Multimedia Management Flight Simulators

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ABSTRACT

The Management Flight Simulator is now being established as a tool to facilitate experiential learning with both undergraduate and postgraduate management students, and managers within learning organisations. Existing MFS provide user-friendly reports and graphical representations of historical data, designed to the limits of human computer interface (HCI) good practice. Although, existing MFS make use of sophisticated quantitative databases and models, but lack the softer data: managers' in-trays, meeting notes, employee feedback, interviews with customers, press and television news reports, industry observers, financial analysts, and so on. Managers in real life rarely make decisions without going to look at a problem for themselves. Using multimedia MFS, users will be able to do the same, by interrogating and making observations using electronic-based media.

Multimedia provides graphics, sound and video interfaces to enrich the students' learning experience. Desktop personal computers are now just powerful enough to incorporate these new multimedia technologies, including digitising and compressing video pictures.

This paper describes the current state-of-the-art as far as the multimedia hardware and software technology is concerned. The scope of applications possible using these new technologies are discussed. A prototype multimedia MFS is under development, designed to demonstrate the scope and nature of user interfaces possible through multimedia. The prototype will be demonstrated at the ISDC 93 conference.

New Technologies for Management Education

Management Flight Simulators (MFS) based on systems dynamics models have already attracted the attention of management educators across the globe. Holtham (1992) comments that the People Express MFS "falls short of the full flight simulation approach. This will undoubtedly require the use of not only the quantitative databases and models, but also the prodigious quantities of softer data: in-trays, meetings notes and so on. It will also need a library of graphic images and video-based data (multimedia). Good managers in real life rarely make decisions without going to look at a problem for themselves. We should expect business students to do the same, but, given the physical and time constraints, this will have to involve interrogating and making observations using electronic-based media." For further discussion of educational applications for interactive video, multimedia, computer-based learning, and virtual reality see Brand (1989), Barker and Tucker (1990) and Cotton and Oliver (1993).

In the UK, the government has made plans to increase student numbers in higher education by 25%-40% over the next decade. Multimedia technologies are expected to assist in teaching these increased student numbers, through distance learning and open learning programmes. Jacobs (1992) sees interactive multimedia as having an enormous educational potential, despite the costs and time involved in developing courseware.

However, many authors are sceptical about the resources required to build such courseware. For example, Ritchie (1992) is concerned about the development time required to produce interactive multimedia learning tools within the academic community. "Given that the current digital media are far more difficult to design for than even the well-known analogue systems, the learning curves for staff will be more like learning cliffs with overhangs; the task will be sufficient to unnerve even the boldest academic unless prepared by training, but training takes time....". He comments that the first £5m allocated to multimedia development projects by the UK Higher Education Funding Council have produced disappointing results. Recent surveys among academics (for example Laurillard et al 1992) have reported a generally low opinion of multimedia courseware, particularly if developed in another academic institution. A typical response is "the present software is designed with idiots in mind. We don't have enough idiots here to make it viable..... there should be more emphasis on software being intellectually stimulating."

The existing MFS (People Express, B&B Enterprises) in the public domain have received a warm reception from adopting institutions, and comprise courseware developed to a high standard. Our objective is to enhance further the learning experience through the use of multimedia technologies.

What is Multimedia?

Multimedia is the convergence of broadcasting and publishing media, and information technology. It is the integration under computer control of text, sound, still and animated images, and motion video. The computer enables the multimedia to be interactive - demanding active participation from users.

Multimedia technologies comprise the following elements:

- **Graphics user interface (GUI)** - representing text and graphics in a form closer to that of paper-based documents, with proportionally-spaced text, a range of typefaces and high definition diagrams and charts.
- **Images** - moving towards the capability of displaying pictures in full photographic quality, in monochrome or colour.
- **Audio sequences** - the addition of music, sound effects, and voice to provide additional emphasis or effectiveness to the information on display.
- **Animation** - giving scope to achieve the kind of attractive, dynamic graphics similar in standard to those used to display titles, charts and tables in television programmes.
- **Video sequences** - the integration of full, moving, television pictures, displayed on all or part of the computer screen.

