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UNRAVELING INFORMATION AND CROCHETING MEANING: DESIGNING COMPLEX INFORMATION FOR MUSEUM AUDIENCES

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ABSTRACT:

This paper discusses the designer's role in presenting scientific knowledge to museum audiences using the *Universe in a Virtual Room: Realising Einstein's Universe*, a stereoscopic 3D animation project at the Museum of Victoria, Australia, as a case study. The exhibition's development by an interdisciplinary team shows knowledge differences between scientists, designers and audiences to be a fundamental problem for those philosophies of user-centred design that argue that the messages that resonate with audiences should be the basis for design. Other accounts of design see visualisation as more than the simple reproduction of content in the service of audiences, considering it to involve important dimensions of conceptualization on the part of the designer. Hence the questions: What is the scope for user-centred design when neither designer nor audience has sufficient grounding to master scientific knowledge? Can design processes and designers' distance from science bring new perspectives to science-based information?

Key words: user-centred design; representation; brokering; interdisciplinarity; VROOM

ABOUT THE PAPER

This paper discusses the practice of co-design within a user-centred design context, an approach that argues designers should act as advocates for audiences in translating information supplied by content creators. In its various manifestations, user-centered design (UCD) proposes that knowledge of the user is intrinsic to the design of visual communications. In this case, however, the designer found audience advocacy an insufficient basis for design given the complexity of the information to be translated and communicated. Since both the content receiver (museum audience) and the content provider (scientist) existed in a differential relationship to the designer a concept of dual users became necessary. It was especially vital to develop a common language between designer and scientist that included the designer's investigation of scientific methods of representation. While it clearly challenged the scientist to elaborate to a lay audience astrophysical frameworks, this concretized the abstract ideas of astrophysics, and enabled the designer subsequently to make them available for audiences with different levels of science literacy.

INTRODUCTION

Museums are just one venue in contemporary society where audiences encounter digital interactive media and sophisticated semi-immersive experiences, the exchange of media forms and messages across diverse social sites being widespread today with the result that digital literacy is becoming increasingly important and ubiquitous. For example, Internet sites such as *Youtube* and *myspace* invite the user into a reciprocal relationship of receiving and generating content. The museum, however, continues to have an uncertain relationship with expectations of digital augmentation since it understands its environs as more than a simple multimedia environment (Brown 2006). Furthermore, the museum is still predominantly the place people go to see the 'real thing' though the incursion of the digital replica is now common in museums, the authenticity of the artifact being secondary to the success of the representation for visitors.[1] In any case museum audiences are used to encountering artifacts at a distance through physical barriers of glass and rope, or textual ones such as inscription or audio representation. The digital image is just an extension of this.

The visualization of scientific and historical content for exhibition spaces presents a twofold problem for the designer. The first is how to interpret complex or intangible, discipline-specific concepts, while the second is how to frame appropriate interpretations through design in order to relay this to an audience. Here, designers, one community of practice, effectively acts as a knowledge broker, working with a scientific community of practice in order that audiences can engage with the boundary object, that is, the visualization of astrophysics data that seeks to disseminate scientific knowledge. The ideas of broker and

[1] You can see Pharlap, the archetypical racehorse champion, at the Melbourne Museum in all its taxidermist glory as well as the ever popular 3D Stereo panoramic representation of a wire frame structure of Pharlap in the VROOM.

