
Inaugural lecture

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smart style

for conveying
information

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Introduction

Rector Magnificus, ladies and gentlemen,

Human culture is embodied in the collection of information transmitted from one generation to another. It is based not only on storing this information, but also on conveying this information in such a way that the relationships within the information are understood. The era of multimedia and internet technology has not changed this overall goal in any fundamental way. Rather it has shifted some emphases, created new opportunities and, simultaneously, introduced new problems that need to be solved. Many researchers struggle with the non-trivial problems of transporting large quantities of multimedia data over networks to ensure that the end-user perceives a video and audio presentation free of glitches and hiccups. There are also, however, problems at the higher level; for example, that of selecting appropriate multimedia content for conveying the information to the user in a way that enhances the communication of the message.

But first, I would just like to explain what this address is not about. Multimedia is more than the cool graphics and cute animations that are used to attract and distract on the majority of commercial websites. Internet is more than the marketing dream of dramatically increased sales through e-commerce, the huge fortunes that were won and lost with the inflating and bursting of the internet bubble and the content-free babble of internet chat groups.

When these terms are used in combination, the buzzword hype increases exponentially and the first application that comes to mind, and indeed probably the largest single multimedia application on the internet, is Web video-porn. To avoid disappointment, this is not one of the focusses of the address, although, as a number of colleagues have pointed out, the problems and approaches I put forward today are equally valid for this particularly lucrative application.

Having established a number of no-go areas, what is this address about? We begin with the assumption that a user requires some information (about flight times to Schiphol, about a recipe for chocolate cake or

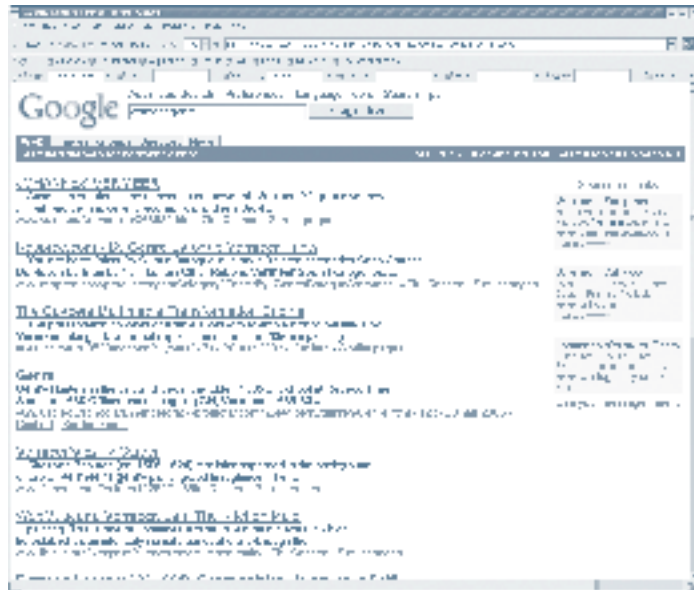
about the genre paintings of Vermeer), and that this information has already been found. 'All' that remains is to convey this information to the user. For this to be successful two things have to take place. The first is to ensure that the information reaches the user, in other words, that it is disseminated correctly. The second is that it is presented in such a way that the user extracts the intended meaning from the information (it is clear which is the departure time, that the eggs are incorporated at the right stage and that there is a distinction between portraits and cityscapes).

That this is a non-trivial task is illustrated by the unexpected guest we had a few weeks ago. Because the way the information presented on the plane ticket led him to believe that the flight number was the departure time, he missed his flight.

To illustrate this further, consider the way that current generation search engines, Google in this case, present the information that has been found.

figure 1

Results of text search
'Vermeer genre' in
Google.