Interactive Video

There are a number of interactive video applications targeted for commercial management training (note - with a focus on "skills training" rather than "learning" in an academic sense). Many run on turnkey hardware, and use soon-to-be obsolete videodisc storage technologies. For example, the Talent Series from Interactive Information Systems (IIS) cost between £1700-£4000 each and include titles such as *Face to Face, Writing for Results, Leading your Team, A Matter of Time, Make the Telephone Work for You, Finance for Non-Financial Managers*, and so on. Price Waterhouse have developed *Account Ability: The Interpretation of Financial Statements*, designed primarily for non-financial managers to gain familiarity and confidence with financial reports.

One key design feature of most of the interactive video applications currently available is that they have a simple tree-structure driving the selection of material. There is no "simulation engine" that resembles the complexity of systems dynamics models.

Multimedia Hardware

Multimedia technologies have a long way to go before they are widely accepted. The computer manufacturers (eager to find new areas of growth to service) claim that there is a fast-emerging multimedia market. Certainly, there are application areas (such as computer-based learning, access to reference documentation, and point of sales information systems) where the additional user interfaces provided by multimedia can offer a high degree of added value. Our particular interest is clearly in the area of computer-based learning applications for management education.

Within the emerging multimedia industry, Commodore (CDTV - Commodore Dynamic Total Vision) and Phillips (CD-I - Compact Disc Interactive) are aiming at the consumer market. The Intel Corporation (DVI - Digital Video Interactive) chipset plugs into PCs, providing digital motion video by compressing frames. DVI is expensive and is aimed primarily at the corporate business market, though DVI-based educational applications do exist. The PC-world (through Tandy and a dozen other manufacturers) has announced the MPC-format as an industry standard for high quality images, sound and animation. Microsoft has incorporated most of the MPC standards into Windows 3.1. So far, sales of computers bearing the MPC logo have been disappointing.

The demands on storage made by non-textual data have, until recently, presented a problem for multimedia application developers using conventional personal computers, with 40MB-80MB hard disc storage. One minute of CD-quality sound requires about 10MB storage space, and a photorealistic image up to 3.8MB. Using VGA images at a resolution of only 320 by 200 pixels, a single second of full-motion digital video at the European standard of 25 frames per second requires 1.6MB of storage. One second of full-screen video requires up to 30MB. Apart from limitations of storage devices, transfer rates vary from 150KB/second for CD-ROM drives to 1.1MB/second for the fastest hard disc drives, and the fastest local-area networks transfer at speeds of only 2MB/second.

Multimedia Software

A number of software packages are available to develop multimedia courseware, including: *Apple Hypercard, OWL Guide, Authorware Professional, Asymetrix Toolbook, Macromind Director, IBM Linkway, Microsoft Visual Basic,* and *PROPI.* Many of these packages will run on both Apple and PC platforms. But several of these packages are really prototypes themselves, have little to offer in terms of simulation engines, and place huge demands on hard disc and RAM resources. Several institutions developing multimedia courseware are starting to develop their own authoring platforms (in *C++* or equivalent), making libraries of routines available in the public domain.

Apple's *Quicktime* is system software for storing and displaying video sequences. *Quicktime* is a system extension (ie. software which adds functionality to the standard Macintosh operating system). *Quicktime* video sequences are currently limited by existing hardware to a small fraction of the screen, at a frame refresh rate which is too slow to give smooth picture motion. The performance does depend on the Apple Mac hardware being used - Quadras can perform at a full 25 (PAL) or 30 (NTSC) frames per second, but LCs can only cope with a maximum of 15 frames per second. *Quicktime* is capable of handling larger pictures at higher resolutions, and faster frame rates, as the performance of future hardware increases. A comprehensive description of *Quicktime* capabilities are given in Drucker and Murie (1992).

There are numerous ways to compress images and video, to reduce the storage space required. Standards are emerging for still images (JPEG - Joint Picture Expert Group), and motion video (MPEG - Motion Picture Expert Group). *Quicktime* has a software implementation of the JPEG standard, and can be used to open and compress any PICT file, with a compression ratio of up to 50:1. Hence 24-bit colour images routinely compress from 300K to 25K without discernible loss of quality. This enables a 30 second video sequence in a small window to be saved in under 1MB storage. *Quicktime* is now available for PC platforms running under Windows 3.1.

Most of our work has been with two packages that run on Apple platforms:

Hypercard 2.1 is *Quicktime* compatible, and provides a very easy to use scripting language. It is well suited to rapid prototyping, having facilities for both navigation and computation. It is also capable of displaying 24-bit colour images in separate windows. Some good examples of multimedia design with *Hypercard* are given in Wilson (1990).

