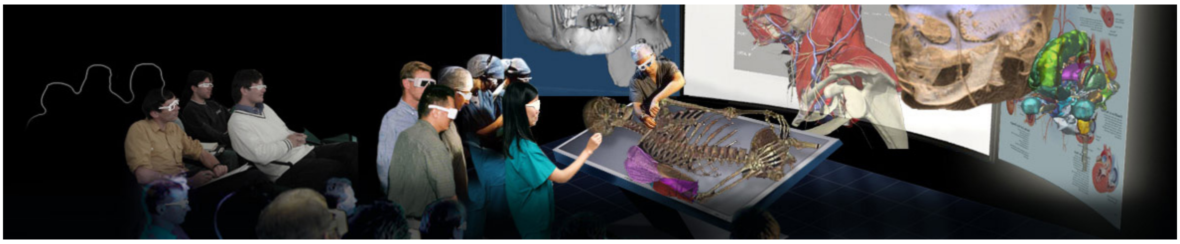
Appendices



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Paul is the Director of the Digital Design Studio, which he established in 1997. He has an international profile in digital visualisation and interaction research concerned with fundamental human computer interface issues, particularly those associated with 3D interfaces, haptics and gesture-based interaction. He has won major research funding from the EU, EPSRC, NESTA, Scottish Funding Council and Scottish Enterprise. His research interests are focused on medical, automotive and defence fields. He has collaborated with a number of world-class research organisations, and has published internationally on the subject of digital visualisation and interaction. Paul leads the Scottish Medical Visualisation Network in partnership with David Rowley.

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In 2004, Philip was appointed Postgraduate Dean for East of Scotland Deanery at Ninewells Hospital and Medical School in Dundee. The Deanery maintains close contact and working relationships with GP and Dental colleagues who are located at Tayside Centre for General Practice and Dundee Dental Education Centre respectively. Previously he was a consultant haematologist in Tayside involved in training and education as specialty advisor for haematology, regional advisor for the Royal College of Pathologists and Postgraduate Tutor with responsibility for SHO training in Tayside.

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David was educated in South Africa and studied radiology in Durban. He emigrated to Scotland in 1997 and has been working there as a Diagnostic Radiologist since his move. He is a general radiologist with an interest in cross sectional imaging. He has a keen interest in teaching and is the Acting Academic Sub-Dean for Glasgow University at Ayr Hospital and the NES Foundation Tutor. He is an examiner in the final year medical examinations at Glasgow University and is on the steering group of the MS Managed Clinical Network.

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Ian qualified in medicine in 1975 but after pre- and post-registration medical and surgical positions, chose to follow a career in anatomy, becoming professor of applied clinical anatomy, University of Dundee and Royal College of Surgeons of Edinburgh, in 2005. He is a Fellow of the British Association of Clinical Anatomists and Honorary Fellow of the Institute of Anatomical Sciences. His expertise includes the delivery of three-dimensional, functional and clinically relevant anatomy to undergraduate medical students and postgraduate trainees.

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Dr James A Miller,
James Miller is Chief Executive of the Royal College of Physicians and Surgeons of Glasgow. James began his career as a student nurse in Edinburgh in 1983. After qualifying in 1986 he worked in a number of clinical posts before becoming involved in education, R&D and quality management in Edinburgh. In 1992, James moved to a hospital in West Lothian where he held a variety of posts including, Deputy Director of Nursing, Senior Nurse Manager and General Manager. Moving to Glasgow in 2001, James took up a General Manager's post at the Southern General Hospital where he stayed for a period of 4 years before taking up his current post in 2005 at RCPSG. Throughout his working life James completed three academic degrees in Dundee Institute of Technology (now Abertay University), as well as Napier (MBA) and Edinburgh Universities (PhD). James is also a Fellow of the Royal Society of Medicine

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Dr Vassilis Charissis BSc(Hons) MPhil PhD
Vassilis specialises in the design and evaluation of human-machine interfaces in automotive and medical fields, and is currently developing a novel HCI interface for anatomy courses and surgical rehearsal through VR technology. He is a member of IEEE Computing Society, IEEE Intelligent Transportation Society and Society of Automotive Engineers (SAE). Vassilis has published internationally on behalf of the Scottish Medical Visualisation Network and is a lead researcher for the Network.

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Published Papers:

V. Charissis, B. M. Ward, M. Naef, D. Rowley, L. Brady, and P. Anderson, (2008), An Enquiry into VR Interface Design for Medical Training: VR Augmented Anatomy Tutorials for Breast Cancer, in Proceedings of IS&T/SPIE 20th Annual Symposium of Electronic Imaging, Science and Technology, 26th -31st January, San Jose, California, USA.

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An Enquiry into VR Interface Design for Medical Training: VR Augmented Anatomy Tutorials for Breast Cancer

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ABSTRACT

This paper presents an initial study exploring and evaluating a novel, accessible and user-centred interface developed for a VR Medical training environment. In particular, the proposed system facilitates a detailed 3D information exchange, with the aim of improving the user's internal 3D understanding and visualisation of complex anatomical inter-relationships. In order to evaluate the effectiveness of the proposed VR teaching method we developed a female 3D model under the guidance of Consultant Breast surgeons with particular emphasis given on the axilla section. In turn we commenced a comparative study between PBL tutorials augmented with VR and the contemporary teaching techniques involving twelve participants. Overall the paper outlines the development process of the proposed VR Medical Training environment, discusses the results from the comparative study, and offers suggestions for further research and a tentative plan for future work.

KEYWORDS

VR Interface, Medical Visualisation, Anatomy, Medical Education, HCI, Breast Cancer, Surgical Training, Haptics.

1. INTRODUCTION

This paper presents an initial study exploring and evaluating a novel, accessible and user centred interface developed for a VR Medical training environment. In particular, the proposed system should facilitate detailed 3D information exchange, with the aim of improving the user's internal 3D understanding and visualisation of complex anatomical inter-relationships. Evidently, recent studies advocate the benefits of VR training methods, which can provide beneficial outcomes by shortening the learning curve [1]. Furthermore complicated anatomical issues can be visualised intuitively by a VR interface, which does not have any physical constrains [2]. Hence it is possible for the user to interact freely with a volumetric 3D model, selecting their own number of infinite viewpoints, a factor suggested to be central in spatial anatomical understanding [3]. In addition the importance of facilitating a balanced deep learning approach including visualisation skills has been highlighted [4].

It is recognised that undergraduate anatomical training has changed in recent years. The availability of cadavers to undergraduates has significantly decreased. In recent years, increasing student numbers and pressures from a growing undergraduate curriculum has resulted in a decimation of students' exposure to cadaveric material and a reduction in total anatomical teaching [5]. It is suggested that current medical and surgical trainees require anatomical resources that are convenient and adaptable to desired educational content and techniques [6, 7].

2. EDUCATIONAL MODEL

Recently there has been increasing interest in contextual situated learning in all disciplines, especially those requiring the application of integrated complex knowledge. A natural extension of the constructivist and situated approaches is the activity-based approach [8], where instructors frame the desired outcomes in terms of knowledge, attitude, skill and behaviours and design the learning activity to facilitate the active internalisation of different types of knowledge and meta-cognitive processes.

Medical Educationalists have become increasingly interested in the inherent opportunities that these techniques offer, in particular when knowledge and skills must be demonstrated perfectly in high stakes situations and challenging social environments. To this end there have been attempts to produce 'thickly authentic' interactive learning techniques to allow knowledge, skills, behaviours and reasoning to be learned in a clinically useful and therefore relevant manner [9]. These simulations also allow the student to fail safely, gaining from the learning experiences of failure with no risk to the patient. This approach has been mirrored by computer educational theorists, describing the role 'epistemic gaming' [10] i.e.: highly interactive problem based resources placed firmly in a realistic professional context. These two approaches highlight a growing area of interest in medical training; structured, contextualised learning in a virtual or 'real-world' environment that mirrors contemporary or professional challenges.

However within medical educational literature there remains doubt regarding the educational benefits of 3D visualisation (stereoscopic) vs. 2D applications in teaching spatial anatomy and operative procedure. Existing publications regarding the advantages of 3D display and rendering look mainly at rotational 2D representations of 3D anatomy in core undergraduate teaching. Stereoscopic projection has been demonstrated repeatedly to improve learning outcomes in training outside medicine [11, 12]. Additionally the specific advantages of free interaction with rotational models when learning complex 3D anatomy has been identified [3]. Also the importance of understanding the role of student spatial-skills has been identified [13]. Currently many described studies exist in isolation from existing educational approaches and are de-contextualised from practical implementation. It was an aim of the inquiry to look at the use of 3D visualization as a resource for student-centred, situated, activity-based and activity-centred design [14] that could be implemented in surgical education.

Adhering to the aforementioned approaches we decided to evaluate the desired learning outcomes for surgical trainees in the subject domain of the clinical and operative management of advanced breast cancer. In association with the Edinburgh Breast Unit and utilising the transitional intercollegiate Membership of the Royal College of Surgeons (MRCS) examination we illuminated the key knowledge required. This was identified in terms of applied basic science, clinical principles and knowledge of operative procedures and protocol. In addition we identified the key skills and processes involved in sentinel node biopsy and the operative approach to axillary clearance. Additionally we developed a series of common case vignettes to create subject interaction and therefore explore reasoning. These principle goals were then mapped to situated activities which formed the basis of the design requirements for the structured tutorials and the semi-immersive VR application.

The primary goal was to place the student in a situation in which they experienced 'thickly authentic', situated learning in the context of a tutorial with a surgical trainer. A framework for this was produced and the VR system described below designed to meet these goals. It was important that an integrated approach was taken in all aspects of design, in order that we could create a design method embracing surgical educational needs, accurate anatomical representation and seem-less information transfer within the described educational model.

3. VR REQUIREMENTS

The aforementioned contemporary issues in medical training fuelled the development of the VR environment, which was based in the existing Digital Design Studio VR facilities. The particular system is developed around a Fakespace Immersive Workbench and entails real-time visualisation, gesture interaction with tactile feedback (CyberTouch™ sensored glove) and 3D sound as depicted in figure 1(a,b). Its semi-immersive design is particularly valuable in assisting with small group tutorial requirements.
Although the particular Workbench was initially developed for automotive engineering evaluation [15] it was found that the table-design of the installation offered an intriguingly similar position and dimensions to an operation table or an examination bed. Hence the existing VR and haptic technology was repositioned in order to enhance this feeling, replicating as much as possible the position of a cadaveric examination.

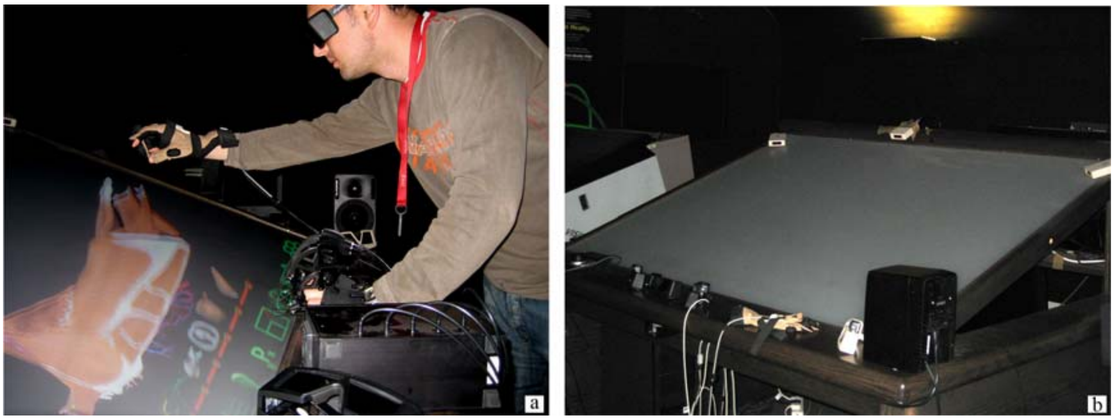

Figure 1: (a) Haptic interface demonstration for the manipulation of the VR human section
(b) The Fakespace Immersive Workbench with the CyberTouch™ sensored glove.

The virtual visualisation was achieved with CrystalEyes shutter glasses. We opted for this type of glasses as it was essential in this setting to provide the trainee and the trainer to see themselves and other members of the group as well as the model. In contrary fully immersive systems using head-mounted displays present a fully virtual environment which lacks the interactivity between the users during anatomy teaching or the trainee/trainer discussion of surgical rehearsal.

A minor pitfall of the system is that only one pair of glasses could be tracked by the table-sensors (typically the person using the haptic glove). Hence the rest of the viewers should be positioned as close as possible to that user (with the tracking-glasses) in order to have minimum visual distortion. However we intend to minimise the visual distortion experienced by the users with the non-tracking glasses by the development of a new VR facility with a substantially larger viewing surface.

The "physical" interaction between user and the VR model is enabled with the use of a tracked CyberTouch™ sensored glove with vibro-tactile stimulators on the fingers and palm. This glove can sense the bend and relative position of the fingers and thumb, allowing interaction via gesture; combined with tracking it can sense the hand's position in space, allowing the user to explore and manipulate the digital model directly in 3D space.

Additionally 3D spatialised auditory cues provide sound effects which signalise a variety of different actions. The depth perception is extensively investigated with sound moves in space appropriate to the manipulation of the model. Notably the initial system was developed on the SGI platform. However contemporary CPUs, graphic card accelerators and large capacity memory DIMMS made implementable the transfer to a high-end PC platform. As such, the prospective system's cost efficiency was reduced radically offering the ability for the research team to experiment in more complex interfaces, models and even consider the development of a mobile system..

4. CONTENT DEVELOPMENT

4.1. 3D Model Reconstruction

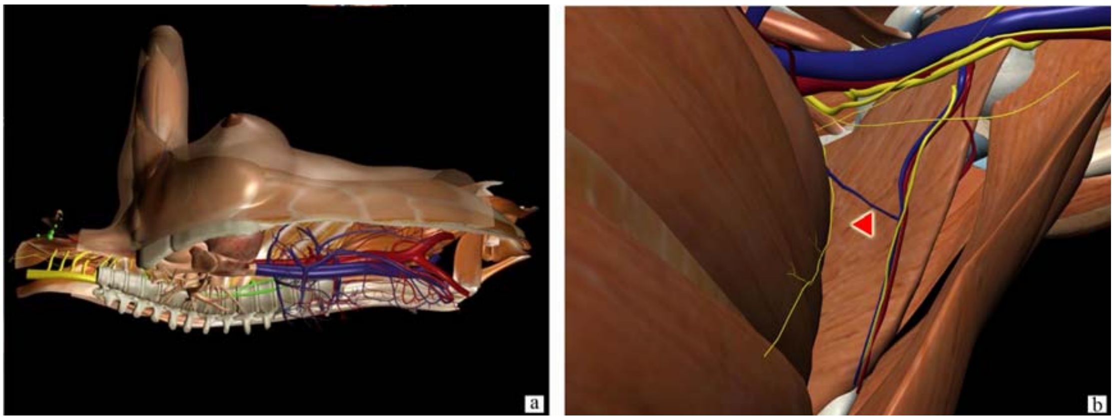

Figure 2: (a) Complete, detailed section of the female VR human body.
(b) Close-up of the 3D model with emphasis on the angular vein and inter-neural zone.

In order to evaluate the effectiveness of the proposed VR teaching method we developed a female 3D model under the guidance of Consultant Breast surgeons. Particular emphasis has been given to the axilla, its contents and surface markings. The nervous, venous, arterial and lymphatic systems were meticulously modelled to depict accurately the complex structures and their relationships as shown in figure 2. Notably the initial 3D human body data was developed with the use of CT and MRI scans. However the over-complex data had to be remodelled substantially in order to comply with the anatomical road-map required during the trainee test evaluation. The identical replication of details that present anatomical landmarks was of outmost importance for the successful conveyance of relevant information to the users. Additionally specific areas of the anatomy under investigation were elaborately developed with the constant input of information provided by the surgeons. Particularly the angular vein of the axilla, first described in 1993 [16]. This was introduced as it is a key surgical landmark in axillary clearance [17]. This exemplifies the importance of this collaborative methodology, and indeed the difference between taught and surgical operative anatomy.

In particular the three dimensional human model's complexity had to be restrained in order to comply with the maximum polygon-number computational ability provided by the customised personal computer. Therefore the model was further reformed and evaluated for optimum performance during projection and navigation. Interestingly the hierarchy and structure of the human model had to be adapted for the display and human computer interaction as well as for serving the examination process (i.e. questions sequence).

4.2 HCI Development

The interaction between the user and the system was investigated explicitly in order to facilitate the requirements for the anatomy teaching of the particular area. Therefore the overall HCI was tailored to simplify the examination of the human model.

The interface interactivity was pushed beyond traditional information and data visualisation by including real-time transparencies in specific sections and organs of the human body enabling the users to comprehend the spatial relationship between lymphatic, vein, and musculoskeletal parts of the body. Interactivity means design parameters can be changed using the same user interface used for the visualisation. In the case of the product model, this means that the user may pick and change objects in real-time. Furthermore these customised interactivities could carry auxiliary functions which might include predetermined or real time simulations for different types of surgical rehearsal. The current virtual model exemplifies such an interactive scenario, as it highlights the potential problems during the surgical rehearsal for a malignant breast disease operation. As the specific interface is under development we form a tentative plan of work in order to incorporate extensive functionality and artificial intelligence in the system, so as to offer various guidelines or suggestions to the user either for the learning anatomy or for understanding the procedures for specific surgical operations.

Incorporating multiple viewing alternatives (i.e. predetermined positions of the specific section) and defining objects or structural parts that can be changed interactively (i.e. pectoralis major and minor transparency) required equally custom-tailored models as well as appropriate interface development that could support such functionalities. Hence the content of the experiment was heavily supported and highlighted from the intuitive HCI design. To this end we consider that an innovative HCI design may be composed of similar interface elements but their re-arrangement and context should be customised heavily for serving different anatomical issues and surgical rehearsal cases. Hence finding ways to make such issues easily understandable from different medical practitioners is illustrative of our approach.

5. EXPERIMENT RATIONALE

The validation study is based around contemporary experiments described in the literature and includes refinements drawn from other group's experiences. In particular it was decided to assess both the quantitative impact on learning outcomes and explore qualitatively the user's experience of the VR interface, their interaction with the data and the perceived educational value of the application. The study design is essentially a comparative randomised control trial with pre- and post-intervention assessment utilising matched quantitative and qualitative instruments.

5.1 Subjects

The target subjects of the validation comprised postgraduate doctors with a declared interest in surgery and one to two years of clinical experience in the National Health Service (NHS). Currently all graduating medical students must complete two years of organised generic postgraduate training (the Foundation Programme) prior to competitive selection for clinical specialities. As part of this process it is important that they complete not only in the foundation programme itself, but also undertake external collegiate membership (entrance) examinations in their chosen discipline. The targeted learning outcomes in the study came directly from the intercollegiate MRCS, and so focused directly on this group. To this end we approached Foundation Year doctors within Scotland and asked for volunteers for the validation study. The response rate was high, as many were studying for surgical membership and saw the study as a route to structured teaching time (total 36).