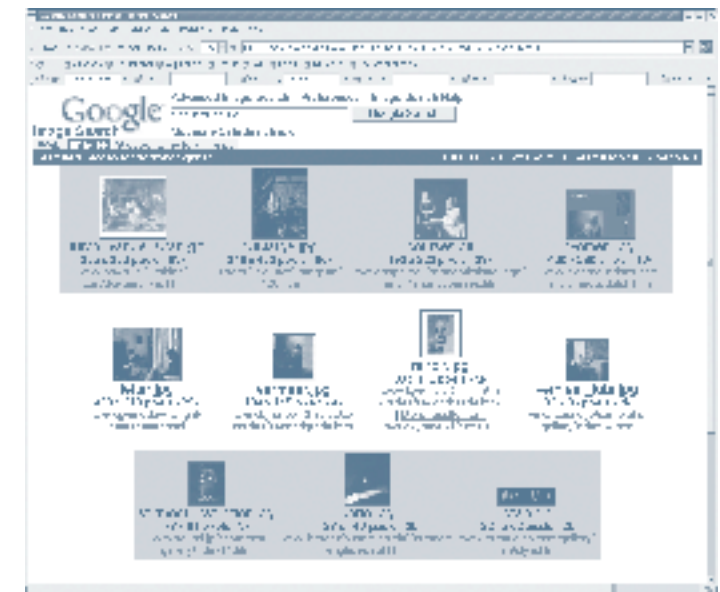


Don't get me wrong. Google is a wonderful tool, and I wouldn't want to be without it, but it concentrates on the search side of the problem, not on the presentation side. What we see as the result is a list of links to Web pages where potentially I can find the information I am interested in. All the information is presented as text – a handy medium, but not necessarily the one I need right now, particularly if I am driving to the airport and need to know at what time my flight leaves.

Similarly, if we do an image search – and again, this is already forcing me to make a choice of media before I even start my search – we get back a seemingly randomly ordered list of images.

figure 2

Results of image
search 'Vermeer
genre' in Google.



Again, I am not complaining about the quality of the search result, but that any information known by the system about the images is not being used to display them in any meaningful way.

What I would much rather have is that the system, knowing my query, is



figure 3

able to generate a presentation which more effectively communicates the information incorporated within the retrieved media items.

A multimedia presentation generated as a result of the query painter 'Vermeer' and keyword 'genre' in Cuypers.



Here the system has not only taken the query into account to find the information, but a selection of media has also been made. In this case, a definition of the word 'genre' and a number of paintings illustrating the concept are shown. These items have been ordered and laid out in the window, along with a title that reflects the initial query. The title and date of creation of the paintings have been included in labels displayed underneath the paintings.

In order to create this presentation, whether automatically or by hand, we need to specify a number of characteristics of the presentation. However complex the process may be, it boils down to making decisions and trade-offs in the style of the final presentation. The style of the presentation can be broken up into three parts, which I will describe one by one.

Three ingredients of a presentation

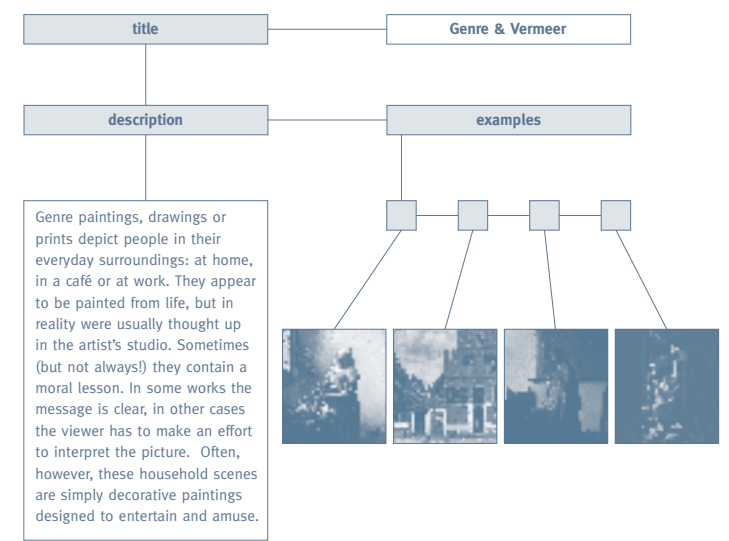
The first, and probably most obvious, ingredient is the content of the presentation. In our example (see figure 3), this is the text from the original query, the paintings by Vermeer, the labels and the definition of

'genre'.

In order to incorporate the content into a coherent presentation, the second ingredient is some sort of structure to connect them together. In particular, which items should be grouped together? For example, the painting and the label depicted in figure 3 belong together. Among items in a group, it should be clear which are more important. For example, the title text uses a larger font than the paragraph of text. If there is some order among the items, such as the year of creation, then this is also part of the presentation structure.

figure 4

Presentation structure of figure 3.