Macromind Director 3.1 was developed primarily as a multimedia presentation tool for the commercial world. Interactivity and external devices are controlled by means of a scripting language *Lingo*. A wide range of events may be captured and used to alter the properties of objects on screen. It is also possible to link in external modules in Pascal and C. It is *Quicktime* compatible.

Multimedia and Management Flight Simulators

Using multimedia technologies with games (or management flight simulators) opens up a whole new set of possibilities for making the experience of a game more realistic and interesting. It provides the opportunity to guide and advice the participants in a new and exciting way. The implementation and use of multimedia depends on teaching objectives, class size, experience of participants etc.

We can start by looking at the two 'extremes' - long distance learning and small groups of executives. In the case of long distance learning it is appropriate to include a large amount of background material in the game. There can be some built-in exercises before the game starts and one could design an extensive debriefing also carried out as a part of the 'game-package'. This material and exercises could be part of the multimedia experience for a single-person user. By including this, the single person can also be 'forced' to go through some of the discussions that often take place in a group setting, and the 'video-syndrome' might be avoided. Included can be as much material as one likes - the player will be able to go through it at her own pace, looking for additional information when she felt a need for it (eg. getting information on strategy frameworks). The dynamic game is kept as the centre point of the 'game-package', and the multimedia is used to create some of the benefits normally associated with a group exercise.

At the other end of the spectrum is a group of executives or employees using a management flight simulator developed for use within their own company. In this case is it not likely that they will want a large amount of background information on the company and situation, although they might still want some information on specific concepts used in the game (which currently they get from the game manual). Using a large amount of information on strategy frameworks, accounting practice etc. will be destructive for the team-learning process (ie. the learning a member of the team should get from participating in the discussions of the team). If this background information on various topics is used intensively, it will break-up the flow in the group discussion and hence probably cause more damage then help.

In between the two extremes of executives using a model of their own company and long distance learning, there is the teaching of undergraduates and postgraduate students. Depending on the objective of the class there are there several possibilities. If the game is used to introduce new concepts there will be a large amount of background material included in the package, and students will explore these using multimedia. Using the game this way would help the students to get a better understanding of concepts, and the learning from the game will be only secondary.

An example of this type could be a series of games that teach economics to non-economics students. Using a number of different games, each representing a certain view on the economy (Keynsian, Neoclassic etc.), each game would contain background material on the specific view of the economy the game represented. This material would be necessary for the students to read and understand before playing the game. The game would then require the students to 'manage' the economy, from the chosen theoretical perspective. In this way the student would be exposed to the different economic frameworks and from the way the 'game-package' is put together learn the differences and similarities between them. A series of games like this could be used in long distance learning or in the class room to teach economics in a new and exciting way.

If the emphasis is on learning the lessons from the game rather then discover and learn about new concepts, the background material will not be needed to the same degree. The main learning would occur from the interaction between the group members, in a similar way to executive groups. This would be the situation where you would deal with a relative small number of students, ensuring that the introduction and debriefing of the game is sufficient interactive.

Examples of multimedia experiences might include factory tours, TV news reports, interviews with customers and employees, country or industry analyses, memoranda, office plans, organisational charts, minutes of meetings, and advertising copy or artwork. The use of a large screen enables full-size letter pages to be conveniently read.

A context that most readers are familiar with is the People Express Management Flight Simulator (Sterman 1988). How would this game change with the introduction of multimedia technologies? Information such as text and pictures could be provided in a number of ways. One could ask for it (using 'pull-down menus' or buttons). Another possibility could be 'pop-up' advice which could be triggered by some circumstances as the game is played.

- **Background information:** Information about the US airline industry and the deregulation which took place in the late seventies. More background information on People Express including the culture and management style of the company. Part of the case study could be included. A competitive analysis of the starting position, some of the model's structure (ie. causal loop diagrams) might also be included.

- **Management Frameworks:** Could include explanations of strategic models (such as five forces or the value chain), or explanations of accounting and financial statements which can be found in the reports.

- **Comments or advice:** This would have to be 'pop-up' messages appearing under certain conditions. There could be a whole series of these, depending on how the game went. It could give advice saying that if the situation was not changed then bankruptcy would soon occur.