Figure 3: Actual screenshot during the evaluation

The volunteers were pre-assessed for anatomical knowledge and prior experience of 3D rotational applications. Twenty-three met the predetermined criteria and twenty were selected. This produced a balanced group of trainees in terms of graduating university (Edinburgh, Glasgow, Dundee, Aberdeen), sex, experience and age. These were then randomised to two trial arms.

The subjects were all current trainees and it is for this reason (ie: rota commitments) that the final total sample size was twelve rather than twenty. This lead to a rather small group size, but was sufficient for this scoping study. This illuminates a major problem for similar studies in this group, and has lead to the concept of developing a portable VR test-bed that can be taken to regional training days and thus increase future sample sizes.

5.2 Experimental Methods

The FY doctors were randomised into two groups:

1. Structured tutorial (traditional resources)
2. Structured tutorial (proposed VR system)

The groups then undertook their respective tutorials at the Digital Design Studio, Glasgow. Both groups were time limited to 25 minutes and guided by the instructor to a identical pre-determined protocols. The tutorial format was activity-based and situated, i.e.: designed to prompt the student into interaction with the real world/VR environment facilitated by the instructor.
The protocol was designed using operative expertise in collaboration with Consultant Breast Surgeons. The learning objectives included surgical anatomical knowledge, the principles of surgical management and operative treatment.

Attempts were made to control variables. All tutorials were undertaken in the same 2 month period the same with the identical protocol, model, equipment and instructor. The tutorials were repeated several times with the maximum of two subjects taking part at any time. Immediately after the tutorial all trainees were debriefed using identical instruments.

5.2.1 Qualitative Method

The subjects were debriefed using a forty point subjective user evaluation questionnaire. Additionally open questions were used to illuminate development issues and direct further work. The questionnaire used a nine point Likert scale, allowing a neutral position. The questions were grouped to explore the interface utility, interactivity, efficiency, subject engagement, and perceived spatial learning. Internal consistency was measured using Cronbach's alpha, responses were analysed by group and individual means.

5.2.2 Quantitative Method

Multiple Choice Questions (MCQs) were used to debrief all subjects. A set of twenty questions, both True/ False and common stem questions were used. The questions were structured into three groups. Respectively these explored spatial anatomy, the surgical approach and clinical principles.
Each group was analysed finding total and question group means, standard deviations and confidence interval ($P<0.05$).

In this paper we were particularly interested in the way the FYs perceive the system's interactivity and how that facilitated contextual spatial learning. Additionally we sought quantative information in order to ensure quality measurement and assurance (i.e.explore the possibility that the system damages learning outcomes). As such the quantative results were reassuring in that they indicated that there was little overall difference between the MCQ scores in either group (VR goup mean **61.25** vs Traditional group mean **60.41).**

6. RESULTS

6.1. Thematic Analysis

Two major themes pre-dominate the responses to the open questions. These themes support the findings of the user questionnaire. The first and most prevalent was exhibited in opposition between the groups and regarded engagement with the activity-based scenario. It is interesting to note that in the VR group students repeatedly commented on the 'immersion' and 'engagement' when speaking about their experience of the tutorial. One student said simply:

'I found it really easy to get into it; it brings the anatomy to life, very like the dissecting lab'

This was almost reversed in the traditional group, where several group members commented on the difficulty they experienced in 'getting into it", this is one example:

'it reminded me of role playing, which I was never very good at as an undergraduate. '

It is interesting to note there were no complaints of difficulty engaging within the VR group.

The second most theme related to the subjects confidence in their understanding. It is quite telling that both groups felt the tutorial enhanced their learning of anatomy, but when asked about their confidence that they had learned accurately, a common response in the traditional group was that they were sometimes unsure if they had communicated their doubts clearly:

'it was difficult. I was asked a question, and I don't know if we were talking about the same thing.'

In contrast members of the VR group found that communication with the trainer was enhanced and that individual misconceptions were exposed:

' If its in front of you, you can both see. He (the instructor) can see if you are wrong. '

It is interesting to note that both groups perceived the same tutorial in very different ways, despite the shared protocol. The results appear to indicate strongly that the ability to share the 3D experience of the anatomy between the trainer and trainee is important, as the analysis of the questionnaires depicts in figure 4.

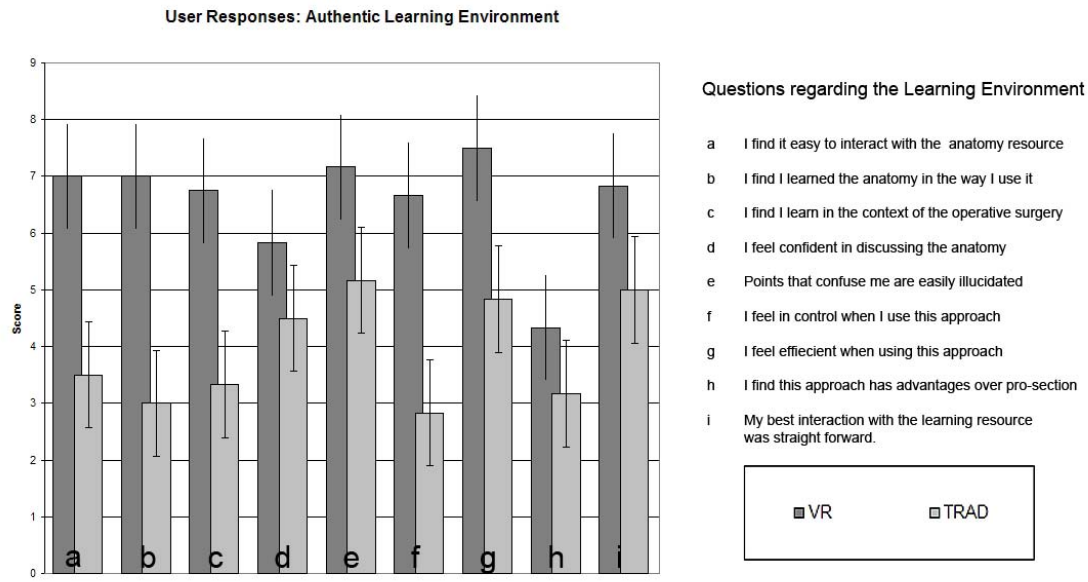

Figure 4: Comparative results between VR teaching environment and the traditional techniques.

6.2 Qualitative Analysis

The above results present a preliminary but, nonetheless, informative assessment of how the VR learning environment augments contemporary teaching methods. Interestingly this small evaluation demonstrate the potential impact of an accurate model displayed interactively via VR (figure 4).

Notably, the use of the VR human body was preferred overall amongst the trainees in the two groups. Specifically, the majority of the participants found the VR anatomy considerably easier to interact with and understand as questions (a)and (b) shown respectively. Evidence collected also suggests that VR augmentation also enguages and empowers the student as they percieve increased control (f), Additionally the results show that with the use of VR the student is not only a receiver of information but he/she is also enabled to interact in real-time with the given data. This would seem to reflect the advantages of situated, activity-based approaches. Additionally student in the VR group describe enhanced communication with their instructor (e) Also of note the students seem to express increased confidence in the accuracy of their knowledge (g).

Finally the results obtained from question (i) indicate that the functionalities of the human computer interaction (HCI) was accumulated very quickly. This can be attributed to the design of the interface as well as the familiarity of the contemporary students with complex operating systems throughout their daily life.

7. CONCLUSIONS

This paper describes the rationale and development process of a user-centred interface designed for a VR Medical training environment. The system was evaluated in a comparative study against the traditional anatomy teaching techniques. Although this is a preliminary study we tried to identify the potential positive elements of a VR environment and highlight the potential pitfalls. The system was perceived unexpectedly well from the users mainly because of the ability to investigate the human body without any physical constraints. However the complexity of the haptic interaction renders the system immobile, hence minimises the number of users that could visit the facilities for further training. To this end we currently investigate a mobile solution that incorporates "off the shelf" data-manipulating devices (i.e. Xbox or Playstation controllers) and we plan in the near future to repeat our user-tests with these devices and larger groups.

Finally, our tentative plan for future work includes further development of the VR interface to include practical pre-operative surgical rehearsal for core surgical procedures.

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An Evaluation of Prototype VR Medical Training Environment: Applied Surgical Anatomy Training for Malignant Breast Disease

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Abstract. This paper presents an enquiry into the suitability of Virtual Reality (VR) technology as the principal training method for applied surgical anatomy. In this work we present the development of a prototype VR medical training environment and the evaluation results of preliminary trials aiming to identify the effectiveness of the system in the subject domains of anatomy teaching and surgical rehearsal, whilst acknowledging current training requirements.

Keywords. Anatomy, surgery, breast cancer, tutorial, semi-immersive, HCI.

Introduction

Recent studies have suggested that VR training methods shorten learning curves [1]. In addition current changes in anatomy and surgical training demand flexible availability of teaching resources. Increasing student numbers and the pressures from a growing curriculum have resulted in a reduction of effective anatomy teaching time and the accessibility of cadaveric materials to trainees has decreased [2]. In contrast educational research highlights the importance of visualization skills in anatomy learning [3]. Hence a cost effective, on-demand solution could be offered by developing a “VR cadaver”. Contemporary attempts to train medical staff using 3D models were encouragingly positive [4, 5].

However previous studies involving 2D web applications and complex interfaces fuelled the development of a VR system emphasizing an interface that could effectively convey information to the user. Hence we developed a detailed 3D model to facilitate training. The model’s complexity is adjustable to student requirements and is easily focused on specific training goals. Additionally, utilizing haptic interaction could improve the user’s spatial awareness of complex structures [6].

The hypothesis behind this study suggests VR interfaces and holographic human body representation could convey appropriate information to the students in an accessibly interactive manner compared with available teaching resources [7].

1. Simulation Methodology

To evaluate the effectiveness of this tool we employed the VR facilities at the Digital Design Studio [8]. Our system incorporates real-time visualisation, gesture interaction with tactile feedback (CyberTouch™ glove) and is based on the Fakespace Immersive Workbench. We opted for this configuration for three reasons. i) The "Workbench's" table-projection surface resembles a surgical table. The trainees therefore experience contextual immersion. (ii) This semi-immersive system projects the 3D model into the user's space, allowing them to see themselves and other group members alongside the model. (iii) The interface is fully customizable to facilitate explicit utilities along with standard navigation. The training, evaluation and assessment materials were provided by the Royal College of Surgeons, Edinburgh. Guided by Consultant Breast surgeons we modelled a 3D representation of the torso, axilla and its contents. The nervous, venous, arterial and lymphatic systems depict accurately anatomical relationships. The detail level focused on the intercollegiate Membership of the Royal College of Surgeons (MRCS) transitional curriculum[9]. Our research focused on Human Computer Interface (HCI) and VR simulation development (Figure 1). The main objective of this activity-centered study [10] was to enhance and accelerate the assimilation of knowledge of surgical anatomy.

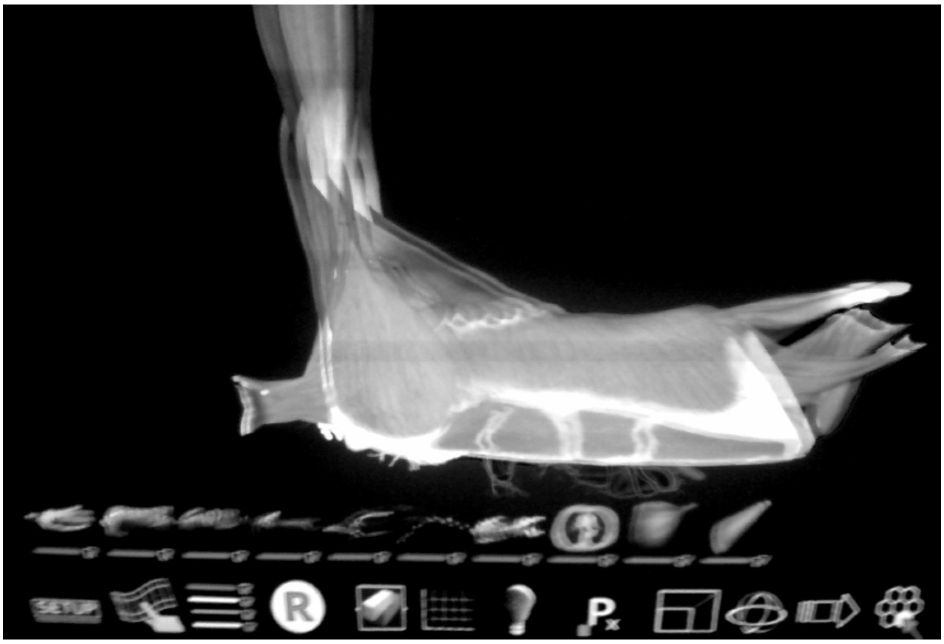

Figure 1: Screenshot from the VR interface.

2. Evaluation & Results

Twelve Postgraduate trainees (FY2) were selected and split into two arms. Both were objectively pre-assessed to ensure suitability. The first underwent a structured PBL anatomy tutorial augmented with the VR model (Figure 2). The second group took part in the same tutorial using traditional resources. The tutorials focused on applied surgical anatomy relating to malignant breast disease. Both arms completed a subjective user evaluation questionnaire and a multiple choice assessment structured to test candidates internal spatial understanding of common surgical approaches and complex anatomical relationships [11]. The subjective evaluation was an adapted Questionnaire for User Interface Questionnaire (QUIS) exploring perceived usability, engagement and value [12].

The results were processed to compare each arm against group and individual means, given standard deviations and confidence (p value 0.05). Grouped questions were compared to illuminate trainee's perceptions of their individual engagement, modified learning approach and internal 3D assimilation.

Table 1: Analysis of mean results of structured QUIS items exploring acquisition of 3D understanding.

<table>
<tr><td rowspan="2">3D Internalization</td><td>Question 1: I find I learn immediately as internal 3D model.</td></tr>
<tr><td>Question 2: I find I have to work hard to create a 3D model internally.</td></tr>
<tr><td rowspan="2">Error Recognition</td><td>Question 3: I find I recognize mistakes in my understanding easily.</td></tr>
<tr><td>Question 5: This approach makes me confident about my learning.</td></tr>
<tr><td>Communication</td><td>Question 4: I find it easy to discuss the anatomy with my facilitator.</td></tr>
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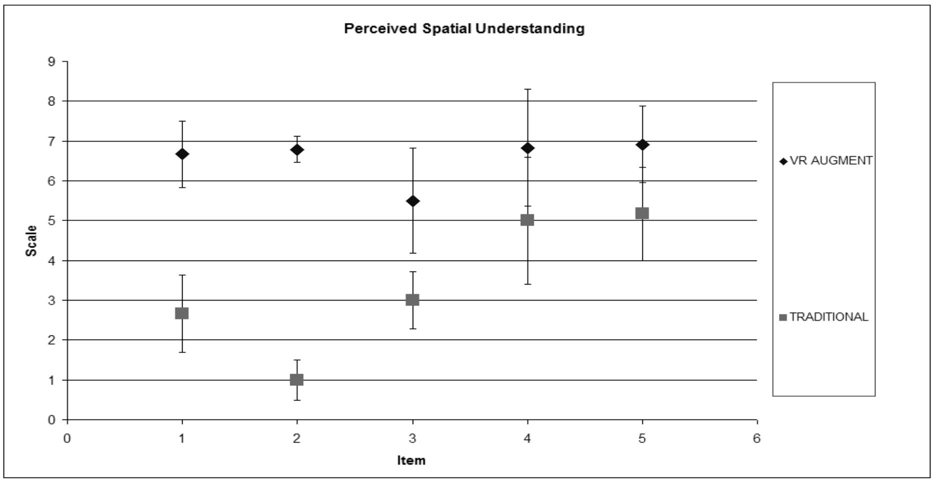

Figure 2: Analysis of mean results of structured QUIS items exploring acquisition of 3D understanding.

Figure 2 presents comparative data demonstrating whole group means attributed to items which explored spatial knowledge transfer and the facility each approach demonstrated in aiding the synthesis, appraisal and amendment of imparted anatomical relationships. Statistical analysis was limited by the small group size.

In addition item groupings demonstrated improved engagement, a reduced reliance on tutor support and higher levels of efficiency and accuracy in learning.

Significantly the VR arm showed higher scores in questions testing spatial relationships, specifically in the context of surgical approaches. However, overall results were balanced between the two approaches, with no significant difference between mean group performances. Figure 3 illustrates the mean results of MCQ questions structured to be “far”, i.e.: requiring spatial understanding rather than direct interpretation of provided resources. In turn the same figure presents the similar overall performances (VR 61.25%, Traditional Resource 60.41%) between the two groups.

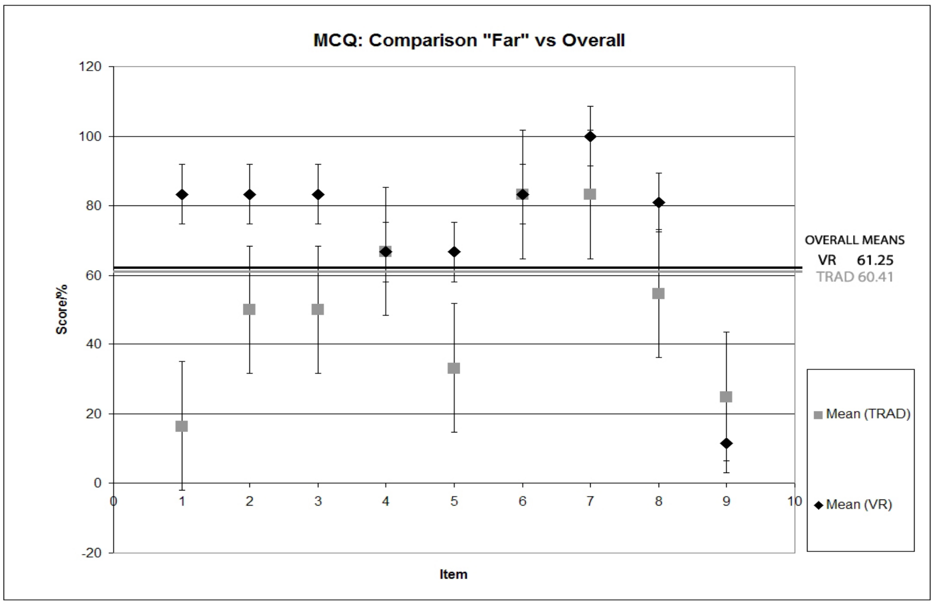

Figure 3: Mean results of “Far” MCQ items contrast with similar overall performance.

Interestingly the structured qualitative interview reinforced the positive outcomes of the MCQ “Far” results. Themes developed within the answers reflected trainee’s enhanced confidence in their anatomical knowledge when able to interact and explore the VR models during the tutorials. Additionally the exploratory attribute of the system was commented upon. This was reported to enable users to illuminate areas of weaker understanding and fill knowledge lacunae.