The third ingredient is aesthetics. This includes aspects such as the layout and alignment, typography and colours. Is the definition aligned with the top of the image? Is the screen filled with information, or is there space left over? Which fonts are used and what sizes are the different pieces of text? What are the colours used for the text and the background, or for link markers that are still to be clicked on or that have already been seen?



One size doesn't fit all

We have determined the ingredients for my presentation, so that the information I am interested in is presented in the most appropriate way. Of course, the problem does not stop here. While I want my information about Vermeer to be presented in this way, there are many others who would like their information presented in some other form. Similarly, any one user may need different ways of presenting the information depending on the time they have, the location they are in or the means they have for viewing or listening to the information.

While the goal is to convey the retrieved information to the user effectively, there are of course very many diverse users who each want their *own* information displayed on their *own* device. Multimedia presentation design is, however, an expensive process, so that to move closer to our goal we need to automate at least parts of the presentation design process. In other words, presentation styling has to become smarter.

The problem

Let us examine our requirements in detail. Given that we have found correct and relevant information for the user, the presentation of this information should convey the underlying relations in the subject matter.

For example, if media items are on the same topic, then this could be conveyed by presenting them in a similar manner. Similarly, if one group of media items concerns a different topic from another group, then the two groups should be distinguished in some way, for example, by using borders or different background colours.

If the user is an expert on the topic, then she ...

*Excuse me, I hope you will permit me a brief digression on the use of genderless pronouns in the perennial problem of describing users in work on human-computer interaction. I feel that the use of 'he' is politically incorrect, that 'she' is overstating the case and that 'they', used in the singular [Pemberton 1986], just grates. I will strive to at least be fair to the cause and abuse all three during my address.
To continue...*

If the user is an expert on the topic, then she probably wants an explanation of a particular topic in a great amount of detail. On the other hand, if a user is unfamiliar with the domain, then definitions and broad explanations are more appropriate. For example, in the Vermeer presentation a definition was given of 'genre'.

The presentation needs to be conveyed in the time the user has available.

For example, if the plane is leaving in ten minutes, then a lengthy explanation of how to find the gate would be inappropriate.

The presentation should use the appropriate media.

It is almost trivial to expect images when querying for Vermeer paintings. However in some media, such as radio or mobile phones, images cannot be displayed (as a trial image of Rembrandt's *Nachtwacht* on WAP once illustrated), while a spoken commentary can at least convey some of the information. Different media also have different impacts on the way we can process the information. For example, if we are concentrating on speech, then it is difficult to read text simultaneously – unless the text is very short and on the same subject.

The presentation needs to be shown in an appropriate style.

We are so used to professionally designed information in our environment that we forget how important style is. With the introduction of the PC in the 1980's and the ability to use and abuse fonts and colours, there was brief exposure to the effects of 'font-itis'. Examples of design by amateurs can still be seen on many personal home pages – although a collective sense of aesthetics is developing. While 'functional' and 'aesthetically pleasing' do not necessarily conflict, as Don Norman [Norman 2002] so aptly puts it, attractive things actually work better.

Finally, the presentation has to make optimal use of its delivery context.

This is the environment in which the user finds himself. If it is noisy then audio would be inappropriate. Even when quiet, perhaps making noise would not be a good idea, for example, when visiting the Rijksmuseum. The user's device capabilities also have to be taken into account – aspect ratio, resolution, ability to deal with colour, speed of network connection.

Where did it all begin?



Conveying information effectively is thus the task we set ourselves. It is not a new problem. It has been studied for years and has still not been solved. It is exactly why it is so difficult to make good films, write high-quality scientific papers or, indeed, deliver impressive inaugural addresses. However, we are not starting from scratch and can build on lessons learned from different disciplines.

Oral tradition

The first means of passing information from generation to generation was the oral tradition, in particular, by means of telling stories. We are very bad at remembering large numbers of unrelated facts and this form was optimised to compensate for this. It is a very old, but still a valid and extremely powerful, way of communicating information. Rhythm and rhyme, in particular, are very effective ways for aiding memory.