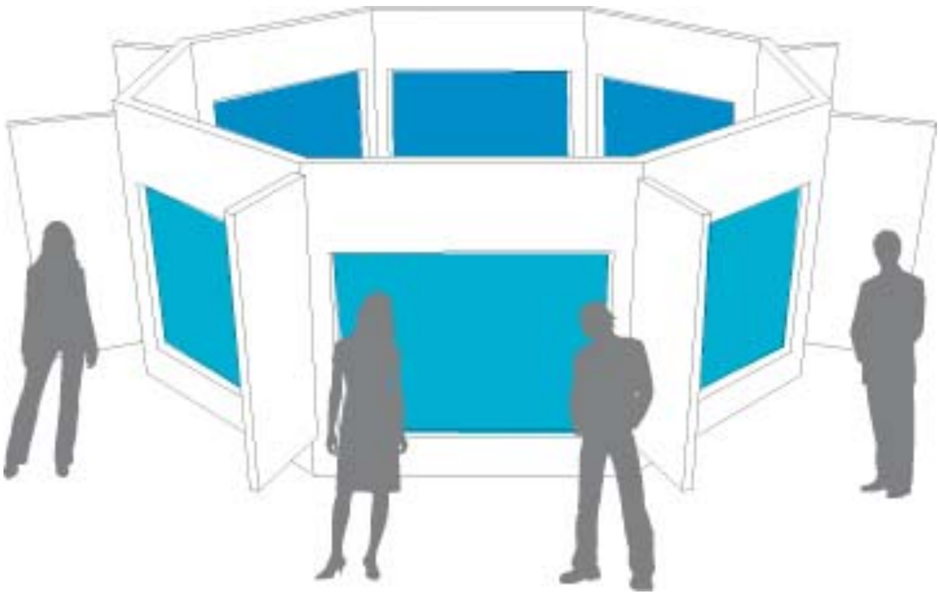
boundary object are derived from Wenger's (1998) theory of communities of practice, which essentially argues that where information is used by multiple groups the form of the intersection (boundary object) between discrete fields of knowledge is crucial to the development of shared meaning. "The job of brokering is complex. It involves the process of translation, coordination and alignment between two perspectives." (Wenger, 1999, p 109) Here, the designer brings to the multidisciplinary exhibition team and the representational task a repertoire of visual literacy, design expertise and experience in formulating information for diverse audiences, contexts and circumstances. Moreover, designers do this work of translation and configuration in an environment of market constraints and user research, which are also critical to the museum and exhibition practice. The scientists and designer engaged in "facilitating transactions between the two practices" and began the foundations of co-design by attempting to introduce "into a practice elements of another." (Wenger, 1998, p.109).

Knowledge about user experience, including its affective and aspirational dimensions, has assisted designers and marketers to engage the attention of consumers (Wright and McCarthy 2004, p.11). Market researchers can identify purchase patterns, interface choices, or how long someone lingers in a space. Experience-centred analysis increasingly focuses on emotional responses. Such developments have some relevance to the audience focus of museum exhibitions. User research is equally relevant to the educational purview of museums, especially those that subscribe to 'learning through scholarly research, formal education training and informal lifelong learning' (Moussouri quoted in Brown 2006, p. 412). As contemporary museums attempt to reinvent themselves as a place of infinite possibility, offering online alternatives and complex digital formats, the concern for content at the behest of audiences' experience of content delivery platforms becomes critical. Similarly, while audience behaviour in exhibitions is often carefully considered and highly monitored, little is known about the more intangible, affective aspects of audience experience, which remain peripheral to exhibition development. As I discuss below, the designer is an effective broker of audience experience in challenging the content provider to consider a nexus between audience perspectives and the dynamics of information delivery.

PROBLEM CONTEXT: THE VIRTUAL ROOM

The Virtual Room (VROOM) is a large-scale stereoscopic digital exhibition platform first presented at the Melbourne Museum in 2003 (http://vr.swin.edu.au/projects/vroom.html). The room (fig. 1) has eight walls, each containing a screen displaying a stereoscopic image. These merge to create the virtual environment. Passive Polaroid glasses are worn to enhance the 3D effect. Intermittent flashes of light and sound that escape from inside the room entice museum visitors to enter the space, as does the beckoning box of Polaroid glasses. Mainly used for the interpretation of science, natural history and cultural heritage content, VROOM exhibitions give a sense of another time or place, including natural history, science and experimental art projects. As with other Advanced Visualisation and Interaction Environments (AVIE) little is known about audience experience in the Vroom, it being hard to investigate what happens with groups of museum visitors moving around in a darkened, digitally augmented space. Are they comfortable; can they concentrate; are they transfixed or irritated or all of these? Do they leave taking something meaningful with them?

Figure 1: Side view of the VROOM screen structure



Use of the VROOM, however, allows a certain freedom in how audiences access content or tap into layers of appreciation, even though it requires the observation of certain protocols (wearing stereo glasses, observing in a dim lit space). Anecdotal research shows that people who 'do the museum' adopt a position somewhat like those who 'do the mall', exhibiting an openness to the possibilities of what they may discover as they wander through the interior. It is mainly students or those with a specific interest who make the effort to read all the instructions and participate within the expectations of the exhibition planners. Others seem content to perambulate.

In the new museum design teams are challenged to use digital technologies to enrich exhibition content. New conventions of presenting information such as temporal and spatial asynchrony, different perspectives and prismatic narrative on multiple screens have a profound effect not only on the message's form and function, but equally importantly on the audience's reception.