The interviews also revealed recurring themes relating to the user interface. User’s varied in the ease with which they were able to utilize the haptic tools, note that the specific interface was designed specifically to facilitate the preliminary investigation and it is our intention to incorporate users’ feedback into future versions.

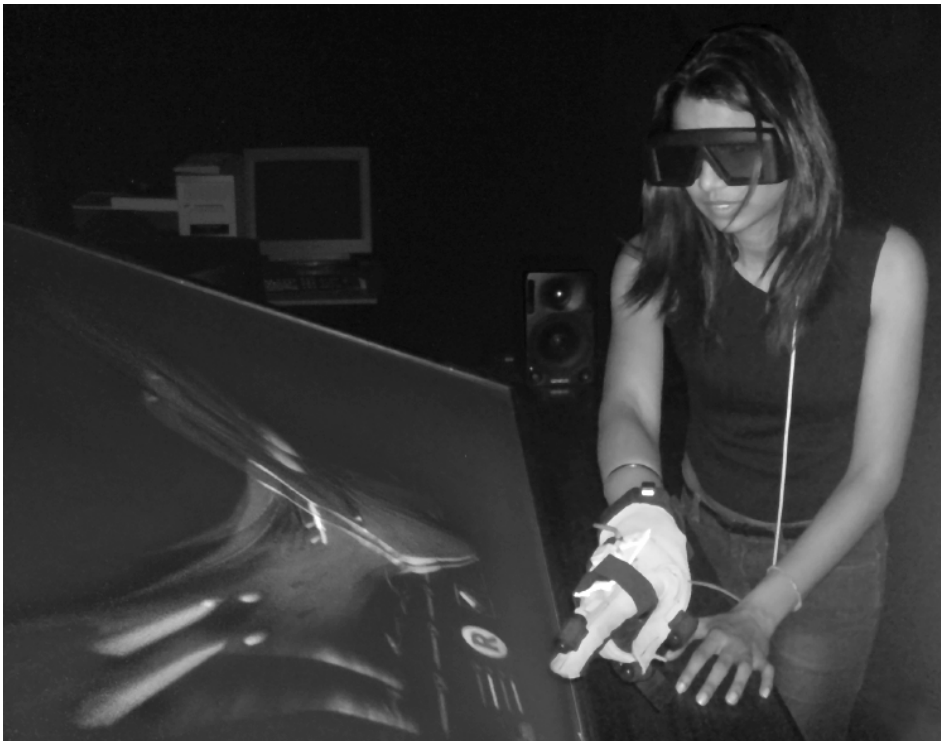

Figure 4: Surgical Trainee during the VR system evaluation.

3. Conclusions

In this paper, we described the design and development considerations of a VR environment specifically designed to integrate with current activity-based tutorials. The results were encouraging and suggest an enhanced synthesis of a spatial anatomical model by augmentation with VR.

However this preliminary inquiry highlighted practical considerations specific to validation for surgical education. This primary evaluation was encouraging but statistically limited by its small subject group. It is our intention to develop further the aforementioned system and improve portability in order to conduct larger studies.

From our experience in performing this study alongside an examination of current literature it seems clear that further work is required to create an empirical evidence base. This combined with the development of practical applications is required in order to bring VR into mainstream surgical education.

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Surgical VR Training Environments:

An Inquiry into the application and validation of Volumetric 3D anatomy tutorials for operative surgical training.

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I. BACKGROUND

An inquiry into the methodology, implementation and evaluation of Virtual Reality (VR) augmented educational tactics applied to operative surgical training. Studies suggest structured VR training shortens the learning curve. Current surgical trainees experience reduced operative exposure exacerbated by depleted undergraduate anatomy teaching. It is hypothesised that surgically focused 3D stereoscopic anatomical models partnered with structured operative curricula could optimize training outcomes from operational exposure.

II. METHODS

We focused on axillary procedures for locally advanced breast neoplasia. We developed a practical methodology for 3D modelling using a specialist surgeon/ anatomist/ 3D modeller team. We modelled a high fidelity 3D representation of the axilla and developed an activity based curriculum. The particular focus was operative anatomy, procedural approaches and applied management principles. A semi-immersive VR interface was designed to facilitate information transfer. This approach was intended as a visual rehearsal and 'schema activator' for use prior to operative sessions. We selected 12 FY2 doctors with a surgical interest and divided them into two arms. We conducted a comparative study of the augmented VR approach and non VR 'traditional' approaches. Both arms were pre-assessed, exposed to the teaching and debriefed using structured MCQs which examined 3D understanding of spatial anatomical relationships and surgical approaches. Subjective user evaluation questionnaires were also completed.

III. RESULTS

The results indicated VR augmentation encouraged engagement, improved understanding of spatial relationships and increased MCQ scores testing spatial understanding and surgical approaches.

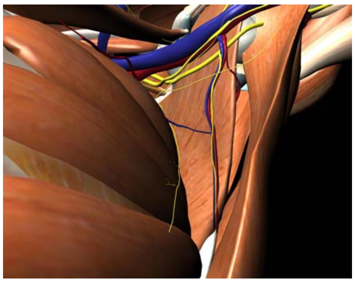
IV. CONCLUSIONS

These initial results are promising and indicate the potential value of further work in this area.

VR	Virtual Reality	FY2	Foundation year two Doctors in training
MCQ	Multiple choice question	3D	Three Dimensional

Surgical Education: A Brief Enquiry into Applied Virtual Anatomy

'Can Virtual Reality Augment Postgraduate Anatomy Teaching?'



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I. BACKGROUND

This paper presents an inquiry into Virtual Reality (VR) training environments and their application in early postgraduate anatomy teaching. There is great interest in the use of VR applications, but there has been little practical application in the UK. In this inquiry we set out to explore anatomy education and the potential role of VR in the postgraduate setting.

In 1993, the UK General Medical Council published Tomorrow's Doctors leading to a nationwide restructuring of undergraduate medical courses. Traditional courses with distinct pre-clinical and clinical phases gave way to a more integrated approach to undergraduate medical education, with an emphasis on the quality and variety of teaching provided. Universally increased student numbers and internal pressures from a growing undergraduate curriculum resulted in a significant reduction in undergraduate anatomy teaching and reduced student's exposure to human cadavers[1]. The effect on the anatomical competencies of doctors graduating these new courses has stimulated concerned debate throughout the UK[2].

Now, more than a decade after Tomorrow's Doctors, postgraduate medical training is being transformed. Modernising Medical Careers has created the two-year Foundation Programme, with early selection to streamlined specialist training. The effect of these changes has driven new interest in educational approaches to anatomical training as it becomes a specialist postgraduate subject[3].

The changes in the emphasis from anatomy as an undergraduate to post-graduate discipline may be reflected by the anatomical knowledge of Foundation Year (FY) doctors. The early postgraduate programme is developed in accordance with the Department of Health's document 'The Curriculum for the foundation years in postgraduate education and training[4]. Interestingly education in anatomy is mentioned only as an opportunist outcome of experiential learning. In stark contrast the current Part A of the transitional intercollegiate MRCS examination retains an emphasis on applied surgical anatomy[5].

Recent studies have suggested that Virtual Reality (VR) training methods shorten learning curves [6]. Recent research indicates Virtual Reality (VR) interfaces and holographic human body representation could convey appropriate information to the students in an accessibly interactive manner compared with available teaching resources [7]. Contemporary attempts to train medical staff using 3D models were encouragingly positive[8,9].

We developed a detailed 3D model to facilitate current training. The model's complexity is adjustable to student requirements and easily focused on specific training goals. Additionally, utilizing haptic interaction could improve the user's spatial awareness of complex structures [10].

This study suggests aimed to answer three main research questions:

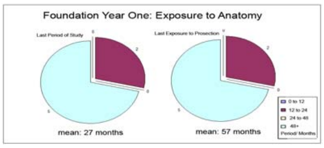
I. What do current Scottish FY doctors think about their anatomical knowledge?
II. What anatomical resources are available to current Scottish FY doctors?
III. Can Volumetric VR augment existing resources available to current FY doctors?

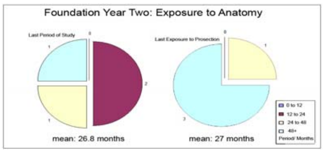
II. METHODS

Informed by current training requirements we designed an anatomically precise model to augment applied anatomy teaching[11]. In turn we developed a VR test-bed specifically for existing problem-based teaching formats. Twelve Scottish FY Doctors, 6 male, 6 female, were selected randomly from a volunteer group. The group represented FY doctor's with an interest in either radiology or surgery. They completed a structured questionnaire using a nine point Likert scale and a series of open questions. These explored their anatomical training, perceived knowledge, attainment of exams and attitudes and concerns. Internal consistency was confirmed using Cronbach's alpha. Demographic data was also collected. The group also took part in a semi-immersive VR tutorial and were debriefed by a second questionnaire using a similar mixed method.

III. RESULTS

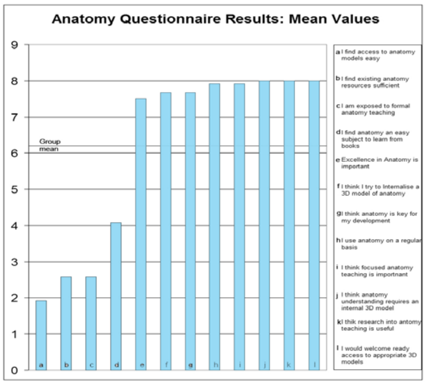
The results reveal concerns that current FY doctors have little recent exposure to anatomical teaching, in particular cadaveric pro-section. For both FY1 and FY2 doctors the mean period since anatomy teaching was 28 months. The mean period since viewing pro-section was 57 months for FY1 and 27 for FY2. This value was explained by the open questions, which revealed that the doctors that had undertaken their collegiate membership examinations (FY1: 15%, FY2: 75%) had arranged private anatomical revision through their graduating university in the preceding 12 months. It is clear that among those who had not arranged teaching, the mean period since exposure to cadveric material in excess of 48 months.





Also clear was that current resources were insufficient for postgraduate demands. The statistical analysis was limited due to the small sample size, however the internal consistency of the results was high (0.81). The results indicated FY doctors were concerned at the lack of accessible anatomical teaching, with questions about access to anatomy teaching and resources scoring the most poorly. In comparison the doctors felt most strongly that anatomy knowledge was central to their professional development, focused anatomy teaching was important and that anatomy required the development of an internal 3D model which was difficult using text books and 2D images.

The debriefing also demonstrated an engagement with



VR, the highest scoring questions exploring engagement, understanding of spatial relationships and increased engagement through inter-action. High scoring questions regarding the VR application indicated respondents found it an efficient way to learn and even indicated that it compared favorably with pro-section.

The open questionnaire revealed several themes.

Respondents indicated that they found it difficult to study from 2D images with confidence, as it could lead to mistakes in understanding. Respondents felt that the accessibility of a 3D cadaver via VR was major advantage. Respondents also indicated that the major barrier to learning via VR was the interface, and several indicated that head-tracking and the haptic glove was an unnecessary feature. The open questions also suggested that for tutorials a 'virtual pointer' for use by the tutor would be a useful addition and that using a less bulky, higher resolution screen (e.g.: LCD vs. Projection) would be appropriate.

IV. CONCLUSIONS

This enquiry illuminates the educational gap formed between 'core' undergraduate anatomy and current postgraduate requirements. It is suggested that current postgraduates find 'dry' anatomy resources sub-optimal and human pro-section in the main inaccessible. Interestingly the new generation of doctors find VR anatomy engaging and approachable, but there remains a deficit in the intuitiveness of the human computer interface. There is a lack of empirical research into the educational benefits of volumetric VR in anatomical teaching and learning. This study indicates a place for volumetric anatomy and the continuation of research in this area.

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Augmented Reality Anatomy Training for Inguinal Canal Region

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ABSTRACT

The proliferation of three-dimensional and augmented reality representations offers significant advantages for the accumulation of spatial knowledge regarding human complex structures. Interestingly the interpretation of complex applied medical sciences often requires a strong grasp of the 3D anatomy to which it relates. In practice the obstacle to learning is compounded when procedural techniques and specialist anatomy are effectively taught simultaneously. However it has been shown that learning can be augmented by the use of high resolution 3D models and intuitive human-computer interaction.

In particular this study investigates the structural complexity of the human anatomy with emphasis to the inguinal canal region. Notably this section was highlighted as one of the most difficult for the undergraduate and foundation doctors to mentally visualise and understand. We contrasted the opinions of consultant surgeons and trainee doctors in order to identify the potentials and pitfalls of a VR explanatory model of the inguinal canal in facilitating for surgical anatomical knowledge.

The inguinal canal was of particular interest due to the sequential complexity of the abdominal layers that are exceptionally difficult to comprehend spatially. Therefore we modelled a high fidelity 3D representation of the inguinal canal in anatomical context facilitated by the close collaboration of a multidisciplinary group. This included anatomists, radiologists, laparoscopic surgeons, and human visualisation and interaction experts. In turn we developed an activity-based curriculum, which standardised the augmented teaching and allowed us to evaluate the perceptions of 10 trainee doctors. Feedback from the laparoscopic surgeons was also derived in order to contrast it with the expectations and results of the trainees and their performance using the VR system.

Overall this paper explores the empirical evidence regarding 3D visualisation and the enhancement of spatial learning and describes the integration of robust anatomical modelling techniques, intuitive human-computer interfaces and current educational theory.

Medical Visualisation, Augmented Reality and Anatomy Training: An Intuitive Approach of Visual Arts and Medicine

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ABSTRACT

Medical visualisation has been an active area of research worldwide over the last two decades. Only recently, however, has technology reached a level of maturity and cost/performance ratio that makes its deployment feasible on a large scale. In addition to providing scope to explore research in medical education, this opens a window of opportunity for ground-breaking research and product development that combines the underlying core technology with user-led know-how to deliver the solutions that today's trainees demand.

This paper presents a study into augmented-reality training environments and their application in postgraduate anatomy teaching and medical rehearsal. Interestingly, previous studies suggested that the interpretation of complex medical sciences often requires a strong grasp of the related 3D anatomy. Furthermore there is great interest expressed in the use of 3D applications, yet there has been little strategic application at the national level.
To this end this paper elaborates a multidisciplinary attempt to explore anatomy education and the potential role of augmented reality in the medical sector. Our endeavour has focused primarily on five case studies exploring current approaches augmented with 3D visualisation and prototype human-computer interfaces. Notably the augmented reality and 3D visual representations do not intent to replace the existing teaching methods but to enhance them though a complementary approach. These tools have particular relevance in modern medical training where procedural techniques and specialist anatomy are effectively taught simultaneously in pressured clinical environments.

Overall this paper elaborates the potential merging of various design, engineering and medical disciplines aiming to facilitate human anatomy understanding in training and surgical rehearsal. Early results suggest that the integration of robust anatomical modelling techniques, intuitive human-computer interfaces and current educational theory working synergistically can improve learning outcomes. Finally the paper offers a tentative plan of future work, which will focus in the development of a standardised, reproducible, and robust platform for further training applications.

Abstract - Paper accepted for UK Radiological Congress (UKRC 2008), Birmingham, UK

Enhanced 3D Visualization: Augmenting Musculoskeletal Ultrasound Training

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KEY LEARNING OBJECTIVES

Specialist medical education is changing to reflect current trainee's needs. Detailed anatomy is becoming a post-graduate subject and increasingly doctors must learn anatomy as part of their early specialist training [1]. Interpreting complex 3D subject matter often requires a strong grasp of the 3D anatomy to which it relates. This is compounded when procedural techniques and specialist anatomy are effectively taught simultaneously. However it has been shown that anatomy learning can be augmented by the use of high resolution 3D models [2]. To this end we developed a resource facilitating training in musculoskeletal ultrasound imaging of the foot and ankle. This application had the specific objective of integrating the teaching of specialist 3D anatomy with clinical procedure and image interpretation.

DESCRIPTION

We employed a visualization methodology that allowed real time interlinking between a low latency rotational 3D anatomical model, visual descriptors of ultrasound technique (positioning, movement, field) and clinical ultrasound images. Notably the system was designed to synchronously augment current clinical training or to be self-led and asynchronous. It was designed to convey the anatomy to a multi-disciplinary audience. The approach capitalises on current educational theory and enhances the current approaches by utilising advanced visualisation with an emphasis on practical and intuitive interfaces [3].

CONCLUSION

This paper explores the empirical evidence regarding 3D visualisation and the enhancement of spatial learning and describes the integration of robust anatomical modelling techniques, intuitive human computer interface and current educational theory. [4].

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Abstract - Paper accepted for UK Radiological Congress (UKRC 2008), Birmingham, UK

International Conference of Medicine Meets Virtual Reality 16th, Long Beach, California, USA. / in Stud Health Technol Inform (2008)

Abstract - Paper accepted for UK Radiological Congress (UKRC 2008), Birmingham, UK

Interpreting Lung Collapse:

A randomised controlled study into the impact of three-dimensional animation

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PURPOSE

The use of computer-generated anatomical models has become widespread in anatomy teaching. Several randomized controlled studies have shown positive learning outcomes in basic undergraduate anatomy. Recent studies have suggested Virtual Reality has a role in shortening the learning curve in postgraduate medical training. Correct interpretation of radiological images often relies upon a three dimensional (3D) internal understanding of anatomy, but little is know about the potential role of enhanced visualization in radiological training. To this end we have designed a randomized controlled study exploring trainee's radiological interpretation of lung collapse, anatomical knowledge and visual-spatial ability.

MATERIALS/ METHODS

We designed a 3D animation series demonstrating the range of lobar collapse. In addition we developed an integrated computer-based educational package bringing together plain film, CT data and traditional schematic diagrams. 20 current radiology trainees at a deanery study day will be randomized into two equal groups, one tutorial group given additional access to the 3D animation resource. Both arms are timed, pre-assessed for knowledge, prior experience, visual-spatial skills and then debriefed by identical MCQ and qualitative survey instruments integrated with the educational package.

RESULTS/ DISCUSSION

The results will be collected (using Questionmark-Perception) and the mean scores compared with a 2-tailed Student's t-test (SPSS). We will use similar methods to analyse the visual-spatial data and in addition utilise chi-squared tests to ensure the groups are comparable. The qualitative analysis includes a Likert questionnaire analyzed for internal consistency (Cronbach's alpha) and thematic analysis of several open questions. The results are explored in relation to recent publications and the scope for further investment in terms of education provision and research.

Literature Review

Medical visualisation today is a vast field of active research and development. The following state of the art review identifies the relevant key players and how the Scottish Medical Visualisation Network expands upon their previous work. The identified key areas include advanced visualisation, simulation and e-education.

Advanced Visualisation

The field of advanced medical visualisation is concerned with creating imagery from raw medical data. Research ranges from the extraction of features from sensor data (e.g. volume visualisation of scans) to novel rendering algorithms for complex three-dimensional data sets. Various research groups focus on advanced visualisation, most of them coming from a computer science and visualisation or signal processing background.