Storytellers are able to adapt their stories to their audience: contracting large episodes into a single evening or spending many hours on details of a particular incident. Exactly this flexibility meant, however, that there was no one 'true' story, but many stories conveying different parts of the underlying collection of events and characters that took part in them.

Visual - still images

Visual information in the form of still images was the first persistent means of conveying information from generation to generation. The cave wall was not a particularly good means of dissemination (being neither portable nor easily reproducible) but the presentation to the end-user was guaranteed to be identical to the artist's creation.

The limitations of the cave contrast with the dissemination of the information on the Pioneer 10 plaque. Its audience is not intended to be our own descendants, but intelligent life forms in other parts of the galaxy. It is difficult to know what any non-human would be able to make of the plaque, given the shared context of only our own galaxy. The location of the sun may be guessed at through the nearest neutron stars, and the organic forms may be recognised as living creatures (but only if the perceiver's visual system uses edge detection).

The visual form, whether photograph or cave wall, is optimised for fast recognition. We are extremely good at recognizing whether we have seen a picture before, even when many are presented in rapid succession.

Initially images were reproductions of what the artist saw in the immediate environment. However, in the course of time, literal images became more symbolic, so that we now find it obvious that the circles at the bottom of the plaque should be interpreted as the sun and the



planets of our solar system. Visual symbols have developed and become more abstract to form the iconic languages surrounding us in our everyday environment, such as the exit sign in this auditorium. This tendency to symbolism, or visual information compression, can be seen in the development through the iconic languages of Egyptian hieroglyphics and Chinese characters to our current phonetically based written method.

Written

Written information is optimised for recording large amounts of complex information that is hard to learn by heart. It is a compact way of storing this information, at the cost of having to learn to interpret it (my 7 year old son has just recently learned to read simple books on his own) and the cognitive processing time of carrying out this interpretation. Symbolic mathematical languages are a further step in this information compression.

The languages of communication in writing developed from those of the oral tradition. These include narrative and rhetoric as different forms of discourse. The ability to refer back to what had gone before meant that these could become more complex.

Dissemination occurred through libraries, whose users, mainly monks and other scholars, were forced to go to the library to access the information contained there. The written word established a trend away from the flexible oral tradition towards a more static notion of information – the written word was an authority, which should not be tampered with. In addition, bundles of pages were packaged together in books which, when referred to or copied, were treated as an indivisible unit – information became ‘quantised’ in the form of documents.

Moving images

A more recent medium is that of moving images. This developed because the appropriate technology became available. For the first time we were able to record live events. In particular, we could analyse processes. I remember a very old film clip of a horse where the frames could be analysed to show conclusively the gait of a galloping horse. In my own lifetime technologies for shooting 1000 frames per second have been developed, allowing the wing patterns of bees and hummingbirds to be captured. Similarly, the only way to convey the correct consistency for chocolate cake batter is to see the way it behaves as the spoon is

drawn through it, which is impossible without moving images. While still images can convey emotion to some extent (I need make no mention of the Mona Lisa), moving pictures allow the presentation of subtle facial movements, a much more effective means of conveying emotions.

Again, capturing images in the direct environment is the immediate reaction to video recording technologies. However, these ‘true to life’ scenes can be segmented and reassembled into a new piece that appears real. This is the art of editing and montage, which can give different meanings to identical clips depending on the context in which they are shown.

Film montage is a relatively new language for conveying information and is still developing. This language has much in common with the narrative of the oral tradition and is less appropriate for expressing complex symbolic information.

Hypertext/hypermedia

Hypertext is a less well-recognised medium than the previous four. For many years a misunderstood medium, but which blossomed with the expansion of the World Wide Web. It too, however, is not as new-fangled as it may appear and has its roots in biblical concordances, religious commentaries and academic citations. Its essence lies in the desire to express relations between pieces of information. It is optimised for cases where these relations are at least as important as the information itself.

To enable the creation of such relations, one needs to indicate which pieces of information have other information associated with them and provide a way of accessing the referred-to information. Chapter names and verse numbers and journal citation conventions are means of doing this. Vannevar Bush, in the 1940’s, envisaged a way of realising more direct access to the referred-to information via mechanical means (using microfilm) but this was never implemented [Bush 1945].