THE DESIGN PROCESS

Visualizing the universe in museum spaces has an established history. Bourke (2007) argues it is 'no small task', involving 'a great deal of physics and computational power mixed together with a healthy imagination.' My role as a design consultant in an interdisciplinary team of content developers, who were mainly astrophysicists, was to find ways to arouse audiences' fascination for the universe. This task, however, was to be approached by explaining fundamental cosmological concepts and involved the translation of complex data into visual form, but not through the conventional strategy of imaging cosmological phenomena, Through the visualisation of computations of cosmological findings the astrophysicists wanted to share observations of the 'Einsteinian' universe with the museum audience. The scientists in the team also involved in the development of the VROOM technology were well aware of the technical possibilities and limitations in this objective. This meant communicating content that incorporated supercomputer simulations involving over one million CPU hours of computation, over 1000 separate calculations, separate observations from astronomical observatories around the world, and the explanation of difficult scientific theories.

The scientists had a dedicated, in-house animation team which is experienced in producing sophisticated public exhibitions, especially for children. The team was open to putting a designer into the mix to improve outcomes. Although they were conversant with the language of film and television and the capabilities of visualization technology, they were less knowledgeable about the elements and principles of design. This deficiency was mirrored by the designer's lack of knowledge about astrophysics, though eventually this disparity between knowledge systems was used to the project's advantage. The designer and head astrophysicists were the main project interlocutors.

Early project meetings produced the name of the exhibition, 'The Universe In a Virtual Room' (UIAVR) and a list of nominal scenes for consideration:

- Big Bang
- Formation of a Galaxy
- Galaxy Collision/merger
- Show sites of star formation
- Show formation of massive stars
- Show explosion of stars with supernova remnants
- Listen to pulsars, see infrared trajectories
- Formation of double pulsars with accretion disks
- Inspiral of double pulsars – show LIGO images
- Zoom out beyond lots of galaxies, with double pulsars inspiralling into each other.
- Make time go backwards at speed to undo galaxy formation/Big bang and loop to scene 1.

This constituted a standard list of 'to do's' for the scientists, but its conceptual scope proved daunting to a designer with very little knowledge in this field. Following the first meeting I decided to diagram the scientists' ideas in order to advance the conversations about form and content in the exhibition as it was apparent that the scientific imagination required investigation on a deeper level given the complexity of the content (fig. 2). For the success of the exhibition a balance clearly needed to be struck between the dynamics of watching (audience) and the rigors of intellection (scientist). The team agreed to aim to disseminate the scientific data in a clear and engaging way, while not alienating the audience with a torrent of facts, and without compromising the integrity of scientific information.

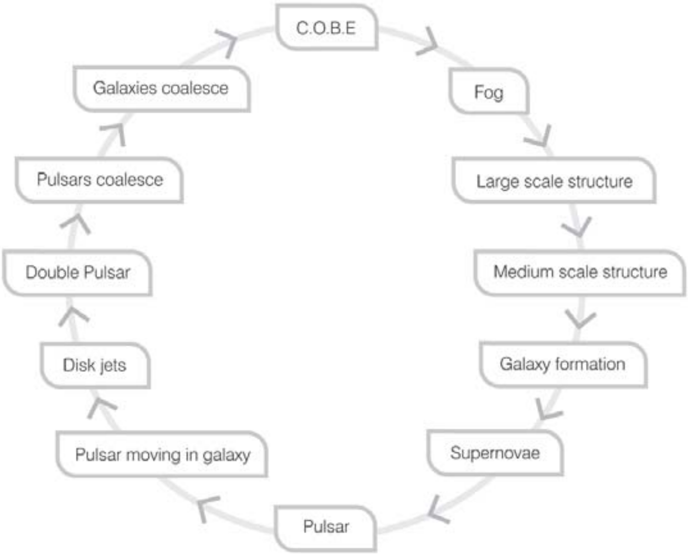


Figure 2: This diagram outlines a rough flow chart documenting the sequence of events for the 'Universe in a Virtual Room' exhibition. *Clockwise:* C.O.B.E, Fog, Large scale structure, Medium scale structure, Galaxy formation, Supernovae, Pulsar, Pulsar moving in galaxy, Disk jets, Double Pulsar, Pulsars coalesce, Galaxies coalesce.