Previous studies strongly suggested that teaching anatomy and surgical rehearsal can be significantly improved using advanced visualisation technologies (Pandey and Zimitat, 2007). Furthermore, the combination with appropriate haptic interaction enables the user to interact freely with a volumetric 3D model, selecting their own number of infinite viewpoints, a factor suggested to be central to spatial anatomical understanding (Nicolson and Chalk, 2006). In addition the importance of facilitating a balanced learning approach including visualisation skills and spatial awareness has been highlighted (Pandey and Zimitat, 2007; Garg et. al. 2001).

Yaoping Hu et. al., (2005), from University of Calgary, Canada, observed that 3D displays of lung cavities are feasible and have distinctive advantages over two-dimensional views by decreasing the workload by about 50%, reducing planning time by about 30%, and increasing the accuracy of predicted re-sectionability by about 20%. These results clearly advocate benefits for employing 3D displays in surgical treatment of lung cancer. To this end, TU Delft has focused on developing new techniques for pre-operative planning and intra-operative guidance, clinical diagnosis and medical research (Blaas et. al. 2007).

Simulation

Surgical simulation typically follows the visualisation process and is currently a very active research area. The field extends upon visualisation by introducing behavioural simulation into the previously static data sets.

Exceptional studies and projects are under development in several departments such as CAVI (Center for Advanced Visualisation and Interaction), University of Aarhus, Denmark with special interest in VR simulation of difficult surgical operations (Sørensen et. al., 2003; Mosegard and Sørensen, 2005). This research group seeks to present a virtual environment where surgeons can train surgical procedures. Their research has focused on the development of faster calculation of deformation and visualisation, with emphasis to simulate very complex morphology in real-time.

A step further is the joint research of the MIT Artificial Intelligence lab, and Surgical Planning Laboratory of Brigham and Women's Hospital which produced a series of projects aiming to enhance reality visualisation of internal anatomical structures overlaid on live video imagery of patients; hence allowing simulation and navigation by the surgeon in virtual surgical rehearsal in real time (MIT, 2005).

Although this might be a future target to achieve for the Scottish Medical Visualisation Network, it still stands as a strong indication of the contemporary and future trends and needs. Finally such partnerships between academic institutions and medical facilities can be achieved solely by close collaborations between multidisciplinary groups.

e-Education

The method of e-Education has lately been adapted by universities across the world as it offers time-flexible training, effortless repetition of tutorials and minimises the space constrains of a classroom (Brenton et. al., 2007). A direct application is the Primal Picture website which is probably the most detailed database for human anatomy teaching. The visualisation of their anatomy examples is derived primarily from CT and MRI scans which were further used to produce highly detailed anatomical structures.

These visual cues are complemented by a succinct document which describes the anatomical details, position and pathology of each section of the human body. However the complexity of the 3D models can often be quite difficult for a student to perceive and accumulate. Furthermore the manipulation of the 3D data is based on a single rotation pattern which does not allow the user to investigate complex structures from multiple points of view.

Similarly ContMedia has developed a human anatomy DVD which includes teaching material in the forms of human anatomy, physiology, anatomy atlas and medical dictionary. However the majority of these products lack intuitive interfaces and visualisation quality, although they can serve the purpose of an introductory course in anatomy.

Typical book-related anatomy material offered a digital format leaning towards an e-Education model which could be physically smaller to store and handle. In particular, Gray's Anatomy 39th edition offers a medical images database which correlates directly with the book's documents and printed images. Still, the images are based in 2D representations, photos or depictions of anatomical structures and do not reflect the spatial relation of the real three dimensional body members.

Towards this educational approach Harvard University Medical School developed the Human Systems Explorer, which is effectively a web-based application that investigates through 2D visualisation complex human anatomy and pathology issues. This software acts as an interactive teaching tool designed to clarify difficult concepts in pathophysiology and examines how the new technology can be used effectively to aid students in the classroom and beyond (Harvard, 2007).

The Scottish Model

Medical Visualisation is an inherently interdisciplinary field. Most initiatives therefore include a range of expertise, typically including medical research or teaching, imaging and sensor technology, computer graphics and visualisation, and human-computer interaction. Most of the networks are research-driven, aimed at generating new technologies and knowledge. The Scottish Medical Visualisation Network takes a different approach in that it is application-driven, aiming to bring visualisation technology into the field.

The Scottish collaboration of different disciplines presented a plethora of case studies that were varying in importance and complexity for each medical specialty. Due to time and cost limitations, five case studies were selected for an initial stage development. The material produced has since been directly transferred into medical lectures with encouraging response from the medical students.

The prototype interfaces developed for the case studies and the advanced visualisation techniques were tested in comparative studies between different Foundation Year Doctors' (FYs) groups. The methodologies employed and the results were peered reviewed and presented in six International and British conferences, providing further proof of the effectiveness of this application-orientated technology.

The Scottish Medical Visualisation Network therefore has a role to play in advanced visualisation surgical simulation and e-education research. The Network is unique in that it is user and applications led giving Scotland an advantage in the international field and the potential to be a world leader in medical visualisation.

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First Workshop - 29th May 2007

Workshop Invitation

Agenda

Welcome - Professor Paul Anderson, Director, Digital Design Studio, Glasgow School of Art

Anatomy Reconsttucted - Professor Ian Parkin, Ninewells Hospital, Dundee

Surgical Rehearsal - Mr Bill McKerrow, Consultant ENT Surgeon, Raigmore Hospital, Inverness

Medical Visualisation - Dr. John Reid, Consultant Radiologist, Borders Genral Hospital, Melrose

Visualisation for Medical Education - Dr Ben Ward, The Royal College of Surgeons of Edinburgh

MEDICAL VISUALISATION WORKSHOP

29th May 2007

"Bringing together academics, clinicians, practitioners, scientists and medical and technical visualisation specialists"

About the workshop:

Contemporary advances in medical 3D visualisation are enabling medical practitioners to view and interact with human body without the need or reliance on the use of physical body.

This workshop is intended to spark debate and reflection on the needs and issues stemming from medical education and surgical rehearsal and explore how visualisation technology can be used to support present and future medical staff.

Who should attend:

Medical practitioners, medical educators, bioengineers, researchers from an academic or clinical background, visualisation experts.

Location:

Digital Design Studio,
House for an Art Lover,
Bellahouston Park,
10 Dumbreck Road
Glasgow, Scotland,
G41 5BW

Workshop Coordinator
Vassilis Charissis
Tel: 0141 353 4616
Email: v.charissis@gsa.ac.uk

Digital Design Studio The Glasgow School of Art

Scottish Funding Council

MEDICAL VISUALISATION WORKSHOP

PROGRAMME 29th May 2007

- 10.30-10.45 Welcome Coffee & Tea

- 10.45-12.15 Presentations

Introduction
Prof. Paul Anderson Director of Digital Design Studio

Contemporary Anatomy Issues
Prof. Ian Parkin, chair of Applied Clinical Anatomy, University of Dundee

Surgical Rehearsal
William McKerrow, Consultant ENT Surgeon, Raigmore Hospital Inverness

Medical Visualisation
Reid, John H DMRD FRCR, Consultant Radiologist, Department of Radiology Borders General Hospital

Educational Medical Visualisation
Ben M. Ward, Royal College of Surgeons of Edinburgh

- 12.15-13.00 Lunch Break

- 13.00-13.45 Medical Visualisation Demonstrations

Large projection Area – Hydra room

Virtual Reality Facility and Haptic Interaction – AutoEval

Virtual Reality Facility and Investigation of human organs - Sci-Fi

- 13:45-15:45 Discussion session

Potential Case Studies

Collaborations & Funding Opportunities

Planning for future

- 15:45 –16:00 Conclusions

DIGITAL DESIGN STUDIO THE GLASGOW SCHOOL OF ART

Scottish Funding Council

Programme

10:30 – 10:45 Welcome Coffee & Tea

10:45 – 12:15 Presentations

Introduction
Prof Paul Anderson, Director of Digital Design Studio

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Planning for the Future

15:45 – 16:00 Conclusions

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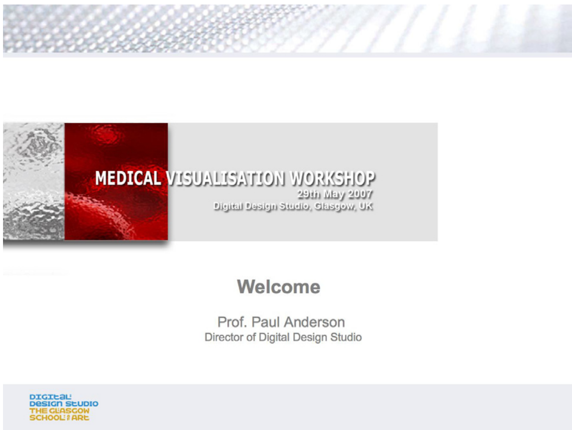
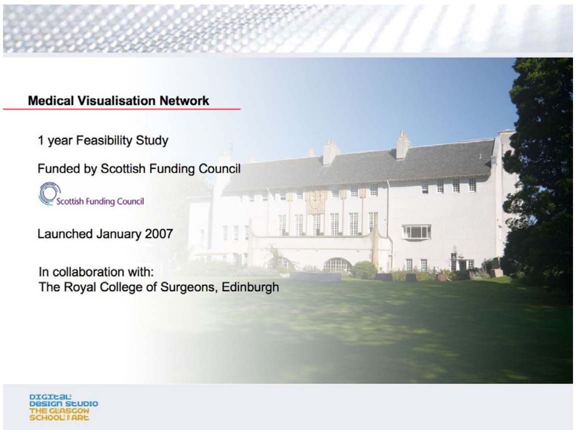
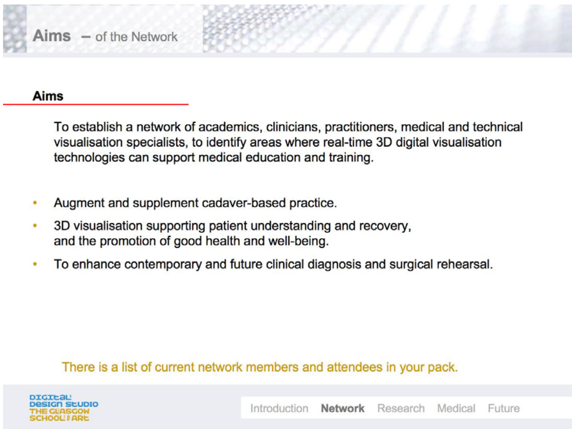
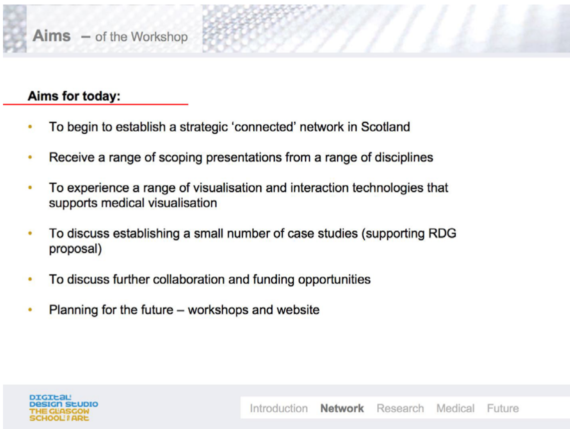
Scottish Funding Council
Promoting further and higher education


MEDICAL VISUALISATION WORKSHOP
29th May 2007
Digital Design Studio, Glasgow, UK
Welcome
Prof. Paul Anderson
Director of Digital Design Studio


Medical Visualisation Network
1 year Feasibility Study
Funded by Scottish Funding Council
Scottish Funding Council
Launched January 2007
In collaboration with:
The Royal College of Surgeons, Edinburgh


Aims – of the Network
Aims
To establish a network of academics, clinicians, practitioners, medical and technical visualisation specialists, to identify areas where real-time 3D digital visualisation technologies can support medical education and training.
• Augment and supplement cadaver-based practice.
• 3D visualisation supporting patient understanding and recovery, and the promotion of good health and well-being.
• To enhance contemporary and future clinical diagnosis and surgical rehearsal.
There is a list of current network members and attendees in your pack.
Introduction Network Research Medical Future


Aims – of the Workshop
Aims for today:
• To begin to establish a strategic 'connected' network in Scotland
• Receive a range of scoping presentations from a range of disciplines
• To experience a range of visualisation and interaction technologies that supports medical visualisation
• To discuss establishing a small number of case studies (supporting RDG proposal)
• To discuss further collaboration and funding opportunities
• Planning for the future – workshops and website
Introduction Network Research Medical Future


Timetable – of the Workshop
Timetable
10.45-12.15 Presentations
12.15-13.00 Lunch
13.00-14.00 Medical Visualisation Demonstrations
14.00-14.15 Coffee
14.15-15.45 Discussion Session
15.45-16.00 Conclusions
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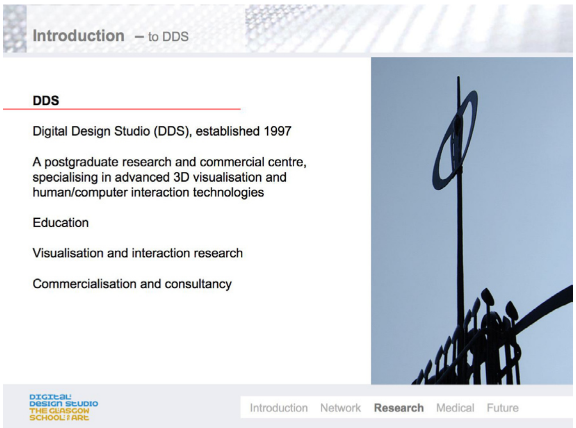
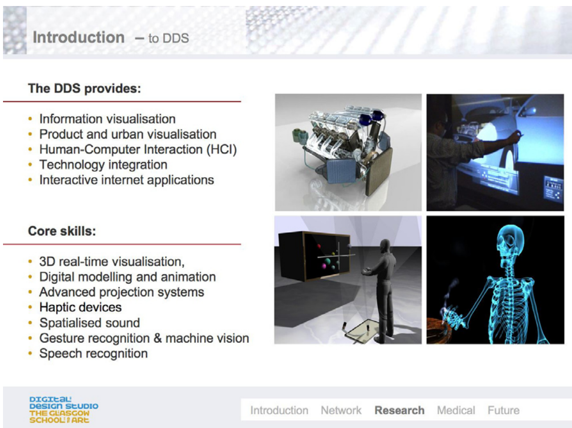
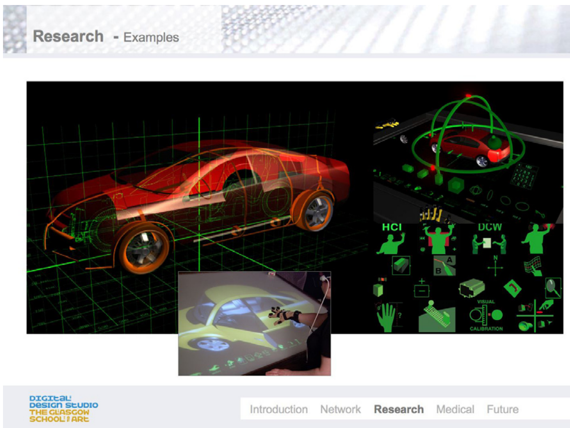
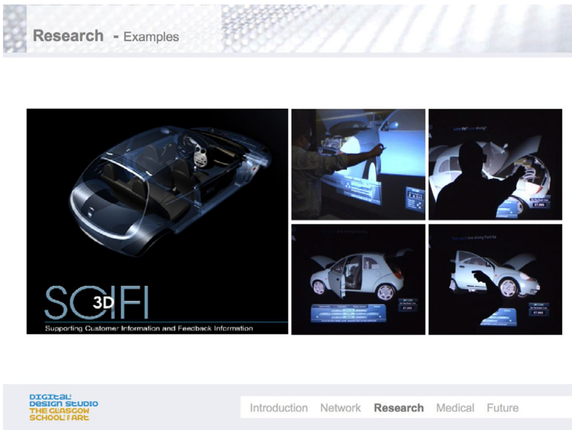
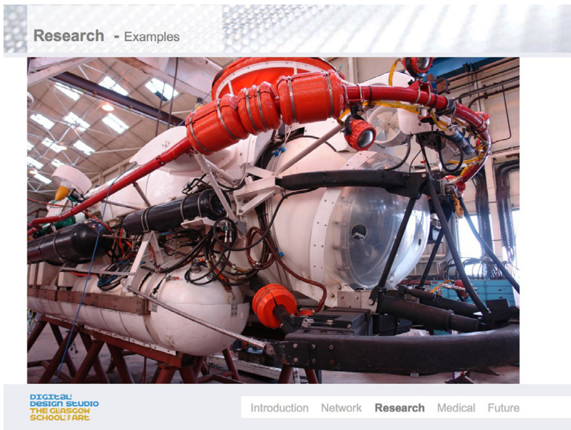
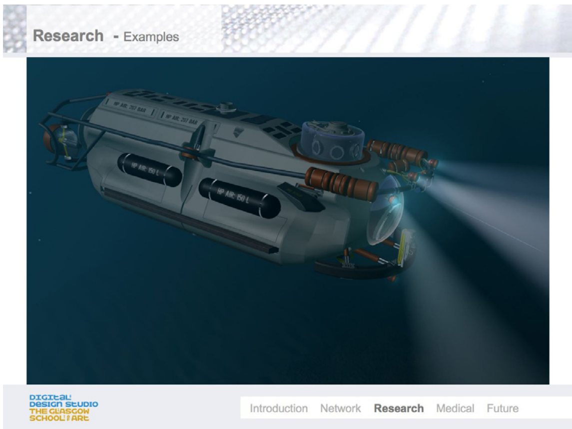

Introduction – to DDS
DDS
Digital Design Studio (DDS), established 1997
A postgraduate research and commercial centre, specialising in advanced 3D visualisation and human/computer interaction technologies
Education
Visualisation and interaction research
Commercialisation and consultancy
Introduction Network Research Medical Future


Introduction – to DDS
The DDS provides:
• Information visualisation
• Product and urban visualisation
• Human-Computer Interaction (HCI)
• Technology integration
• Interactive internet applications
Core skills:
• 3D real-time visualisation,
• Digital modelling and animation
• Advanced projection systems
• Haptic devices
• Spatialised sound
• Gesture recognition & machine vision
• Speech recognition
Introduction Network Research Medical Future


Research - Examples
HCI
DCW
Introduction Network Research Medical Future


Research - Examples
SCIFI 3D
Supporting Customer Information and Feedback Information
Introduction Network Research Medical Future