Instead, we are now familiar with the (none too optimal) use of underlined blue words in Web browsers of our choice, where clicking is the most common method of accessing the referred-to information.

Hyper-images are a fairly simple extension that works well in iconic images, such as the back and forward buttons in many browsers or clickable items on a map. Hyper-audio sounds even stranger, but has also been tried [Arons 1991]. Changes in pitch and iconic sounds can be used to indicate where the ends of links are. Speech controls can then be

used to follow the last-mentioned link.

Hyperlinked information can serve two purposes. One is to make the underlying relationships among pieces of information explicit. Another is that the presence of navigable links within the information allows the user to interact with the presented information and explicitly choose topics for further perusal.

Even within text, the most explored 'hyper' form, different languages of links, sometimes referred to as the rhetoric of hypertext, are still developing.

Multimedia

So where does this leave us with multimedia? Again, multimedia is in no sense new, but it is the art of choosing the appropriate medium, or indeed appropriate combinations of media, for the job. A familiar example is the map – an effective combination of image plus text. News programmes make many such media decisions for showing 'on location' film clips, or graphs for illustrating currency and share prices.

Presentation and dissemination technologies

Technology provides both constraints and opportunities for the development of new languages. In the film world, for example, when initially audio had to be omitted, techniques were developed to compensate. Originally, this was through the use of text insets to convey what actors were purportedly saying or thinking. Later, these were removed because of the development of mime techniques, which fulfilled the same role.

The techniques used to make oil-based paint forced artists to make (charcoal) sketches of landscape paintings outdoors. The real painting had to be done in their studios, where they had access to the tools needed to make the paints. Only after the invention of the paint tube were artists able to paint outdoors. This resulted in the development of new artistic languages, including impressionism.

An important development in the history of different media types and their languages is that, for the first time, they can all share the same presentation platform: the computer. Initially, this sharing mimics the forms from before they migrated to the computer, just as initially films were used for recording theatre-like shows, and TV news was radio news with a camera. Even writing took a while to catch on, where words were spoken out loud while reading. Gradually, as we learn to deal with



the media and their combinations, new forms will develop. We have recently seen the evolution of a Web site genre. Initially, Web sites merely provided access to existing forms of electronic documents, linked together by simple HTML pages. Today, developing good Web content has become a recognised discipline, where professional Web sites utilise the potential of the new medium.

Conveying information requires more than presentation technologies – dissemination technologies play an equally important role. The dissemination of mass media has always been dominated by professionals in large organisations. Only they can offset the high costs of a high quality product against the large numbers of end-users. This contrasts with individual-to-individual dissemination. Individuals and non-professionals are able to afford this because of the lower costs, and a reduced quality of presentation is often made up for by the personalisation of the message. Most of us, at least, would not judge a love letter by its typographic quality.

Again, the development of technology has made this distinction less relevant. The internet supports both forms of dissemination. Web sites are used as a mass medium by professionals, but also by amateurs to disseminate family pictures to a very small, but enthusiastic, audience. Likewise, large organisations are also able to provide specialist information targeted at very small user groups, at the same time that amateurs have succeeded in setting up massively popular sites with limited means.

Multimedia and internet technology

Given that we now have a unifying environment for multimedia and internet technology, what are its societal implications?

Anyone, be they professionals or amateurs, can publish or access multimedia information on the internet.

We have access to information anywhere we happen to be, through broadband, modem, mobile phone or wireless, using whichever device we happen to have with us at the time.

The information is available at any time. In contrast to the almost quaint notion that dictates that we watch the 9 o'clock news at 9 o'clock, we can choose when exactly we want to watch the most up-to-date news, or even the news from yesterday or last year or the day we were born ...

With the potential combinations of media on the 'universal presentation platform', we can use the most appropriate medium or combination of media.

For this utopia to be realised, large amounts of information need to be conveyed effectively to a wide variety of users in a wide variety of contexts. Traditionally this would imply large amounts of expensive manual design effort requiring skills that only professionals possess. To make this scalable and cost-effective, a significant part of this design work needs to be automated.