A collaborative working process was sought, the scientists' involvement in co-designing requiring mutual understanding between disciplines and across relevant ideas. The designer proposed the following structure:

(a) Articulate content with the designer's explicit comprehension
(b) Design content for museum audiences
(c) Plan the content in the exhibition space
(d) Discuss advantages and limitations of 3D stereoscopic parameters

Initially, when considering audience needs in VROOM the designer approached this context as a naïve observer. This approach was sufficient for gathering rudimentary information about the behavior of the users, but proved insufficient later as more in-depth information was needed. Co-design is based on a deep mutual understanding between the content provider and product designer. Such mutual understanding is possible in the case of everyday products, but is initially unlikely in the case of the complex knowledge invested in a virtual universe. A more interventionist approach was required to establish a working framework with the scientists. If the designer was not to be the only active participant in the design aspects of the project, the scientists had to be exposed to the designer's principles and practices.

What Wright and McCarthy have typified as 'real shared understanding' (2005, p. 21) began informally. The designer met with the scientists to discuss Einstein's theories of the universe. The scientists attended the designer's workshops to become exposed to the formal elements and principles of design and to discuss examples of best practice. In order to assist the transmission of understanding here, the designer asked the scientists for examples of their favourite movie or book, the latent assumptions about pictorial, narrative and rhetoric conventions in these choices providing a basis for the construction of meaning in the exhibition to be explored. The latter planning stages for the exhibition included consideration of the museum audience and the physical site. Visits to the VROOM were taken, specifically to observe the audience. Content remained a secondary consideration on these visits.

The pre-planning process happened over six weeks, discussions becoming complicated as the scientists became involved in the problem of visualising the data. To address this difficulty, the designer set out to participate in the professional lives of the scientists involved in the project. The designer took notes, drew diagrams with the assistance of scientists and observed the results of powerful computations and related 3D outputs. During this time the designer did some cosmological homework to compensate for her lack of grounding in the field. The designer also began to record audio files where the scientists were asked to describe their theories and results to people of different ages, a method for suffusing the scientists with the perspectives of the audience in order to involve them in the ideation and content development process for the exhibition. A script meeting was then undertaken, the designer and scientists setting a thematic structure to drive the narrative and interpretation strategies.

BROKERING CONFLICT IN VISUALISATION

Forlizzi and Lebbon argue that where scientist, designer and audience 'become active participants in the creation and interpretation of the visual message.….the designer is empowered, shifting from a decorator of messages to an agent who has influence on the social implications of delivering a visual dialogue' (2002, p.4). In this case UIAVR, the visualisation medium, became a foundational language for the designer and the scientists given the potential sources of information in astrophysics (pure data, maths, code, equations, radio, audio) and considering how complex content was to be deciphered. However, as work on the exhibition progressed further incongruities in meaning and function of the scientific images arose, proving to be a major hurdle for the representation of the data. The visualisation strategies used in science and design appeared distinct.

Standish and Galloway observe that 'making sense of large quantities of data generated by high performance and highly complex computer models is a visualisation practiced everyday by astrophysicists' (2002, p.1). These specialist methods of communication, however, are intended for scientist-to-scientist communication and are beyond the capacity of the lay person to understand. As Standish and Galloway explain 'non visual techniques by contrast always require a hypothesis which is tested by analytical techniques on the data. Consequently non-visual data will miss what is suspected.' By contrast they characterize the human visual system as 'a supreme pattern recogniser honed by millions of years of evolution'. In the designer's advocacy for the audience, visualisations were vital in illuminating how scientists worked.[3] Here, a primary objective became the representation of the process of Einstein's theories in the visual cognitive register, rather than standard narrative or alphanumeric form. It also proved to be a suitable medium for translating content into the 3D stereoscopic animations and audios needed for the VROOM platform. Indeed, the potential for the audience to connect with a new and rich source of information provided by the layers of visual material generated at various stages of the design process promised to be an exciting breakthrough.

Ultimately, however, it became apparent that the actual meanings and techniques of visualisation were contested ground, equating with James Paul Gee's representation (2005) of a conflict of two cultural models and problematising the designer's role as a broker of meaning.[4] This conflict, moreover, underscored that it would not just be scientists and designers who had different conceptions and ways of talking about the universe (cultural models) but also scientists and members of the public. The designer's brokering role in producing visual representations that encourage dialogue across the groups and between cultural models was both underscored and put at risk.