Research - Examples
Introduction Network Research Medical Future


Research - Examples
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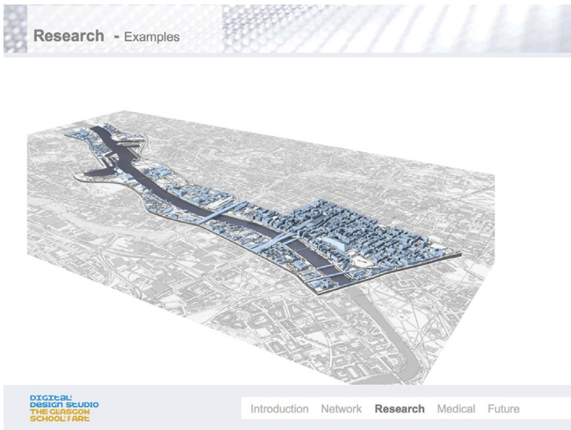
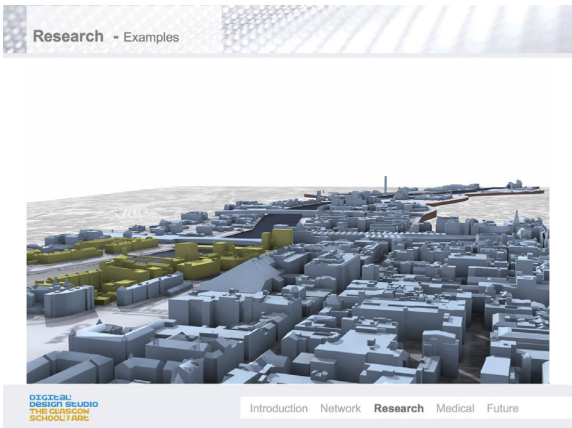
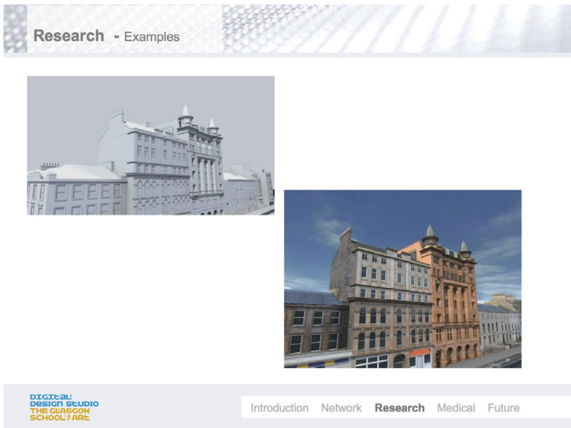

Research - Examples
Introduction Network Research Medical Future


Research - Examples
Introduction Network Research Medical Future


Research - Examples
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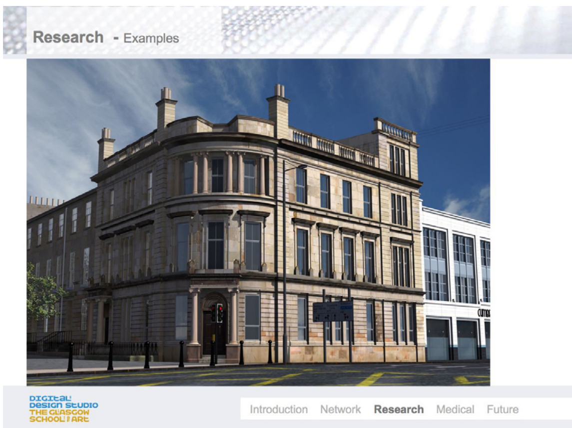
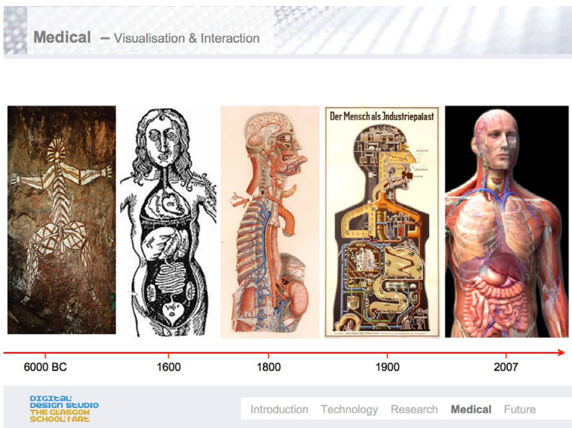

Research - Examples
Introduction Network Research Medical Future


Medical – Visualisation & Interaction
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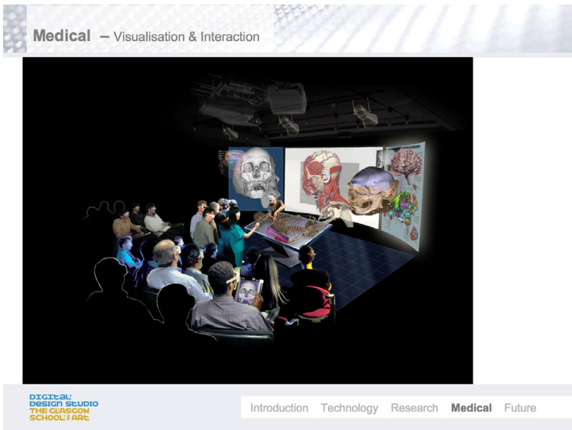
Introduction Technology Research Medical Future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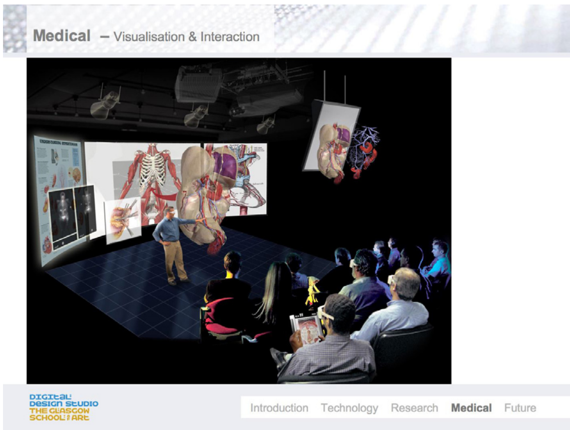
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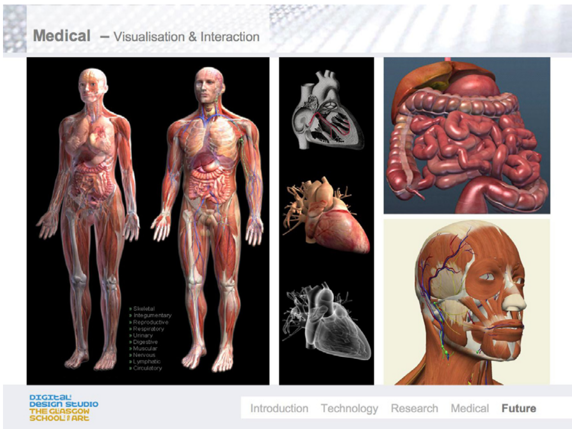
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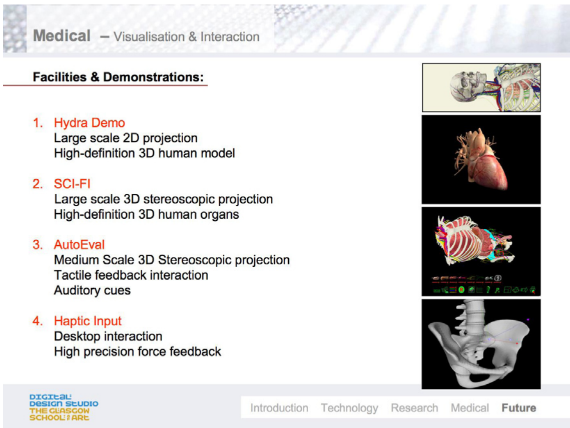
Medical – Visualisation & Interaction
Facilities & Demonstrations:
1. Hydra Demo
Large scale 2D projection
High-definition 3D human model
2. SCI-FI
Large scale 3D stereoscopic projection
High-definition 3D human organs
3. AutoEval
Medium Scale 3D Stereoscopic projection
Tactile feedback interaction
Auditory cues
4. Haptic Input
Desktop interaction
High precision force feedback
DIGITAL DESIGN STUDIO
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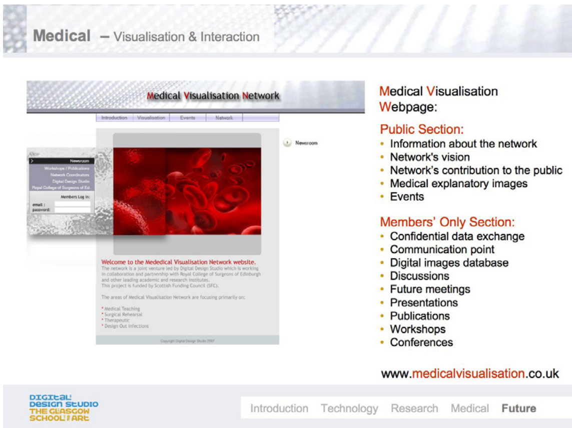

Medical – Visualisation & Interaction
Medical Visualisation Network
Medical Visualisation
Webpage:
Public Section:
• Information about the network
• Network's vision
• Network's contribution to the public
• Medical explanatory images
• Events
Members' Only Section:
• Confidential data exchange
• Communication point
• Digital images database
• Discussions
• Future meetings
• Presentations
• Publications
• Workshops
• Conferences
www.medicalvisualisation.co.uk
DIGITAL DESIGN STUDIO
THE GLASGOW SCHOOL OF ART
Introduction Technology Research Medical Future

Anatomy Reconstructed

Anatomy

How it all fits together

How it all works

Anatomy: Digital Design Workshop May 07

Anatomy Reconstructed

Anatomy

How it all fits together

How it all works

What could be easier?

Anatomy: Digital Design Workshop May 07

Cadaver

3-D

Active learning

(dissection/pro-section)

Position and relationships for examination, surgical approach and tumour spread

Anatomy: Digital Design Workshop May 07

But if the cadaver is not available:

Reconstruct to offer the same 3-D, active, spatial learning

Anatomy: Digital Design Workshop May 07

Joints: movement

(heart, lungs, intestine, blood flow, nerve conduction)

Procedures

Anatomy: Digital Design Workshop May 07

Joints: movement

(heart, lungs, intestine, blood flow, nerve conduction)

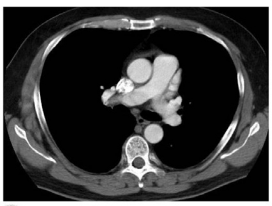
Procedures

Simulate:

Function, movement

Clinical procedure or surgical approach

Anatomy: Digital Design Workshop May 07



Sectional Anatomy

Relate cadaver to clinical investigation

i.e. add "life"

Keep abreast of advancing diagnostic technology

(digital reconstruction is here)

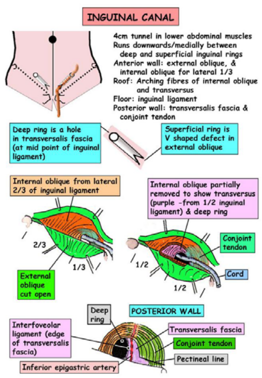
Anatomy: Digital Design Workshop May 07

Difficult Concepts:

Impossible (almost) with embalmed cadavers

Inguinal canal

Hernias



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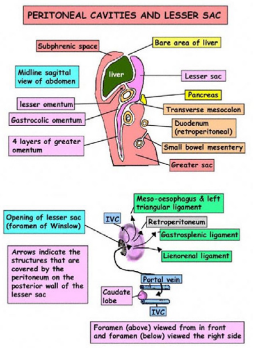
Lesser sac



Anatomy: Digital Design Workshop May 07

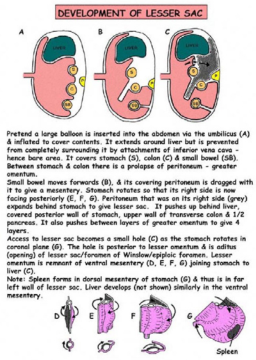
Think in 3-D

Moving

Translation from embryology to adult

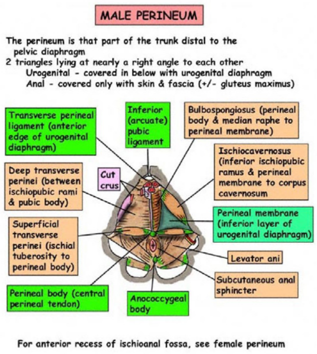
Potential spaces

(are exactly that, but clinically important)



Anatomy: Digital Design Workshop May 07

Perineum



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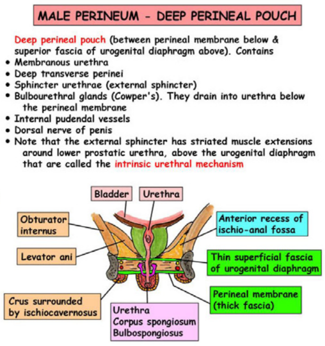
Perineum

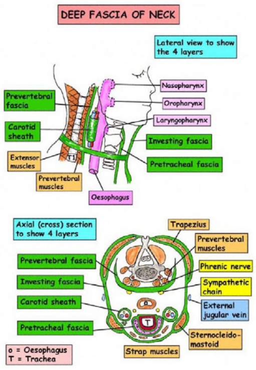
View from different angles to understand

Alteration with posture, age and clinical condition



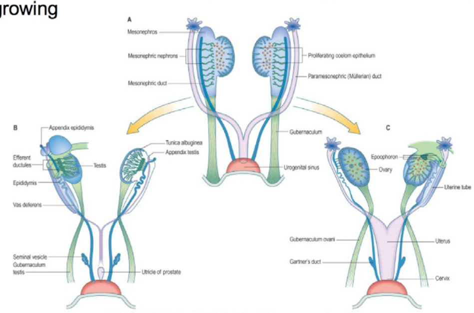
Anatomy: Digital Design Workshop May 07

Fascia and fascial spaces of neck and thorax



Anatomy: Digital Design Workshop May 07

Embryological 3-D development, moving and differentially growing



Anatomy: Digital Design Workshop May 07

Anatomy Reconstructed

- Reconstruct to offer the same 3-D, active, spatial learning
- Simulate: function, movement; clinical procedure or surgical approach
- Add "life" and keep abreast of technology
- Difficult concepts: not visible on cadaver; 3-D; moving with development, posture and age
- Inguinal region; peritoneum and lesser sac; perineum; potential spaces
- Embryology (similar issues): watch A become B or C

Anatomy: Digital Design Workshop May 07

Anatomy Reconstructed

Add insight and understanding to promote learning, and safe clinical practice

Illustrations courtesy of: University of Dundee; University of Cambridge; R.H. Whitaker; Gray's Anatomy, Elsevier

Thank you

Anatomy: Digital Design Workshop May 07

Surgical Rehearsal

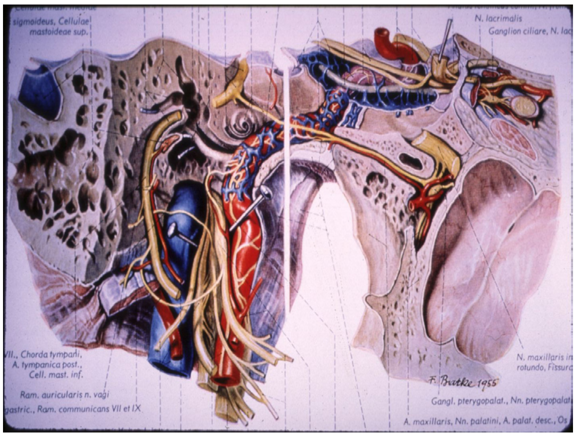
Bill McKerrow
Consultant ENT Surgeon
Raigmore Hospital, Inverness

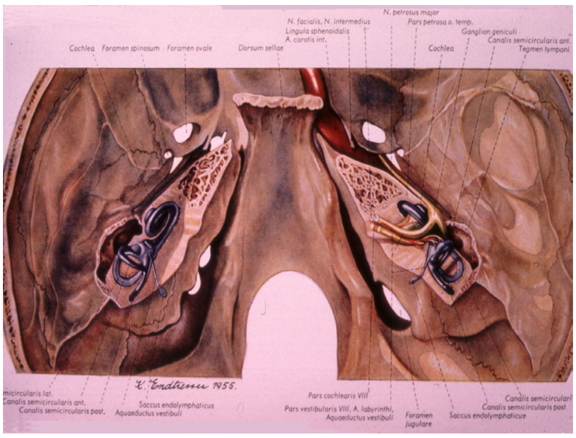
Some Challenges in Delivery of High Quality Surgery

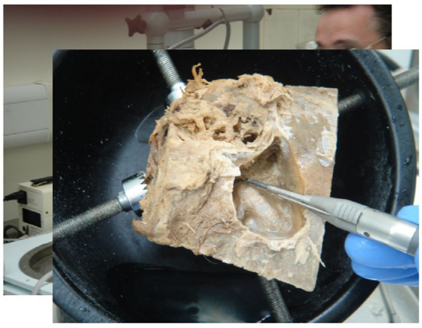
Training
Refreshing
Skills Maintenance
Skills Development

Current Practice

Learn Anatomy
Learn steps of operation
Watch
Assist
Progressively do parts of procedure
Do all procedure
Achieve competency in all circumstances





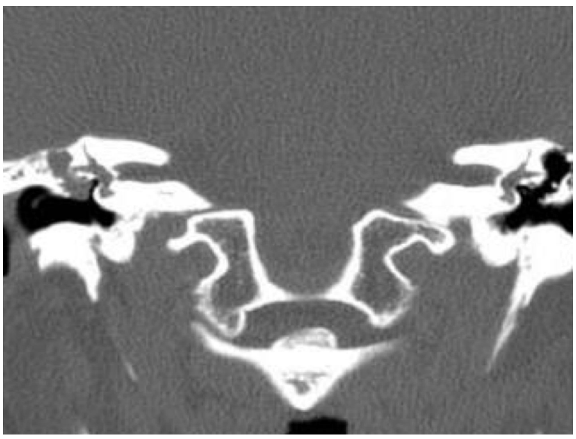


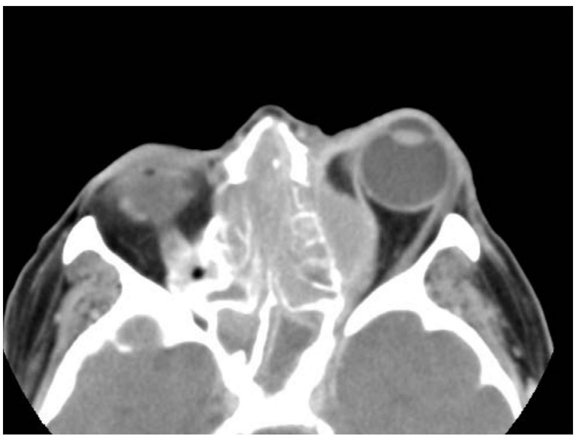
A New Dimension

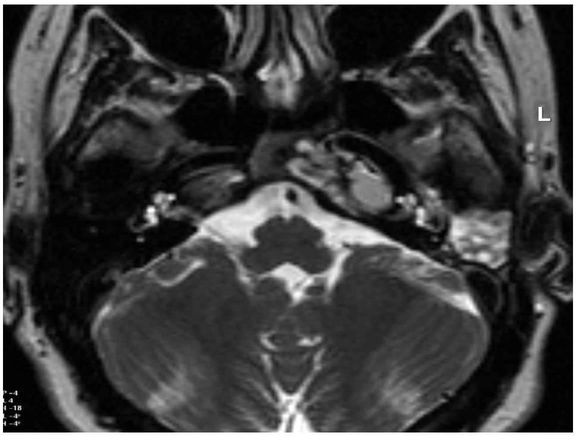
How can we practice for real operations?
Different anatomy
Different pathology
Different hazards

Imaging

Ultrasound
CT
MRI

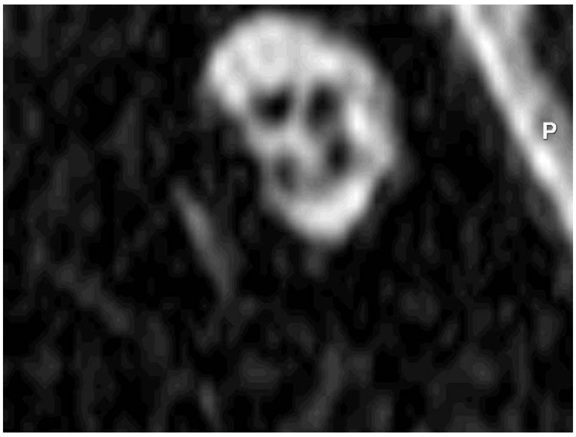






The Concept

To transfer individual patient clinical anatomical and pathological data (photographic and imaging) into a three dimensional virtual reality format.