Automating design in general, however, is a notoriously difficult problem and we do not even claim to be able to replace the human designer. Instead, we strive to improve current presentation technology by capturing the knowledge used by professional designers and using it within tools for conveying information. Our approach is thus to take each of the requirements for conveying information effectively and to develop an explicit model of the knowledge needed to make an informed choice for the design.

For conveying underlying relations in the subject matter, we need to understand these relations. A domain model is an explicit specification of the relationships among the concepts on a particular topic. For many domains, these models have already been developed, and interchange languages for these models are now being developed in the context of

the semantic Web.

To establish a suitable level of detail, we need a model of how larger amounts of information can be structured before being presented. For example, the narrative of a novel or film provides this structure. We call this the discourse structure.

Allow me to illustrate briefly what I mean by different discourse styles for the same information. As a first example, we have an 'encyclopaedia' discourse style. This is suitable for a user who has little time and wishes to drive their own information-gathering process. A large amount of information would be displayed on the screen and many links would be given to explore the information not currently on the screen.

figure 5

Encyclopedia discourse style. Courtesy of Katharina Schwarz.



A dramatically different interface to the same query would be a 'storyteller' discourse style. Here there would be virtually no interaction, and the user would be able to sit back and listen to, for example, descriptions of different parts of the painting.

figure 6

Storyteller discourse style. Courtesy of Katharina Schwartz.



To convey information to the user, we need to determine the time available to the user. For this, we need to model information about the user. What is their current task? Are they in a hurry?

In order to choose appropriate media, we need to build models of the characteristics of the media themselves. How much human processing does a particular medium require? How quickly can a human process it? In addition to its human-bandwidth characteristics, what network bandwidth does the medium require? Which medium is appropriate for the message to be conveyed? Does a process need to be conveyed, making video an appropriate choice, or does the user want to see details of a painting, requiring a high-quality still image?

To determine an appropriate style, we need to capture models from graphic design. Not only the traditional layout, colour and typography issues of graphic design, but also the temporal and linking issues particular to computer-based interactive multimedia. The style of the interaction itself is also a consideration. Should the interface require

intense concentration from the user (as in many gaming environments), or should the user be able to sit back and relax while watching a long segment?

Finally, in order to ensure that any presentation will make optimal use of the technology at hand, we need to build a model of the device capabilities. Mobile phone manufacturers are already establishing standards for capturing this information. Other considerations are whether the presentation is intended for a Web site, a PowerPoint presentation or, indeed, paper.

Style dependencies

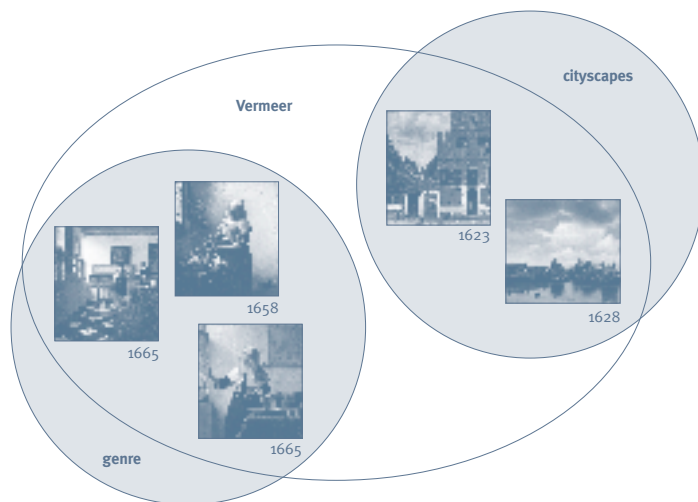
So far, we have derived the ingredients we need to specify for a particular presentation, and we have indicated which models are needed to drive the choices made. Even given the existence of these models, which is still far from true, our problem is still not solved. The catch is that the style ingredients – content, presentation structure and aesthetics – are mutually dependent. Resolving these dependencies is exactly why graphic design is difficult and the reason that our style has to get smart.

An illustration of this is that a background colour should not clash with the colours of any images being displayed. In this case, the aesthetics, the choice of colours, are dependent on content. Another example is the amount of content that can be included in the space available, such as a 28-page booklet. Here the content is dependent on the presentation structure.