The designer was focused on achieving optimum audience experience within the parameters of the exhibition environment (3D, stereoscopic, octagonal space, passive-Polaroid glasses).The scientists also needed to think about the best ways to give access to their information if their approaches were not to affect negatively the audience experience in terms of sense data, cognition, feelings and expectations. Bruner argues that, 'experience comes to us not just verbally but also in images and impressions' (Bruner 1986, p.5). Reflecting a customary role, the designer necessarily acted as a translator from scientific to audience perspectives and thus from one cultural model to another.

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[3] Jorge Frascara argues '[f]or such a change to happen, the communication must be detectable, discriminable, attractive, understandable and convincing. It has to be constructed on a knowledge of visual perception, human cognition and behaviour, and with consideration for the personal preferences, cognitive abilities and value systems of the audience.' (Frascara 1997, p.3)

[4] Gee's example of such situated meanings: '[S]ome children consider that, when sugar is dissolved into hot water, there is 'nothing left but the taste'. But, when a solid is put into a liquid and dissolves so that no parts of it are visible, the correct *everyday* way to describe this is to say that the solid has 'disappeared'. In everyday, non scientific practice, 'disappeared' here does not mean 'All material, including any esoteric material discoverable by scientists (such as molecules or atoms), has gone out of existence', Rather, it means that some object that I formerly saw is now no longer visible.' (Gee 2005, p.63)

Cultural models embody ways of talking (discourse). Where they are routinized for specific communities they can be called repertoires. As part of an 'empiricist repertoire', (Gilbert and Mulkay 1984, p.40) the scientists arguably relied on assumptions about the audience being unable to dispute scientific visualization, therefore being somewhat passive semiotic recipients. In a related sense Bruno Latour highlights the conventional assumptions of the scientific image:

> But why, then, scientific images? Surely, these offer cold, unmediated, objective representations of the world […] they simply describe the world in a way that can be proven true or false. Precisely because they are cool, they are fresh, they can be verified, they are largely undisputed, they are the objects of a rare and almost universal agreement. (Latour 2007)

The designer proposed that the process would be most valuable in assisting audiences to gain insight into scientific ideas if they could see how scientific theories were generated and developed. It was decided to include an insight into how Einstein might have gone about concretising an idea as a series of facts and figures. Again, this effort to reveal the machinations of scientific research revealed additional differences in understanding the nature and purpose of visualisation between the designer and the scientists, inevitably pointing to a similar variance with the views of audiences on these matters.

The scientists involved in implementing the project at the level of hardware and software focused on the state-of-the-art details of the delivery system, putting their energy into considering optics, perspective geometry and interactive rendering. This technical expertise was fundamental to the function of the exhibition, but as audience advocate the designer was concerned that such factors didn't take over, and the designer challenged the scientists to consider the effects on the audience and advocated the content delivery of the combinatory delivery system. For George Legrady to 'experience space is to engage with it through one's presence, to possess it by being immersed in it, in the way one possesses space when inside a room, in a park or on the streets' (2002, p.222). The combination of factors affecting audience experience in the VROOM, such as the semi-lit space, wearing Polaroid glasses, tracking 3D stereo animation and audio effects across a series of screens and the challenge of negotiating the space with others present, were intrinsic to the design approaches adopted and required radical perspectives.[5]

The scientists typically favoured simple representational methods that imposed a definitive scientific truth-effect, arguably limiting the audience's opportunity to experience layers of meaning. For the designer, the single image, while potentially interesting on an aesthetic level, truncated meaning. For Latour (2007), a scientific image 'is a set of instructions to reach another one down the line'. However, for many people

[5] As Legrady continues, '[f]or artists and communicators who want to create a specific experience, conceptualising the interface environments, within which the digital-based interactive artworks are to be experienced, becomes as much an integral component to the design process as the design of the interaction and the visualisation of the information data'. (Ibid.)