The Goal

Rehearsal of the surgical procedure for the individual patient

Medical visualisation workshop

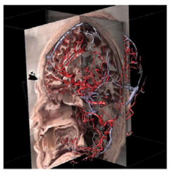
29th May
John Reid
Melrose

Our core business:

- What's wrong with the patient?
- What can you do for the problem
- What is the prognosis

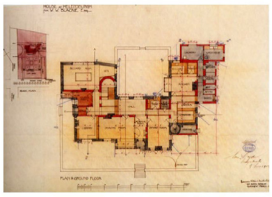
Radiology

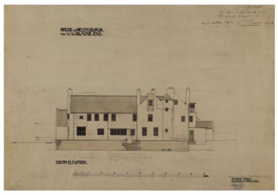
- Anatomy:

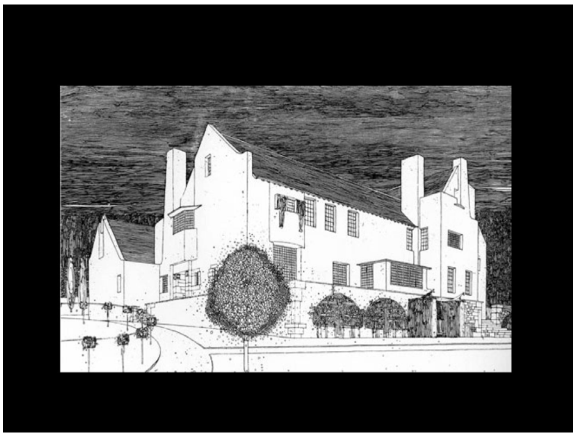


Radiologist cf architect

- We use 1 or 2 dimensions

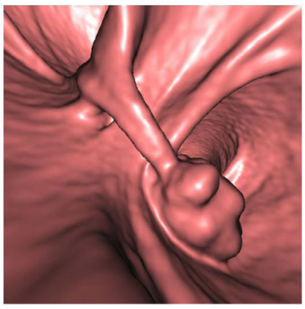




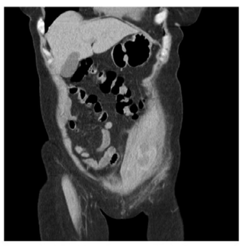


Multiplanar reformats

Transmission of information



Treatment planning / monitoring



3D imaging

- Multiplanar reformats as routine
- 3 D colonography
- 3 D bronchoscopy
- 3 D nuclear medicine

- 3 D information transmission

3D imaging

- Multislice CT / MRI
- Multiplanar pathology datasets
  - Teaching
  - Reporting
  - Treatment planning

Visualisation for Medical Education 'Putting it all in Context'

Mr Ben Ward
Surgical Fellow (UOE)
RCSed (ESSQ)

What are the current Challenges? How can we help each other meet them?

- Medical Education in 2007
- Osmosis and Survival?
- Facing the Net Generation
- Medicine's never a game, is it?

Challenges in Medical Education 2007

- Why is Medical Education so important?

- Traditional Training vs MMC,
- Shifting Focus on undergraduate curricula,
- Shorter more focused postgraduate training,
- Continued Learning through-out a career,
- Emphasis on Revalidation/ CPD

Osmosis and Survival? Educational needs for modern Medicine

- Changing Undergraduate Curriculum/ Staffing levels in Anatomy Teaching
- Postgraduate effects of the new undergraduate curriculum
- Sophisticated learners/ Sophisticated subject
- Facing the Net Generation (NetGeners)
- From Undergraduate to CCST and beyond
- Increasing requirement for flexibility; distance learning; eLearning
- The development and practical evaluation of Web3D Technology

- **There is a pressing need for robust evaluation of new methods including publication of real world development experiences.**
  H. Brenton et al. / Computers & Education 49 (2007) 32–53

Facing The Net Generation Our New Generation of Doctors

- A new population of learners with unique characteristics
- 7% of the population today (Bartlett 2005)
- Very education oriented. (Whitney-Vernon 2004)
- NetGeners learn differently from their predecessors
- Not only are NetGeners acculturated to the use of technology, they are saturated with it.
- Oblinger and Oblinger 2005; Prensky 2006; Tapscott 1998

By the age of 21 the average NetGener will have spent….

- 10,000 hours playing video games,
- 200,000 e-mails,
- 20,000 hours watching TV,
- 10,000 hours on cell phones,
  Oblinger and Oblinger 2005; Prensky 2006; Tapscott 1998

- under 5,000 hours reading
  (Bonamici et al. 2005).

Digital Natives 10 Years of the Net Generation

- Having been raised in an age of media saturation and convenient access to digital technologies, NetGeners have distinctive ways of thinking, communicating, and learning.

- (Oblinger and Oblinger 2005; Prensky 2006; Tapscott 1998).

Medicine isn't a Game, or is it?

- Computer games have made a significant cultural, social, economic, political, and technological impact on society
  (Newman 2004),
- Given the widespread popularity of video games, their ability to sustain long-term player engagement with challenging tasks its no wonder they interest educationalists.
  (Gee 2003),
- Gaming is interesting in its tendency to elicit proactive player communities
  (Rheingold 1994),

Game-Informed Learning:
Applying Computer Game Processes to Higher Education M.Begg, D.Dewhurst, and H.Macleod

Game-informed Learning

- Developed from the same principles as constructivist pedagogy and PBL.
- **The educational processes themselves should be informed by the experience of game-play.**
- Students invited to perform as medical investigators
- Students compelled to intervene in a simulated environment where each intervention creates consequences that prompt further action.
- Interaction with a rich, involving, stimulating, interactive contextualised environment promotes an enriched engagement with the subject domain.
- The provision of 'thickly authentic' settings. (Shaffer and Resnick 1999).

Game informed learning at RCSed

budding surgeons make the cut

The College is hosting a Surgical Skills competition to involve school children in the Quincentenary celebrations, writes *Andrew de Beaux*

A pilot day in November 2002 assured all involved that the Surgical Skills School

primary aim of the competition was to engage pupils in the Quincentenary celebrations, the secondary aim to

with a tour of the museum. After lunch it was back to the skills lab to get plastered – quite literally. Both members of the team applied a forearm POP to each other – not at the same time of course! The day finished with a key-hole surgery session. Stacking sugar lumps, then cutting a circle out of a glove increased the competition between the teams. Indeed, the enthusiasm and technical skills of the school kids have been very impressive.

Teams from Aberdeen Grammar, Albyn School for Girls, Balwearie High, Boclair Academy, Dollar Academy, Dumfries Academy, Grange Academy, Keith Grammar, Kelso High, Kenmay Academy, Knox Academy, Lanark Grammar, Linlithgow Academy, Lochgilphead High, Millburn Academy, Morrisons Academy, Peterhead Academy and St Thomas of Aquinas High School are through to the two semi-finals.

Finger on the **Pulse!!** What the American's are doing.

- Funded by the US Office of Naval Research
- Designed by developer 'BreakAway', Hunt Valley (Md.)
- $7.5 million project for Nursing, Medical training.
- Proof-of-concept prototype finished by the end of 2006.

PULSE!!

Clinical Gaming and Learning

- Any domain of knowledge, academic or not, is first and foremost a set of activities and experiences.

  Physicists *do* physics. They *talk* physics. And when they are being physicists, they *see* and *value* the world in a different way than do non-physicists.

- When learners use real tools and methods to address issues they care about motivation and learning tend to follow.
- When one treats knowledge first and foremost as activity and experience, not as facts and information **the facts come to life.**

Meeting the challenges together.

- Allows rehearsal of clinical decision making in a rich, authentic, safe, ?remote, plastic, environment.
- Visualisation extends the scope of subject domains.
- Game-informed learning; face to face, augmented reality, online.
- 3D visualisation for 3D 360° immersion.
- 'Thickly Authentic' settings suit NetGener learners.
- Enhanced engagement promotes critical mass for eLearning communities.
- An exciting and expanding area of educational research
- The for Scotland to gain an expert community in a globally relevant field.

If your Browsing........

- http://www.educationarcade.org
- http://www.gamesforhealth.org
- http://www.socialimpactgames.com

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Second workshop - 14th November 2007

Agenda

Sometimes - what you see is not what you 'get' - Professor David Rowley, Director of Education, The Royal College of Surgeons of Edinburgh

Welcome - Professor Paul Anderson, Director, Digital Design Studio, Glasgow School of Art

Medical Educational Research: Health though Innovation - Dr Ben Ward, The Royal College of Surgeons of Edinburgh

Anatomy Reconstructed - Professor Ian Parkin, Ninewells Hospital, Dundee

Speaker Profiles

Partner Profiles

Certificate of Attendance

14 November 2007

Agenda

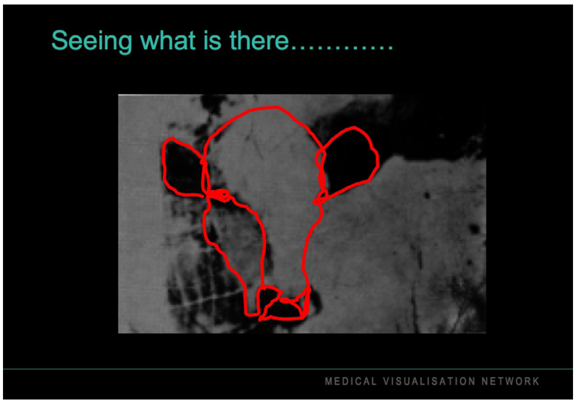
Chair: Prof. Paul Anderson

09:15	Registration (coffee and tea)
09:45	Welcome by John Orr, President of the Royal College of Surgeons, Edinburgh
09:50	Professor David Rowley, Director of Education, Royal College of Surgeons, Edinburgh
10:00	Professor Paul Anderson, Digital Design Studio, Glasgow School of Art
10:10	Improved rendering of 3D images to augment applied anatomy teaching Presentation by Dr Ben Ward, Royal College of Surgeons, Edinburgh and Lucy Whittaker, Edinburgh University
10:30	Procedural rehearsal of a virtual lumber puncture with haptic (feeling) feedback. Presentation by Dr David Chanock & Dr Jillian Hewitt-Gray, Ayr Hospital
10:50	A 3D animation of the anatomy of the ankle and foot for ultrasonography training. Presentation by Dr David Chanock and Mr Anand Rattansingh, Ayr Hospital
11:10	The development of 3D modelling for undergraduate teaching (inguinal canal). Presentation by Professor Ian Parkin, Ninewells Hospital, Dundee
11:30	The use of 3D animation to visualise structures from 2D plain films of the chest. Presentation by Dr David Chanock, Ayr Hospital
11:50	Q&A session
12:30	Lunch and Networking
13:30	Open Space – circuit of demonstrations including: ● Phantom arm haptic Lumbar puncture ● Approaches to VR research – the 3D heart ● Real-time VR anatomy - demonstration of the virtual human body ● A semi-immersive VR interface with 3D visualisation, 3D sound and haptic demonstration of a virtual human body
15:00	Plenary session
15:30	Close

Digital Design Studio ■ Royal College of Surgeons


MEDICAL VISUALISATION NETWORK
second workshop
Sometimes – what you see is not what you "get"
Professor David I Rowley
Director of Education at the Royal College of Surgeons of Edinburgh
Professor of Trauma and Orthopaedic Surgery, Dundee University
Visiting Professor of Surgical Education, Edinburgh University
Digital Design Studio
The Glasgow School of Art
THE ROYAL COLLEGE OF SURGEONS
Scottish Funding Council


What do you see?
MEDICAL VISUALISATION NETWORK


Seeing what is there…………
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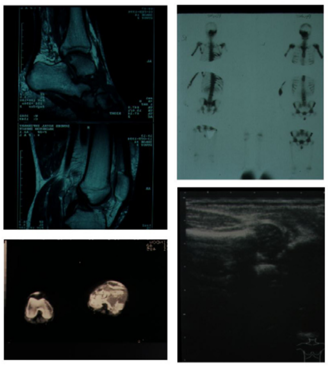
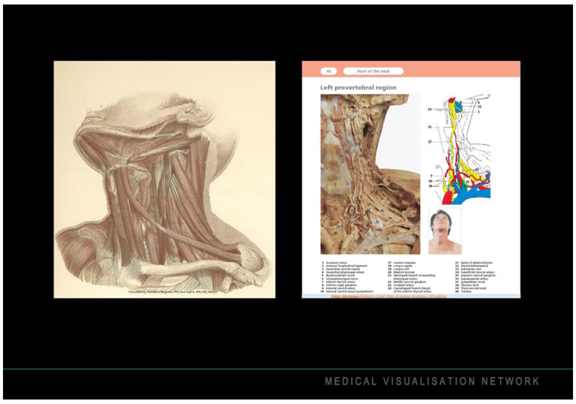
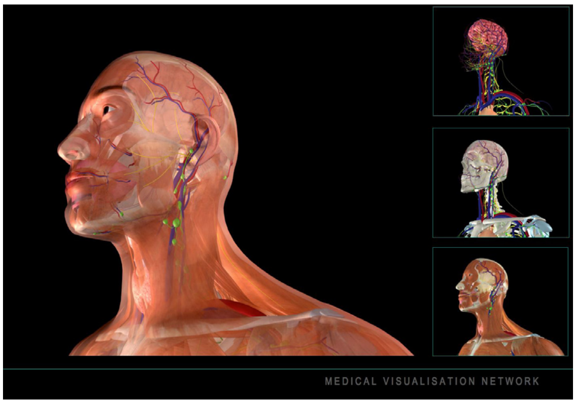
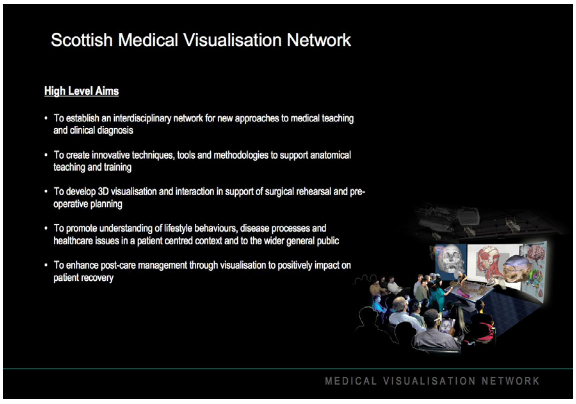


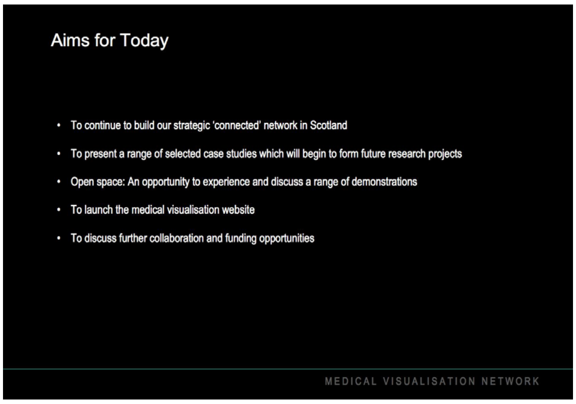

Left prevertebral region
MEDICAL VISUALISATION NETWORK

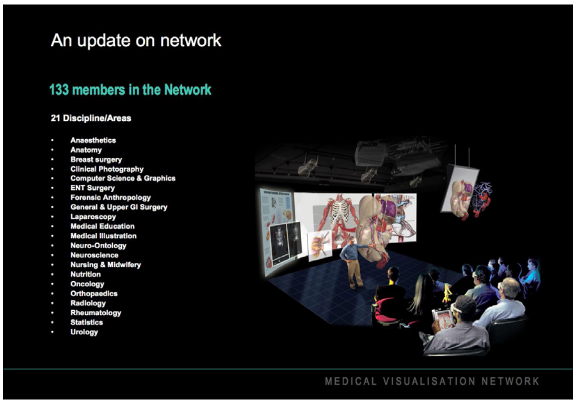

MEDICAL VISUALISATION NETWORK

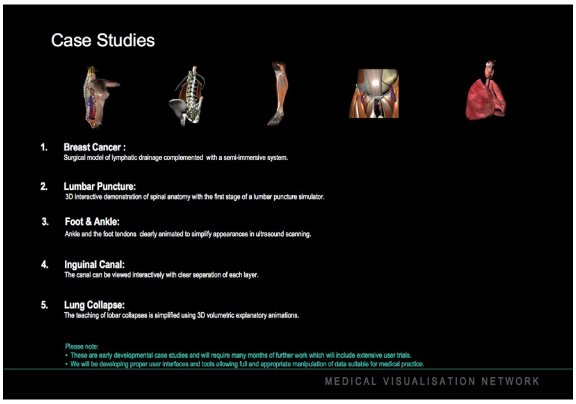

What we want to achieve
Make it easy for all of us to see the things we look at better…
Shorten the learning curve for beginners
Help the expert see more
Let us practice safely
Make life safer for patients
MEDICAL VISUALISATION NETWORK


MEDICAL VISUALISATION NETWORK
second workshop
Welcome
Prof. Paul Anderson
Scottish Funding Council


Scottish Medical Visualisation Network
High Level Aims
• To establish an interdisciplinary network for new approaches to medical teaching and clinical diagnosis
• To create innovative techniques, tools and methodologies to support anatomical teaching and training
• To develop 3D visualisation and interaction in support of surgical rehearsal and pre-operative planning
• To promote understanding of lifestyle behaviours, disease processes and healthcare issues in a patient centred context and to the wider general public
• To enhance post-care management through visualisation to positively impact on patient recovery
MEDICAL VISUALISATION NETWORK