- **Video:** can be used in much the same way as the information above. Video provide a 'more lively' form of communication, but there is a limitation of how long and how many sequences of video one can have in a game due to the amount of space even compressed video occupies on disc storage. Video could give some of the impressions currently provided by the Harvard Business School videos of Donald Burr. His personality is important for the understanding of what actually happened with People Express. A normal game will not give this impression, but some video-clip might be able to do this. Other possibilities could be a tour of the factory floor, a view of how the service is actually performed, an impression of service quality through interviews with customers, and an opportunity to form a judgement of motivation issues through comments and discussions with employees.

Developing a Multimedia Management Flight Simulator Prototype

Existing MFS such as People Express (Sterman 1988) or B&B Enterprises (Sterman 1991) have been developed on an Apple platform using *iTHINK*[1] or *STELLA*[1] to build the model, with the gaming front-end developed in *Microworld Creator/Explorer*[2]. Front-end gaming interfaces built using *Hypercard 2.0* could be linked to *STELLA* models with an interface such as *STELLAstack*[1] or *SIMGAME* (Simons 1989). No such interface currently exists for *iTHINK*

[1] *iTHINK*, *STELLA* and *STELLAstack* are trademarks of High Performance Systems Inc.

[2] *Microworld Creator/Explorer*, and *S**4* are trademarks of Microworlds Inc.

models, so our solution was to use *S**4*[2]. *iTHINK* can be used to develop a simulation model. The equations can then be exported to *S**4*, which is then used to run the simulation in the background. *Hypercard 2.1* interfaces to *S**4* in real-time using files for transferring data and messages between the two applications. *Hypercard 2.1* does have a script language supporting variables (called *containers*), but the time required to develop systems dynamics equation parser and execution routines would be considerable. The only drawback to using *S**4* to execute the equations is the speed of the interface - its very slow! Performance could be improved by writing interface code in Pascal or C++ and creating a Hypercard XCMD (eXternal CoMmanD) which would run much faster. Figure 1 shows the links between the software applications *Hypercard* and *S**4*.

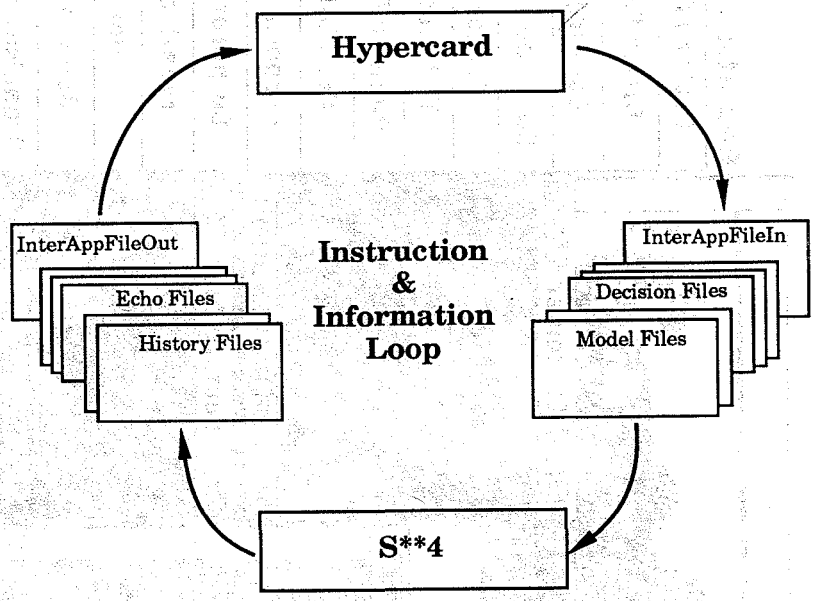


Figure 1. Adapted from the S4 User Manual (Microworlds Inc. 1992)**

Our Multimedia Management Flight Simulator Prototype has been developed to standards in conformance with current practice in HCI (Human-Computer Interaction) - see (for example) Baecker and Buxton (1987) or Shneiderman (1987). The hardware platform is an Apple Mac SI with 9MB RAM and 80MB hard disc, 24-bit colour card, System 7.1 and *Quicktime 1.5*. Additional hardware includes a CD-ROM drive, a SYQUEST 44MB cartridge drive, a Supermac Videospigot digitiser card and a Microtek Scanmaker 24-bit colour scanner. Development software used includes *Hypercard 2.1* for the gaming front-end, *S**4* for the simulation engine, *iTHINK 2.2* to build and test the model, *Adobe Photoshop* to scan and manipulate still images, and *Adobe Premier* to edit digital full-motion video. An Apple Mac Quadra 40/900 was used to run the prototype at full-speed, and to capture a typical run on analogue S-VHS video for demonstrations to interested audiences.