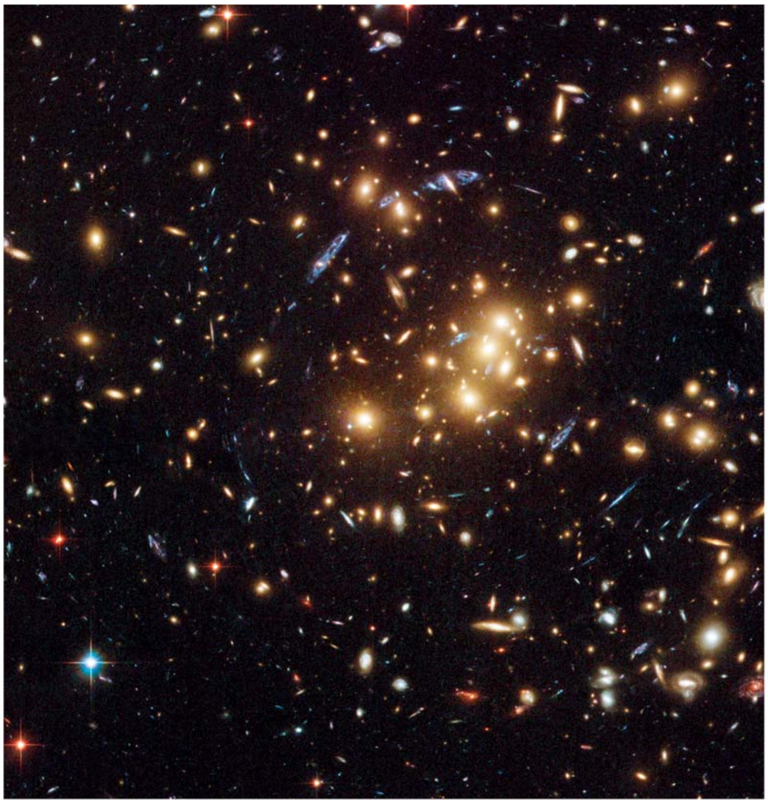
they 'are not even images, but the world itself. There is nothing to say about them except learning their message'. He, in fact, argues that scientific representations of galaxies, atoms, light, genes and the like are not actually real but manufactured, it becoming increasingly apparent that 'without huge and costly instruments, large groups of scientists, vast amounts of money, long training, nothing would be visible in those images. It is because of so many mediations that they are able to be so objectively true'. (p.21)

These cascading processes and associated imagery, as Latour points out (2000), allow scientists to use data to its full potential. However it was mentioned that working on the content for UIAVR in an intertextual way was essential. Even where the designer could not grasp the meaning of the data she could still use the 'entangled connection that each image has with all the others' (Latour 2007 p.21) as a productive element in designing content, the pictorial relations that were revealed expanding meaning for the museum audience.

Consider the following example:

Figure 3

These images represent data recorded from the Hubble telescope. This data shows where the matter is located in space and in time. It is a picture of dark matter.



NASA/ESA Hubble Space Telescope finds dark matter ring in galaxy cluster

Credit: NASA, ESA, M.J. Jee and H. Ford (Johns Hopkins University)

