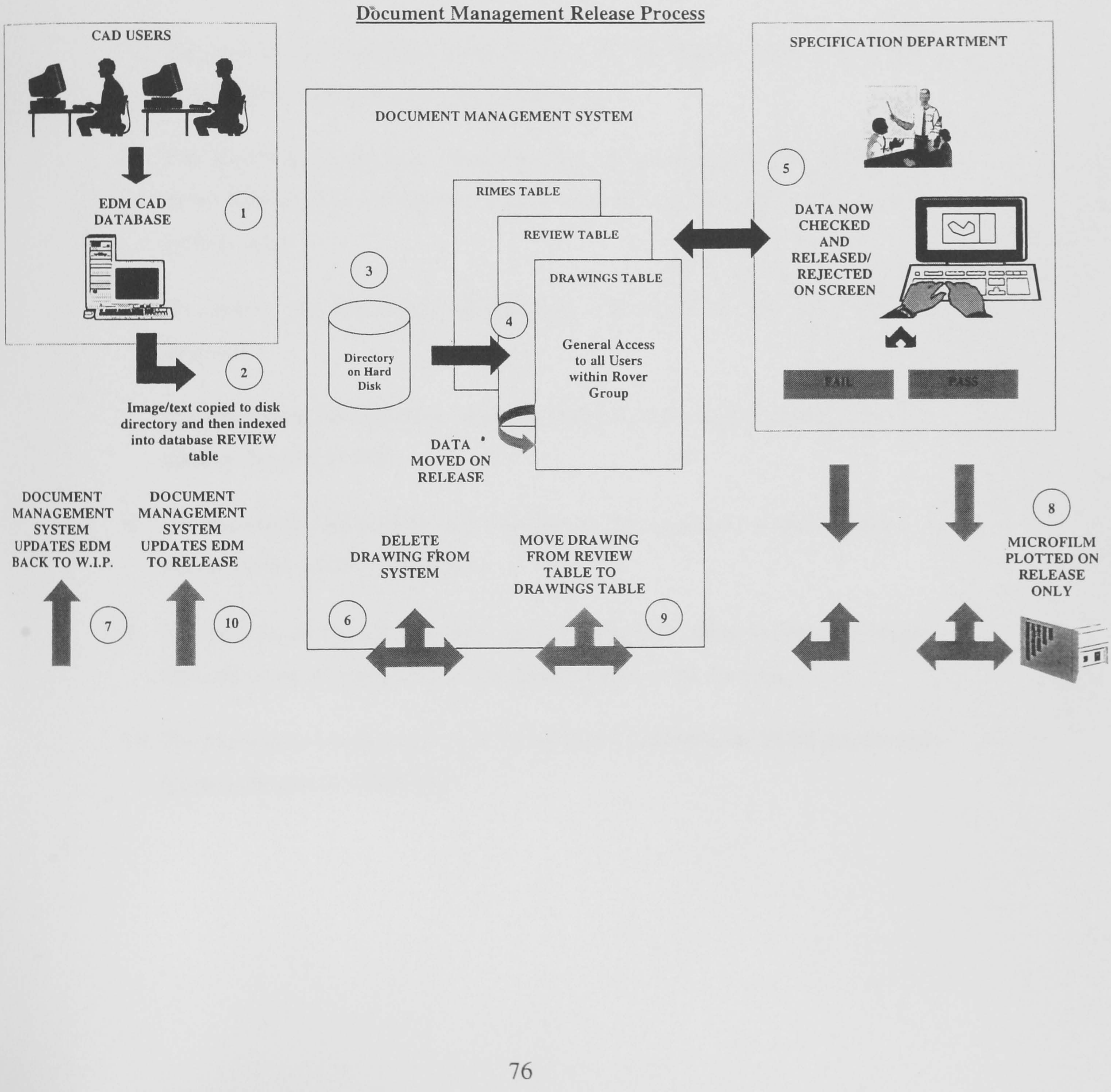
6. On failure, the specification engineer walks to the print room and destroys the CAD plot and microfilm.

7. The specification engineer then updates the EDM system back to WIP (Work In Progress) to allow the CAD engineer to edit the part.

8. On successful release the specification engineer returns the mod-pack to the print room and updates the EDM system to *RELEASE*.

9. The print room then copies the CAD plot and distributes them by post to a circulation list of downstream users.

Figure 13 New Document Management Release Process



New Document Management Release Process Description

1. On completion of the CAD part, the engineer files the part for *REVIEW* in the EDM system.

2. The EDM system then sends a raster plot file and a text file to across the network to the Document Management system.

3. The file arrives into a disk located within the Document Management system. Ready for indexing.

4. The part is automatically indexed into the 'REVIEW' table where only specification engineers can view the drawing.

5. The specification engineer checks the part on screen against the BOM and either *REJECTS* or *RELEASES* the part through the Document Management system menu.

6. On failure, the Document Management system deletes the part from its database.

7. The Document Management system then log's itself into the EDM system and updates the part to WIP.

8. On successful RELEASE the Document Management system creates a microfilm for archive purposes.

9. The system moves the drawing from the 'Review' table to the 'Drawings' table allowing all system users immediate access to the drawing.

10. The Document Management system then log's itself into the EDM system and updates the part to RELEASE.