Aims for Today
• To continue to build our strategic 'connected' network in Scotland
• To present a range of selected case studies which will begin to form future research projects
• Open space: An opportunity to experience and discuss a range of demonstrations
• To launch the medical visualisation website
• To discuss further collaboration and funding opportunities
MEDICAL VISUALISATION NETWORK


An update on network
133 members in the Network
21 Discipline/Areas
• Anaesthetics
• Anatomy
• Breast surgery
• Clinical Photography
• Computer Science & Graphics
• ENT Surgery
• Forensic Anthropology
• General & Upper GI Surgery
• Laparoscopy
• Medical Education
• Medical Illustration
• Neuro-Ontology
• Neuroscience
• Nursing & Midwifery
• Nutrition
• Oncology
• Orthopaedics
• Radiology
• Rheumatology
• Statistics
• Urology
MEDICAL VISUALISATION NETWORK


Case Studies
1. Breast Cancer :
Surgical model of lymphatic drainage complemented with a semi-immersive system.
2. Lumbar Puncture:
3D interactive demonstration of spinal anatomy with the first stage of a lumbar puncture simulator.
3. Foot & Ankle:
Ankle and the foot tendons clearly animated to simplify appearances in ultrasound scanning.
4. Inguinal Canal:
The canal can be viewed interactively with clear separation of each layer.
5. Lung Collapse:
The teaching of lobar collapses is simplified using 3D volumetric explanatory animations.
Please note:
• These are early developmental case studies and will require many months of further work which will include extensive user trials.
• We will be developing proper user interfaces and tools allowing full and appropriate manipulation of data suitable for medical practice.
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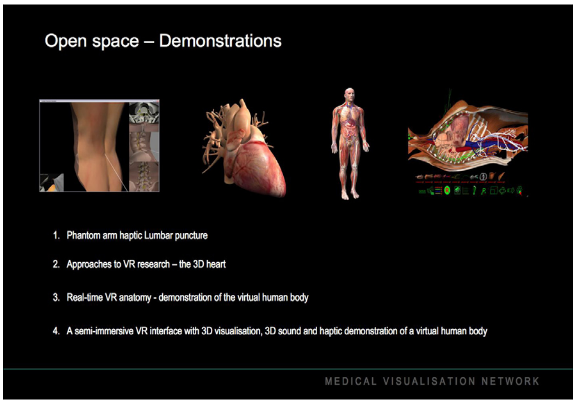
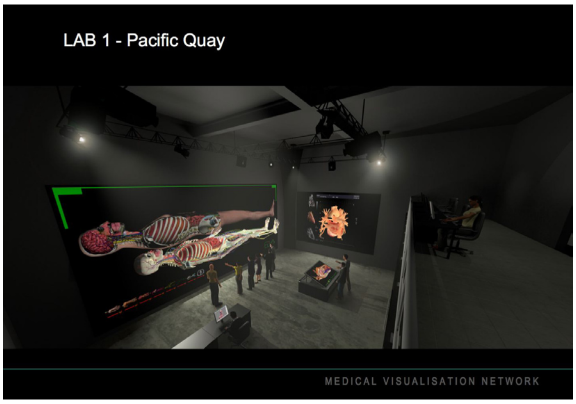
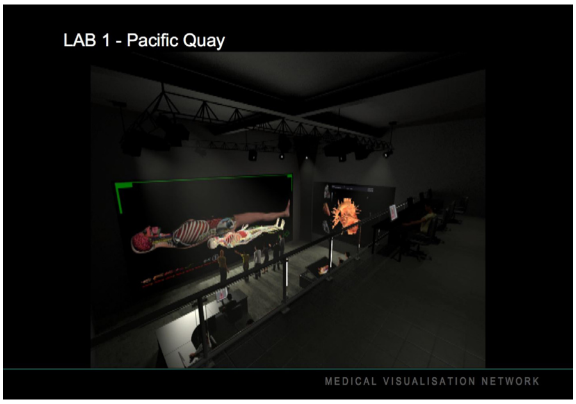

Open space – Demonstrations
1. Phantom arm haptic Lumbar puncture
2. Approaches to VR research – the 3D heart
3. Real-time VR anatomy - demonstration of the virtual human body
4. A semi-immersive VR interface with 3D visualisation, 3D sound and haptic demonstration of a virtual human body
MEDICAL VISUALISATION NETWORK


Medical Visualisation Network Website
MEDICAL VISUALISATION NETWORK
WELCOME TO THE SCOTTISH MEDICAL VISUALISATION NETWORK.
www.medicalvisualisation.co.uk
MEDICAL VISUALISATION NETWORK

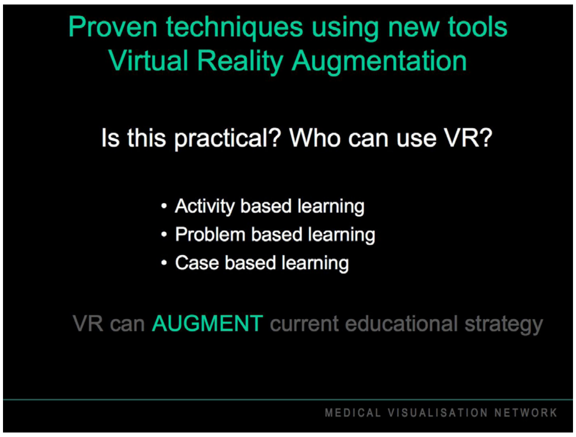

The Future DDS - Pacific Quay
MEDICAL VISUALISATION NETWORK

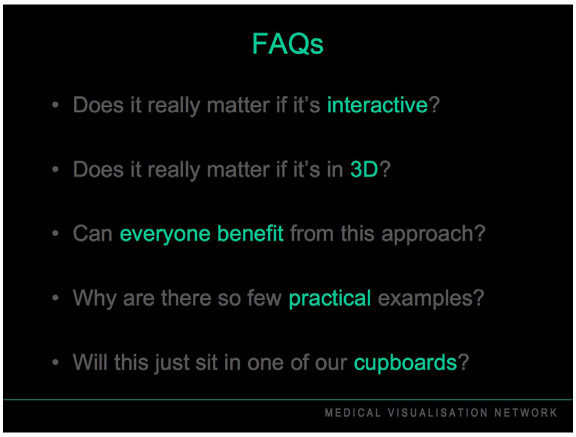

LAB 1 - Pacific Quay
MEDICAL VISUALISATION NETWORK


LAB 1 - Pacific Quay
MEDICAL VISUALISATION NETWORK

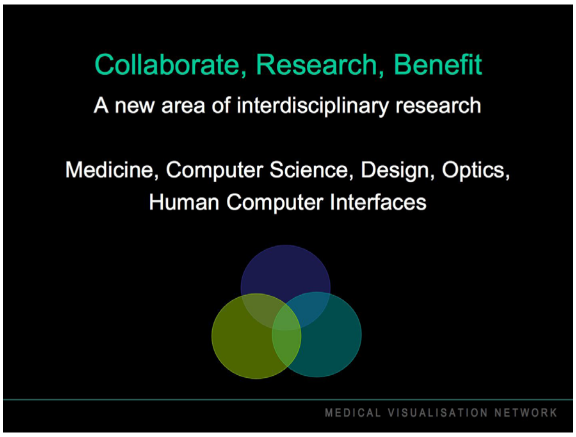

MEDICAL VISUALISATION NETWORK
second workshop
Medical Educational Research
Health through Innovation
Dr Ben Ward
Scottish Funding Council

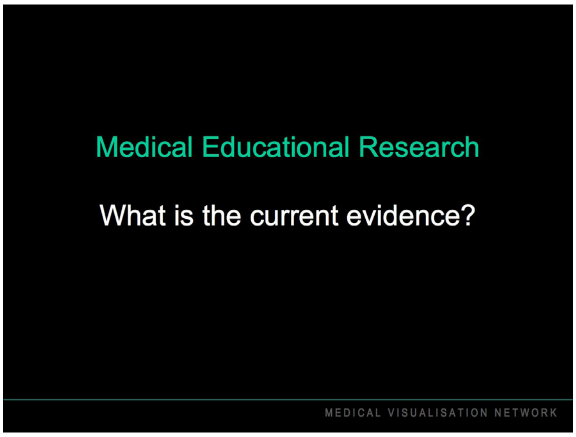

New challenges and opportunities
• A changing landscape
• Increasingly exacting standards
• Increasing pressures of time and budget
• New opportunities for excellence
• How will we educate in the future?
MEDICAL VISUALISATION NETWORK

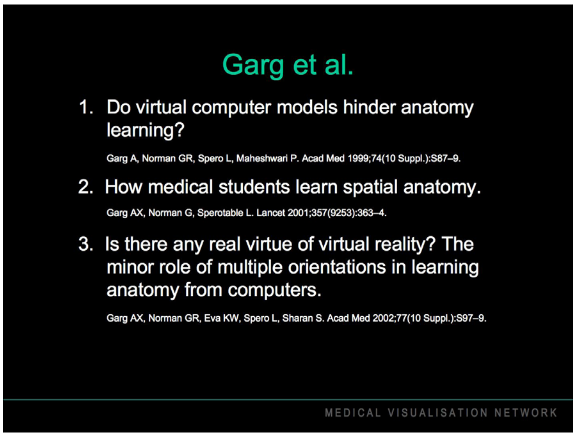

Proven techniques using new tools
Virtual Reality Augmentation
Is this practical? Who can use VR?
• Activity based learning
• Problem based learning
• Case based learning
VR can AUGMENT current educational strategy
MEDICAL VISUALISATION NETWORK

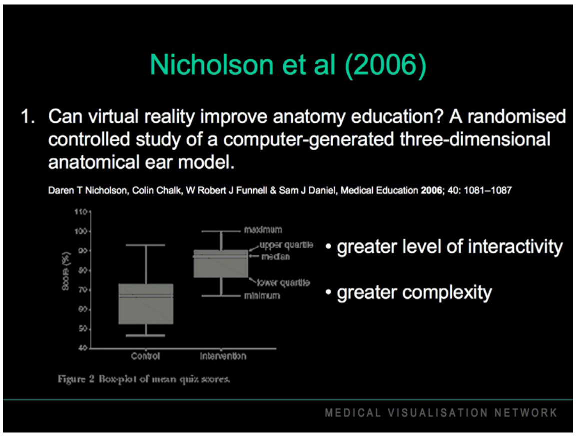

FAQs
• Does it really matter if it's interactive?
• Does it really matter if it's in 3D?
• Can everyone benefit from this approach?
• Why are there so few practical examples?
• Will this just sit in one of our cupboards?
MEDICAL VISUALISATION NETWORK

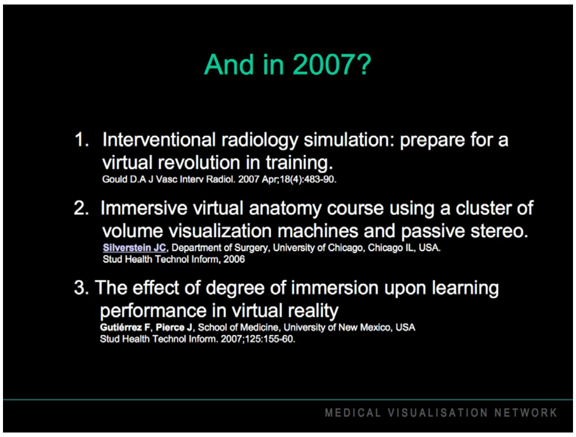

A strategic approach for Scotland
• A collective approach to R&D
• The formation of an expert community
• The practical application of innovation
MEDICAL VISUALISATION NETWORK


Collaborate, Research, Benefit
A new area of interdisciplinary research
Medicine, Computer Science, Design, Optics, Human Computer Interfaces
MEDICAL VISUALISATION NETWORK

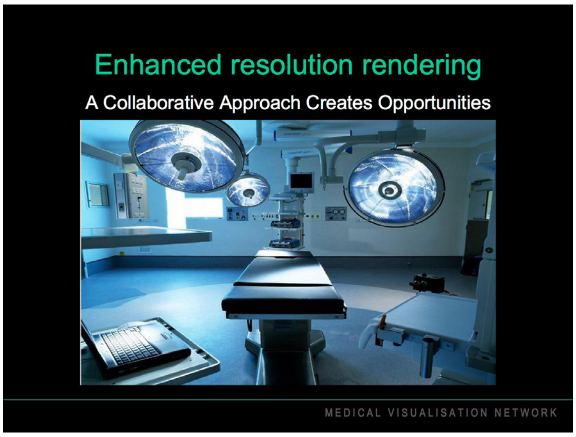

Medical Educational Research
What is the current evidence?
MEDICAL VISUALISATION NETWORK


Garg et al.
1. Do virtual computer models hinder anatomy learning?
Garg A, Norman GR, Spero L, Maheshwari P. Acad Med 1999;74(10 Suppl.):S87–9.
2. How medical students learn spatial anatomy.
Garg AX, Norman G, Sperotable L. Lancet 2001;357(9253):363–4.
3. Is there any real virtue of virtual reality? The minor role of multiple orientations in learning anatomy from computers.
Garg AX, Norman GR, Eva KW, Spero L, Sharan S. Acad Med 2002;77(10 Suppl.):S97–9.
MEDICAL VISUALISATION NETWORK


Nicholson et al (2006)
1. Can virtual reality improve anatomy education? A randomised controlled study of a computer-generated three-dimensional anatomical ear model.
Daren T Nicholson, Colin Chalk, W Robert J Funnell & Sam J Daniel, Medical Education 2006; 40: 1081–1087
110
100
90
80
70
60
50
40
Score (%)
Control
Intervention
maximum
upper quartile
median
lower quartile
minimum
• greater level of interactivity
• greater complexity
Figure 2 Box-plot of mean quiz scores.
MEDICAL VISUALISATION NETWORK

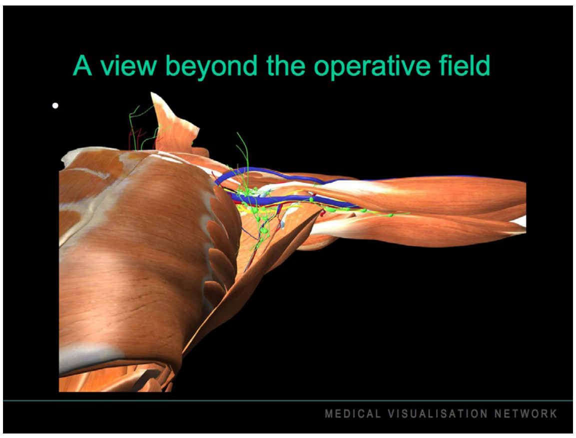

And in 2007?
1. Interventional radiology simulation: prepare for a virtual revolution in training.
Gould D.A J Vasc Interv Radiol. 2007 Apr;18(4):483-90.
2. Immersive virtual anatomy course using a cluster of volume visualization machines and passive stereo.
Silverstein JC, Department of Surgery, University of Chicago, Chicago IL, USA.
Stud Health Technol Inform, 2006
3. The effect of degree of immersion upon learning performance in virtual reality
Gutiérrez F, Pierce J, School of Medicine, University of New Mexico, USA
Stud Health Technol Inform. 2007;125:155-60.
MEDICAL VISUALISATION NETWORK

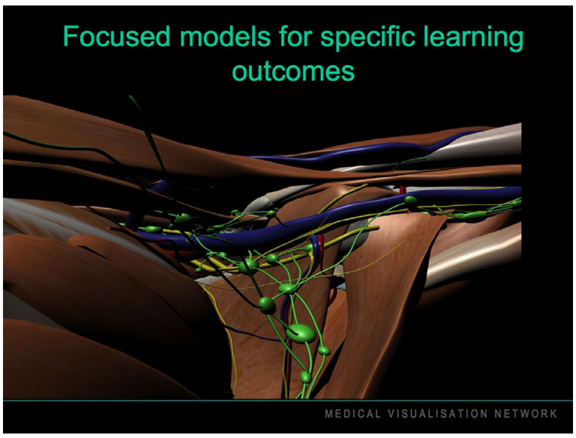

Not all VR is the same!
MEDICAL VISUALISATION NETWORK

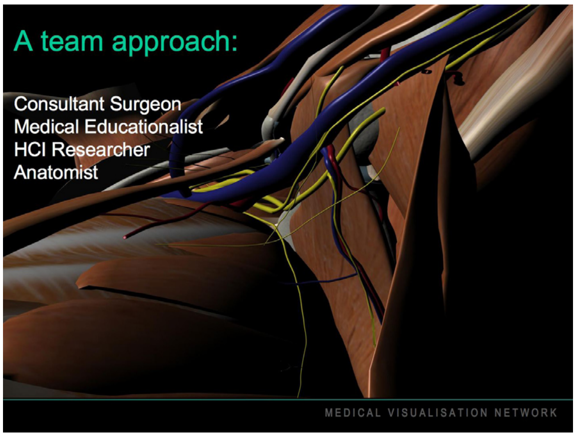

Enhanced resolution rendering
A Collaborative Approach Creates Opportunities
MEDICAL VISUALISATION NETWORK

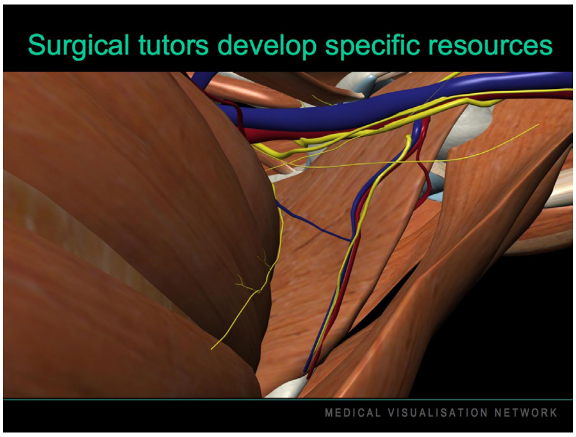

A trainee centred approach
MEDICAL VISUALISATION NETWORK

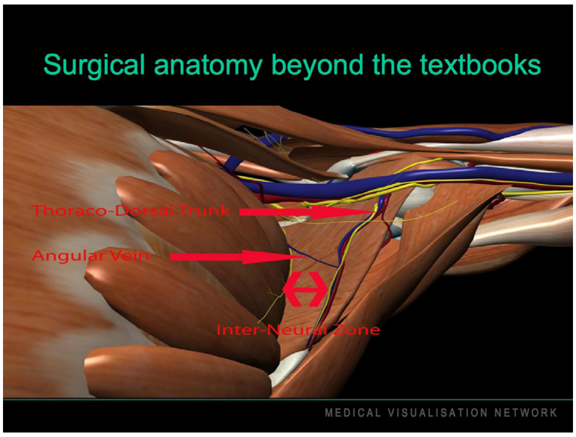

Promoting patient safety virtually
MEDICAL VISUALISATION NETWORK

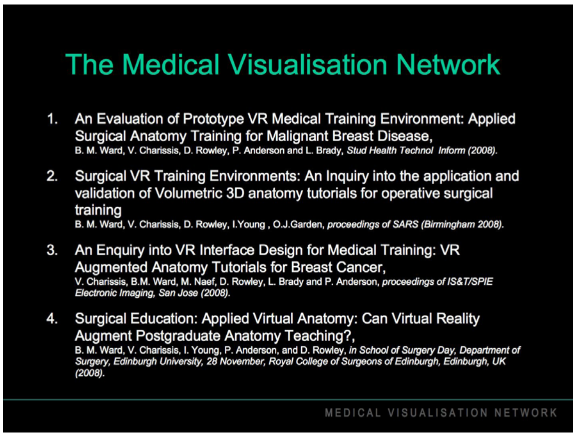

A view beyond the operative field
MEDICAL VISUALISATION NETWORK


Focused models for specific learning outcomes
MEDICAL VISUALISATION NETWORK


A team approach:
Consultant Surgeon
Medical Educationalist
HCI Researcher
Anatomist
MEDICAL VISUALISATION NETWORK