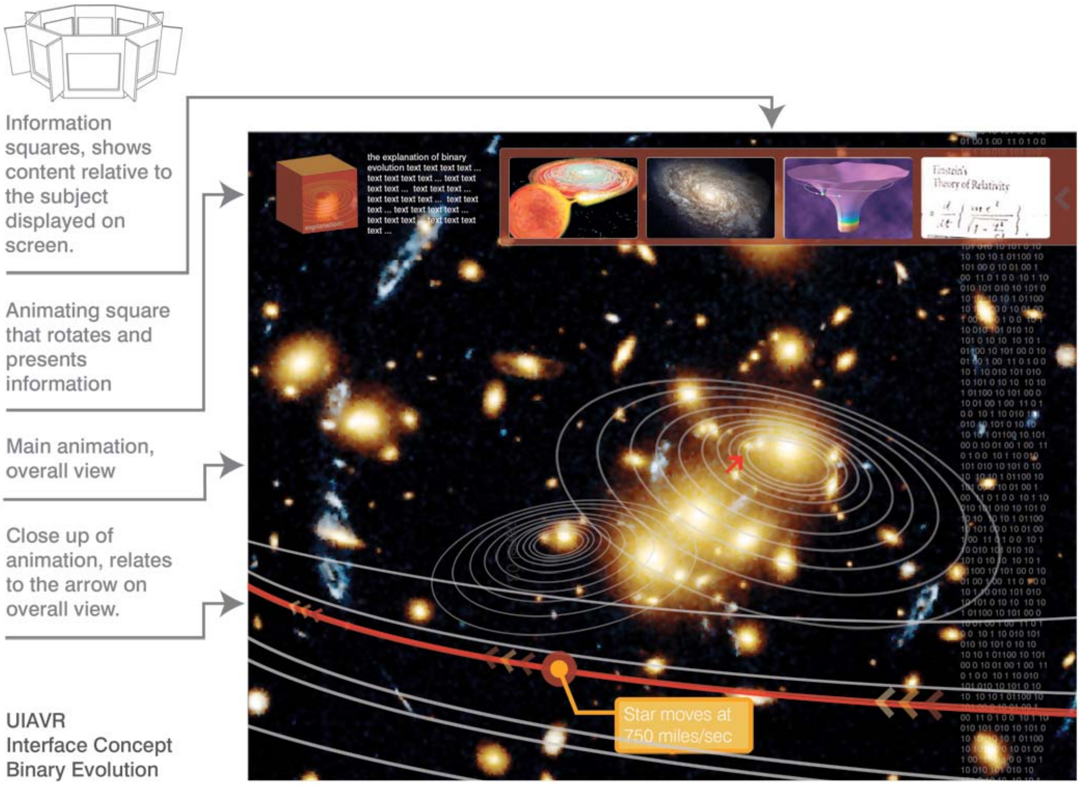


Figure 4: The designer sought to show the complexity of the image by adding visual layers. This interface offered a deconstruction of the scientific image, and illuminated the data encoded in it. The image contained results of the scientist's research and theories. One could see that a picture of stars albeit a compelling image was specific knowledge pertaining to the scientists' 'situated meaning' or 'knowledge system'. The image layers unpack abstract data for the audience.

The above example demonstrates the serious obstacles and some disagreements in the process of co-designing as a result of differences between a scientific representational repertoire and the advanced vocabulary of information design.

The designer realized that no universal method of collaboration exists where conceptual conflict might be avoided. In fact, conflict does not necessarily inhibit collaboration, on the contrary, it added a new dynamism to discussions and to understanding the complexity of visualising the content. Wenger's discussion of brokering similarly suggests "a community of practice is neither a haven of togetherness nor an island of intimacy insulated from political and social relations. Disagreement, challenges, and competition can all be forms of participation." Indeed, he concludes that, "as a form of participation, rebellion often reveals a greater commitment than does passive conformity." (Wenger, 1998, p.77)

Ultimately, the design largely reverted to a conventional linear and narrative model for representing scientific content. However, several elements of co-design were successfully integrated and selected for production for the VROOM, such as in the combination of real time modeling of a supernova and the aesthetics of the graphic data. As a pragmatic response to challenges in the co-design process the designer invented a methodology for the purpose of cultural translation, based on Latour's work. Its central outcome was the cascading effect of images, which enabled the audience to access layers of meaning beyond the standard presentation of cosmological facts.

CONCLUSION

The Centre for Astrophysics and Supercomputing at Swinburne University of Technology is 'dedicated to inspiring a fascination in the universe through research and education'. This is demonstrated by the centre's impressive record of conducting public awareness programs for all ages across many platforms. Spaceworks, a division within the department, focuses on astronomy visualization, enhancing human vision through perceptual technology and computer generated images. It is a method of communication that allows scientists to contribute to the dissemination of knowledge and understanding but at the popular level depends on collaboration with those experienced in visualization. Here, art-science synergies have a long history. In the eighteenth century naturalists' oral and visual presentations of their information were extremely popular, the middle classes flocking to elaborate performances, panoramic installations and exhibitions of such material.

Today, designers collaborate in the production of science and history information with researchers. For Jorge Frascara, co-designing 'visual communication is more an interdiscipline than a discipline […] it is a problem oriented, interdisciplinary creative action.' (1997, p.3) In this he suggests the need for new principles and methods to accommodate hybrid disciplinary frameworks. In the UIAVR project, the scientists and the designer collaborated extensively, but the process of developing shared frameworks between the scientific data and the design perspectives necessary for its presentation for museum audiences proved difficult. These difficulties highlighted a clash of cultural models and attendant semiotic strategies. In response the designer adopted the role of cultural translator, which entailed extensive investigation of an unknown knowledge system (astrophysics) and its representational repertoire, with the aim of interrogating complexity and revealing the scientific process through visual layers. In the aim for audience advocacy and the effective communication of scientific content, the example makes it apparent that the designer must assume an *active* role in shaping both content and communication strategies. In fact, the designer should pursue advocacy for the audience even if it risks encroaching on the traditional representational repertoire of science or any other knowledge system. Crocheting meaning, to return to the paper's title, is a process of unraveling and re-assembling such repertoires to achieve accessible but ideally layered meaning for museum audiences.

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