Another dependency is that of presentation structure on the content. This dependency is not so much on the images and texts *per se*, but on the relationships among them from the underlying subject matter. Allow me to illustrate this. Let us suppose we have a collection of paintings by Vermeer, which are to be incorporated into a presentation. There are, however, too many to be displayed on the screen at the same time. Some are genre paintings (they display some aspect of daily life) and others are cityscape paintings. This allows us to make groupings within the presentation structure that reflect this distinction. An appropriate ordering criterion of multiple paintings in either group could be the date of creation. In this way, we can build up a presentation structure that not only depends on the underlying meaning in the material, but it can also be used as one of the mechanisms for conveying it effectively.

figure 7

Presentation structure depends on content.



Technological impact

To recapitulate, in order to convey information effectively to an end-user, we require models of the knowledge required, and we have to make trade-offs and resolve dependencies during the process of creating presentations. If we are to build a system that is faced with this challenge, then what are the requirements imposed on the system design?

Given that we use multiple models of different knowledge types, the process is knowledge intensive. The system needs to be able to relate different types of knowledge and take this into account at different stages in the process. In addition, the system has to be constructed in a way that allows trade-offs to be made. There is no single algorithm or heuristic for coming up with 'the' solution, so the system needs a plug-in architecture that allows flexible experimentation with alternative algorithms. In addition to this symbolic-level processing, the system has to calculate the pixel positions and split-second durations for the final presentations. Processing numerical constraints is thus a required part of the functionality. In case constraints are not met, the system needs to

be able to backtrack and try other solutions.

An outline architecture of the system consists of separate knowledge modules, which communicate with a central process. This is based on the reference architecture proposed for intelligent multimedia presentation systems [Bordegoni et al. 1997]. Jacco van Ossenbruggen and Joost Geurts are working on a system that meets such requirements. The modules of this architecture encapsulate the knowledge required for the different models, namely the domain, user, discourse, design, media and device characteristics.

The domain model itself is not a topic of our research, since many other groups are involved with capturing domain knowledge, in particular in the context of the semantic Web. Katya Falkovych, however, is investigating the ties between the properties of a domain model and its influence on the presentation generation process. User models are extremely difficult to capture, but are essential in influencing many of the decisions in the process. Paul De Bra's AHA! group is investigating the role of user models in adaptive hypermedia systems. Susanne Loeber, Suzanne Little and Katharina Schwartz have been looking at the relationship of the user model with the discourse and design models. Stefano Bocconi is investigating the role of domain information in creating an appropriate discourse structure. This contrasts with the approach being taken by Martin Alberink and Lloyd Rutledge. They are investigating the potential of domain independent methods for generating coherent discourse. Frank Nack and Yulia Bachvarova are concerned with the characteristics of media for their ability to convey the desired message and for their suitability for the user. Amit Manniesing is currently implementing ways of choosing colours from a colour model, as a first step towards a design model. Geert-Jan Houben's HERA group is researching the use of these models in the context of an adaptive hypermedia querying system. Systems like this need to be firmly rooted in the global Web architecture. This forces its design to be based on standard representation languages and shared technologies. Fortunately, this is offset by the significant advantages of being able to reuse third party multimedia content, declarative knowledge and off-the-shelf tools. It also allows others to embed our work in their own Web environments.



In addition to the current Web, the semantic Web is also beginning to develop. For those who have missed the hype so far, the goal of the semantic Web is to make information on the Web processable by machines. In other words, the meaning implicit in the content of Web pages is made explicit. Most talks about the semantic Web use semantically assisted information retrieval to illustrate its application – a super-Google, if you will. This will give us our correct and relevant information. For our own work, however, the semantic Web is most important once this information has been found. We want to make use of any available semantics to assist in conveying the information to the user.

Just as we can now share style sheets for Web pages, because the style information has been encapsulated and made explicit, separate from the content to which it refers, with the semantic Web we should be able to share our smart style – declarative descriptions of discourse characteristics and design rules. In addition, we can make the meaning conveyed in our multimedia presentations explicit using semantic Web languages, so that the generated presentations themselves also become processable by software agents in addition to being more accessible to human agents.