Example screens from the prototype are shown in figures 2 and 3. All still pictures and full-motion videos are in windows which allows the positions and size (up to full-screen) to be changed by the user at run-time.

Figure 2. An example output screen with still images and full-motion video

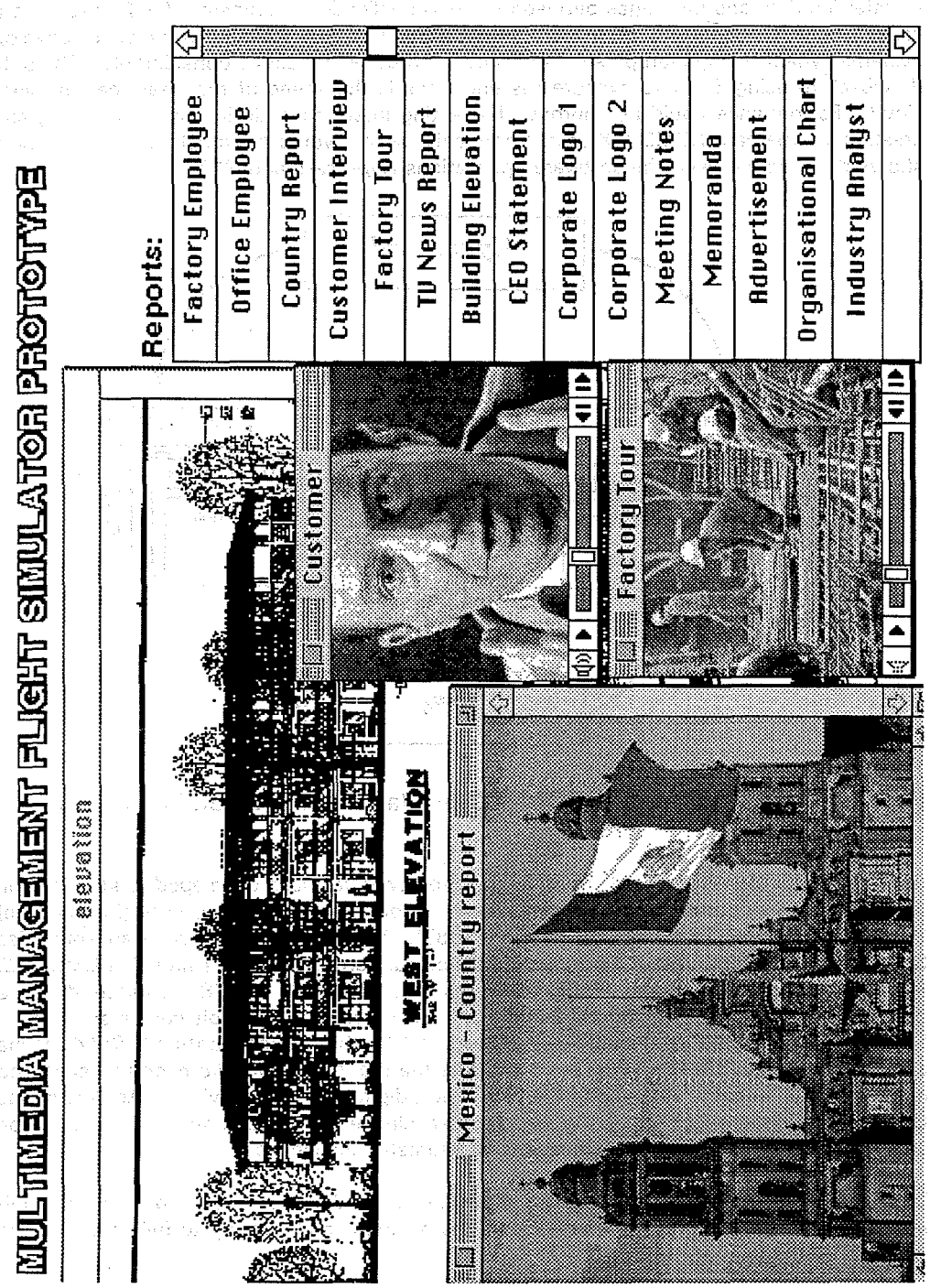
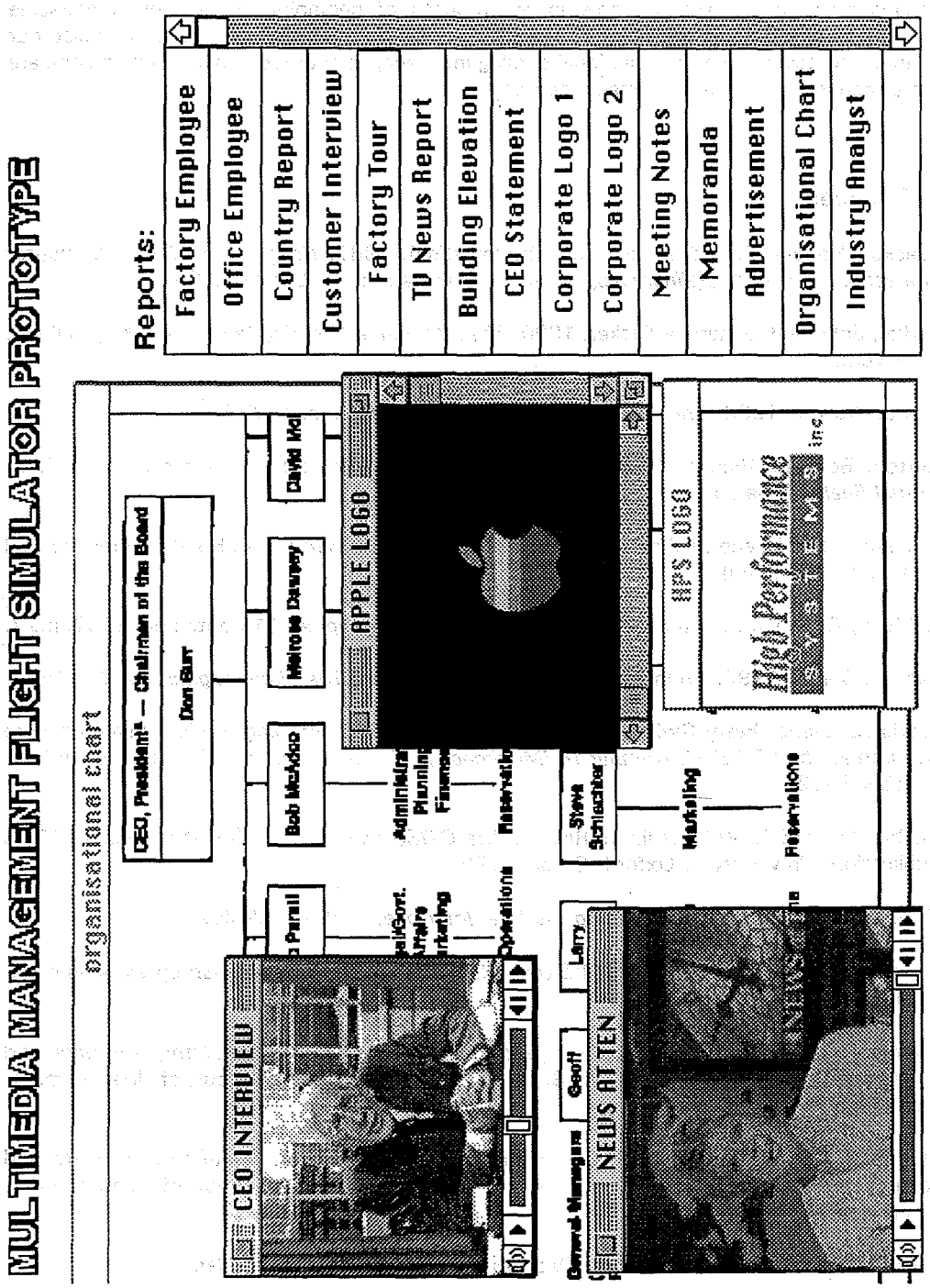


Figure 3. A further example output screen.



Conclusion

Using the prototyping methodology allows us to experiment with the design criteria for user interfaces, as well as the link between the system dynamics simulation engine and the gaming front-end. We are now in the process of beginning to develop a full-scale multimedia based gaming simulator, of a UK company in the brewing sector. It is also our intention to develop a more traditional gaming interface, so that we can attempt to compare the effectiveness of the multimedia approach.

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