In conclusion

During this address I have described the different types of languages used in different media for conveying information. For conveying information effectively on a computer, we can make use of all of these – plus new ones yet to be developed. I have described the three ingredients (content, presentation structure and aesthetics) that have to be specified when creating interactive multimedia presentations. The existence of the computer as a ‘universal’ presentation device connected to the internet provides as yet barely explored opportunities. Not only for finding information, but also for conveying this information to end-users. When dealing with huge numbers of personalised presentations, for which human design resources are too expensive and scarce to employ, as much of this process as possible needs to be automated. We thus need to smarten up our style for conveying information effectively to the end-user.

The Web is currently enjoying adolescence, and we can do nothing more than speculate how its functionality will slowly mature. It emerged in a document-dominated era, where information is locked into the media that presents it. We are already experiencing the paradigm shift: on-line newspapers are beginning to diverge from the printed version. As the semantic Web develops, the distance between information and its presentation will become larger, so that quantised pieces of information created for an author-specified target audience will begin to become less common. Instead, information repositories can be consulted and the results combined and conveyed effectively to the user. The source ‘document’, singular, will no longer exist, and in this perspective we will return to the personalised style of the oral tradition.

Acknowledgements

Although I am giving this address today, I would not have been here without the help and support from many others. I would first like to thank the Technische Universiteit Eindhoven for their confidence in creating this chair. I would also like to thank the Centrum voor Wiskunde en Informatica (CWI) for their support of the Multimedia and

Human-Computer Interaction group, set up by Dick Bulterman more than 10 years ago. I would also like to thank my teachers from the past, in particular Alan Bundy in Edinburgh University, whose method of running a research group - both scientifically and socially - has been the model on which I have built. Dick Bulterman and Arnold Smeulders have also played essential roles in my development.

I would like to thank the Rijksmuseum for allowing their material to be used in the NWO ToKeN2000 projects and thus also in this address. While English was once my native language, I would like to thank Christine Scheel, Sjoerd Mullender and my parents for boldly unsplitting my infinitives in the text of this address.

Working at the TU/e and CWI would not be the pleasure it is without my colleagues. In particular, I would like to thank Paul De Bra and Geert-Jan Houben for our collaboration. At CWI, I am aware of the privilege I have of working with established researchers such as Lloyd Rutledge and Frank Nack, and our current apprentices Joost Geurts, Stefano Bocconi, Katya Falkovych, Amit Manniesing, Katharina Schwarz and Yulia Bachvarova. One name has been missed out, but I cannot thank Jacco van Ossenbruggen for his contribution to building up my research group, for it is as much his group as mine.

My professional life is of course only part of who I am. Between my partner and I we have two professorships and two children. Neither of us could have stood the pressure were it not for my parents-in-law, Henk and Corry, and my own parents, Ray and Peter, who have supported us in looking after the children, moving house and just generally whenever they could, while knowing full well that we should slow down and take it easy.

Finally, my thanks go to Frank who has always encouraged me to pursue my own goals, at whatever cost to himself. There are few female professors in my field, and even fewer with children. I could not have done this without your support – thank you for sharing in building our two hobbies – family and work.

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<http://www.crossmyt.com/hc/linghebr/s>

Curriculum Vitae



Prof.dr. L. Hardman has been appointed parttime professor multimedia and internet technology at the department of Mathematics and Computer Science at the Technische Universiteit Eindhoven as of September 2001.

Lynda Hardman started her computing career after graduating in mathematics and physics at Glasgow University (1982). She later joined Office Workstations Ltd. (OWL), where she became the development manager for Guide – the first hypertext authoring system for personal computers.

She moved to Heriot-Watt University where she investigated the problems of navigating in hypertext. Continuing this, she started work on a reference model for hypermedia documents back at OWL. She joined the Multimedia and Human-Computer Interaction group at the Centrum voor Wiskunde en Informatica (CWI) in 1992. She continued the hypermedia reference model work to produce the Amsterdam Hypermedia Model, which formed the basis of her PhD thesis (UvA, 1998), while also collaborating on the design of the hypermedia authoring system CMIFed. This work formed one of the bases for the W3C Synchronized Multimedia Integration Language (SMIL) recommendation. She has lead the group at CWI since 1999.

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