Surgical tutors develop specific resources
MEDICAL VISUALISATION NETWORK


Surgical anatomy beyond the textbooks
Thoraco-Dorsal Trunk
Angular Vein
Inter-Neural Zone
MEDICAL VISUALISATION NETWORK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1. An Evaluation of Prototype VR Medical Training Environment: Applied Surgical Anatomy Training for Malignant Breast Disease,
B. M. Ward, V. Charissis, D. Rowley, P. Anderson and L. Brady, Stud Health Technol Inform (2008).
2. Surgical VR Training Environments: An Inquiry into the application and validation of Volumetric 3D anatomy tutorials for operative surgical training
B. M. Ward, V. Charissis, D. Rowley, I.Young , O.J.Garden, proceedings of SARS (Birmingham 2008).
3. An Enquiry into VR Interface Design for Medical Training: VR Augmented Anatomy Tutorials for Breast Cancer,
V. Charissis, B.M. Ward, M. Naef, D. Rowley, L. Brady and P. Anderson, proceedings of IS&T/SPIE Electronic Imaging, San Jose (2008).
4. Surgical Education: Applied Virtual Anatomy: Can Virtual Reality Augment Postgraduate Anatomy Teaching?,
B. M. Ward, V. Charissis, I. Young, P. Anderson, and D. Rowley, in School of Surgery Day, Department of Surgery, Edinburgh University, 28 November, Royal College of Surgeons of Edinburgh, Edinburgh, UK (2008).
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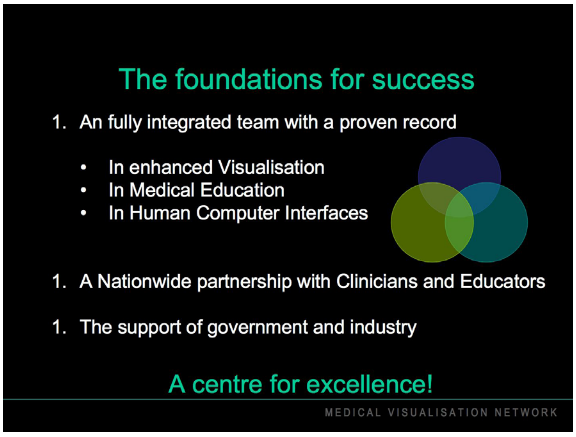
The foundations for success
1. An fully integrated team with a proven record
• In enhanced Visualisation
• In Medical Education
• In Human Computer Interfaces
1. A Nationwide partnership with Clinicians and Educators
1. The support of government and industry
A centre for excellence!
MEDICAL VISUALISATION NETWORK

second workshop

Anatomy Reconstructed

Professor Ian Parkin

DIGITAL DESIGN STUDIO THE GLASGOW SCHOOL OF ART · THE ROYAL COLLEGE OF SURGEONS · Scottish Funding Council

Anatomy Reconstructed

- Gold standard: 3-D, cadaveric, hands-on, active, directed student learning
- Add insight and understanding to promote deeper learning, and safe clinical practice
- Cadaveric specimens are not always available
- Different stages of learning and training may benefit from a different approach

MEDICAL VISUALISATION NETWORK

Anatomy: Reconstructed (Workshop 1)

- Reconstruct to offer 3-D, active, spatial learning
- Simulate: function, movement; clinical procedure or surgical approach
- Add "life" and keep abreast of technology
- Difficult concepts: not visible on cadaver; 3-D; moving with development, posture and age
- Inguinal region; peritoneum and lesser sac; perineum; potential spaces
- Embryology (similar issues): watch A become B or C

MEDICAL VISUALISATION NETWORK

Anatomy: Reconstructed (Workshop 1)

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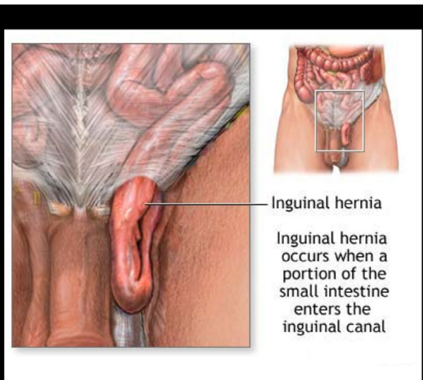
MEDICAL VISUALISATION NETWORK

Why?



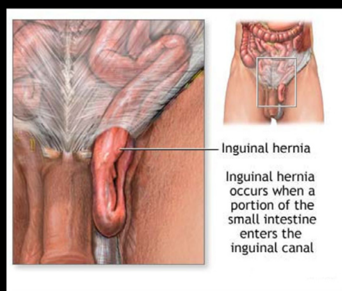
MEDICAL VISUALISATION NETWORK

Why?

Clinical examination

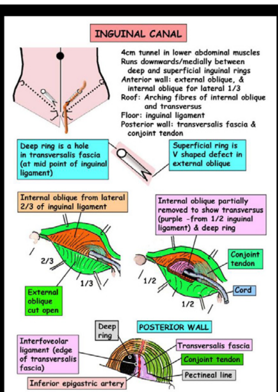
Differential diagnosis

Surgical approaches

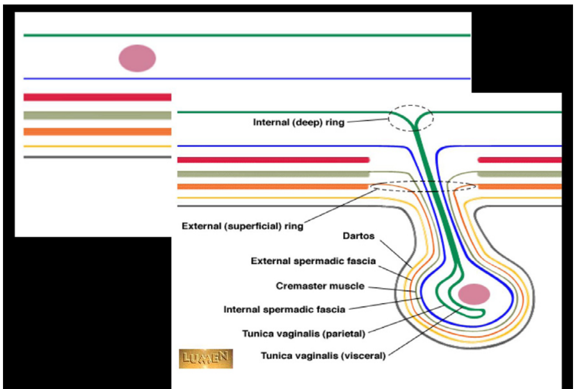


MEDICAL VISUALISATION NETWORK

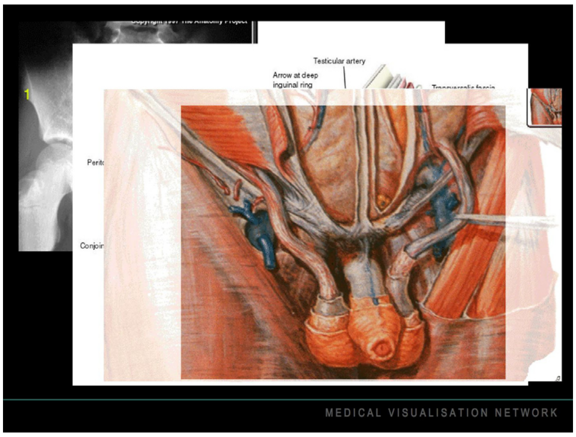
Current Visual Aids



MEDICAL VISUALISATION NETWORK



MEDICAL VISUALISATION NETWORK



Current Visual Aids

- Static
- Artificial
- Non-interactive
- May be inaccurate

MEDICAL VISUALISATION NETWORK

Medical Visualisation Network

- Build and alter to become accurate
- Interactive
- Visualise different anatomical or surgical approaches:
  - Adapted for different audiences
  - Laparoscopic camera view
- Whole layers may be added or removed

MEDICAL VISUALISATION NETWORK

Medical Visualisation Network Future Plans

- Create the interfaces
  - User friendly, professional packages
  - User trials
- Full-time research and development team

MEDICAL VISUALISATION NETWORK

Medical Visualisation Network

- See what you think of this "proof of concept" demonstration
  - Which shows raw data, collected, corrected, manipulated
  - And is very much "work in progress"

Thank you, your comments and suggestions will be greatly appreciated

MEDICAL VISUALISATION NETWORK

14 November 2007

Speakers

Prof. Paul Anderson

Paul is the Director of the Digital Design Studio, which he established in 1997. He has an international profile in digital visualisation and interaction research concerned with fundamental human computer interface issues, particularly those associated with 3D interfaces, haptics and gesture-based interaction. He has won major research funding from the EU, EPSRC, NESTA, Scottish Funding Council and Scottish Enterprise. His rsearch interests are focused on medical, automotive and defence fields. He has collaborated with a number of world-class research organisations, and has published internationally on the subject of digital visualisation and interaction. Paul leads the Scottish Medical Visualisation Network in partnership with David Rowley.

Prof. David Rowley

David is Professor at the University Dept. of Orthopaedic and Trauma Surgery, Ninewells Hospital and Medical School, Dundee, Director of Education, Royal College of Surgeons of Edinburgh and Visiting Professor of Surgical Education, University of Edinburgh. He is a lower-limb construction surgeon now entirely in the elective field and runs a global audit and outcomes unit assessing the long term results of hip and knee replacements. He has a particular interest in knee arthroplasty and foot surgery and biomechanics. He has carried out infection studies for the International Committee of the Red Cross and undertaken several field missions. David leads the Scottish Medical Visualisation Network in partnership with Paul Anderson of the Digital Design Studio.

Mr John Orr

John is President of the Royal College of Surgeons of Edinburgh. He is Consultant Paediatric Surgeon at the Royal Hospital for Sick Children in Edinburgh. His expertise is in general paediatric surgery with an interest in paediatric urology, with published work in surgery, emergency paediatric surgery and paediatric urology. John is Chairman of the Scottish Audit of Surgical Mortality, and a member of the Academy of Medical Royal Colleges, the Joint Committee on Surgical Training, JCSM and the Surgical Forum. He has previously been Chairman of the SAC in Paediatric Surgery, Medical Director of the Royal Hospital for Sick Children, CD Surgical Services Western General Hospital, and Chairman of the Intercollegiate Committee for Basic Surgical Training.

Mr Ben Ward

Ben is Clinical Lecturer in the Department of Surgery at the University of Edinburgh leading 5th Year Undergraduate teaching in general surgery. His interests include e-learning and Virtual Reality applied to surgical anatomy teaching and practice. He is part of the development team for a new online Masters degree in basic surgical sciences, the Edinburgh Surgical Sciences Qualification. He is a member of the ESSQ content and assessment groups and is particularly interested in online case-based learning. He has published internationally on behalf of the Scottish Medical Visualisation Network and is a Board member and lead researcher for the Network.

Dr David Chanock

David was educated in South Africa and studied radiology in Durban. He emigrated to Scotland in 1997 and has been working there as a Diagnostic Radiologist since his move. He is a general radiologist with an interest in cross sectional imaging. He has a keen interest in teaching and is the Acting Academic Sub-Dean for Glasgow University at Ayr Hospital and the NES Foundation Tutor. He is an examiner in the final year medical examinations at Glasgow University and is on the steering group of the MS Managed Clinical Network. David is a Board member of the Scottish Medical Visualisation Network.

Prof. Ian Parkin

Ian qualified in medicine in 1975 but after pre- and post-registration medical and surgical positions, chose to follow a career in anatomy, becoming professor of applied clinical anatomy, University of Dundee and Royal College of Surgeons of Edinburgh, in 2005. He is a Fellow of the British Association of Clinical Anatomists and Honorary Fellow of the Institute of Anatomical Sciences. His expertise includes the delivery of three-dimensional, functional and clinically relevant anatomy to undergraduate medical students and postgraduate trainees. Ian is a Board member of the Scottish Medical Visualisation Network.

Digital Design Studio ■ Royal College of Surgeons

14 November 2007

Partners

Digital Design Studio, Glasgow School of Art

The Digital Design Studio (DDS) was established in 1997 as a specialist postgraduate research and commercial centre of Glasgow School of Art. It has an international reputation for research and teaching in digital technologies for advanced 3D visualisation and interaction.

DDS activities revolve around interactive virtual reality: virtual environments with 3D sound where digital models are displayed in 3D space, and interaction with the models is possible through gesture, touch (tactile and force feedback) and physical "props". A wide range of research and commercial projects explore the potential of such environments in the fields of architecture, medicine, education, games and entertainment, heritage and transport. The DDS has been successful in securing research funding from SFC, EPSRC, AHRC, NESTA, and the EU. It has a large portfolio of projects with business and industry in Scotland, the UK and Europe, centred on expertise in real-time 3D visualisation, 3D sound, modelling and animation.

This research requires a broad range of expertise, and the DDS has an international staff comprising multidisciplinary designers, 3D digital modellers, animators, programmers, architects, artists, scientists and engineers with a wide range of knowledge and experience who enjoy the challenges of visualisation. Research activity at the DDS is underpinned by one and two year masters degrees in animation and a growing Ph.D. community.

The Royal College of Surgeons of Edinburgh

In 1505, the incorporation of the Barber-Surgeons of Edinburgh came into being with the granting of its Seal of Cause by the Town Council of Edinburgh. Since then, the Royal College of Surgeons of Edinburgh has been dedicated to the maintenance and promotion of the highest standards of surgical practice, through its keen interest in education, training and rigorous examination and through its liaison with external medical bodies. Whilst being keenly aware of its antiquity (the College celebrated its quincentenary in 2005), the College prides itself also on its innovation and adaptability.

At the beginning of the 21st Century, the College has over 17,000 Fellows and Members, only half of whom live in the British Isles. Whatever their location, the Membership is concerned to fulfil the prime purpose of the College. Quite simply this is the maintenance and promotion of the highest standards of surgical practice and surgical training. Until very recently, the College has been concerned almost entirely with the setting of standards and the conduct of examinations designed to ensure that these standards are being maintained. Today the College is increasingly concerned with the provision of surgical education and training in addition to maintaining and enhancing its historic role.

Scottish Funding Council

The Scottish Further and Higher Education Funding Council (SFC) is a non-departmental public body responsible to – but operating at arm's length from – the Scottish Government. It distributes more than £1.6 billion of public funds annually to colleges and universities on behalf of the Scottish Government.

The Council provides financial support for learning and teaching, and research and associated activities in Scotland's 19 higher education institutions (HEIs). As well as providing financial support for learning and teaching in Scotland's 43 further education (FE) colleges, the Council provides resources to enable colleges to offer bursaries to students on non-advanced courses.

The Council is responsible for working with Scotland's colleges and universities to develop strategies in support of ministerial priorities and securing coherent, high quality provision of further and higher education and supporting the undertaking of research. In addition, SFC has a statutory function to provide Scottish Ministers with advice and information on matters relating to further and higher education. It is also responsible for ensuring that the quality of further and higher education provision is assessed and enhanced, and is required to monitor the financial health of both sectors.

second workshop
14th November 2007

Certificate of Attendance

This is to certify that

attended this workshop

DIGITAL DESIGN STUDIO THE GLASGOW SCHOOL OF ART

THE ROYAL COLLEGE OF SURGEONS

Scottish Funding Council
Promoting further and higher education

Research Partners

The Scottish Medical Visualisation Network is partnering with a range of organisations to ensure both academic relevance and commercial outreach of all its activities. The following sections list the established partnerships at the end of the initial feasibility study.

Royal College of Surgeons of Edinburgh is dedicated to the maintenance and promotion of the highest standards of surgical practice, through its keen interest in education, training and rigorous examination and through its liaison with external medical bodies.

A founding partner of the Network, RCS is committed to its future growth.

NHS Education for Scotland (NES) helps to provide better patient care by providing educational solutions for workforce development by designing, commissioning, quality assuring and where appropriate providing education for NHS Scotland staff.

NES is represented on the Network Board by Professor Philip Cachia. NES has already funded two research projects (see Sections 0 and 0 above).

Centre for Health Science, Inverness (CfHS) is a focus for excellence in healthcare and biotechnology research, education, training and business development, the first of its kind in the UK. Located adjacent to Inverness's Raigmore Hospital, this multi-million pound facility represents a major milestone in adding to the already significant cluster of health science activity in the Highlands and Islands of Scotland.

The Centre for Health Science has already opened Phase 1 of its development with Phases 2 and 3 due for completion in the summer of 2008. The aim of the Centre is to instigate collaboration, knowledge transfer, improved clinical outcomes, publications and commercialisation. The endeavour and innovation of its partners has pushed the Centre into the national and international arenas with a number of new developments already in the pipeline.

CfHS has funded a research project on the anatomy of the shoulder (see Section 0 above) and could become a centre for dissemination for the Network in the future.

Castle Craig Hospital provides inpatient treatment for those suffering from alcohol and drug dependence and other addictive disorders. Established for 19 years, the hospital and treatment are under medical management. The hospital is a prime and extra contractor to the National Health Service, is recognised by the Dutch healthcare system and is a preferred provider both to major UK medical insurers and to the US Department of Defence.

Negotiations are ongoing with this partner for a research project on the effects of addiction on the brain (see Section 0 above).

Scottish Health Innovations Limited (SHIL) has been established to support the development and commercialisation of innovations arising within the NHS in Scotland. With funding from the Scottish Executive's Chief Scientist Office, Scottish Enterprise, Highlands and Islands Enterprise and the Department of Trade and Industry, it seeks to identify and develop new technologies which can be exploited through partnerships with the private sector. SHIL is able to provide high quality advice and assistance on market application and intellectual property protection to investors and researchers throughout NHS Scotland.

Thereafter, considerable value is added to these innovations by providing managerial and funding support during their development and commercialisation. It seeks to improve quality and value for money of patient care throughout NHS Scotland, increase the generation of income to the NHS, stimulate economic wealth in Scotland through the creation of new jobs and enterprises, and delivering new market opportunities for businesses interested in licensing NHS Scotland technologies.

We are talking with SHIL and Yorkhill Sick Children's Hospital's Physiotherapy Department about Hippotherapy – the evaluation and development of a physiotherapy device.

GE Healthcare is dedicated to helping our partners in healthcare predict, diagnose, inform and treat disease earlier than ever. They are ushering in a new era of healthcare through medical imaging and information technologies, medical diagnostics, patient monitoring and life-support systems, disease research and drug discovery.

They are currently considering a network proposal for a collaborative venture into ultrasound anatomy and techniques for regional anaesthesia. They have agreed to the collaboration in principal at UK and European level; US backing is pending.

Sumarian services deliver actionable insight out of a business' most underused asset - data. They interrogate, analyse, model and interpret data to allow a business make the most informed, fact-based decisions for its IT and business future.

Meetings have been held with this company to explore future IT and data solutions for the Network.

TPLD is one of the global leaders in the emerging Serious Games market. We are focused on delivering Games-Based Learning (GBL) solutions and technologies to aid organisations in their drive for competitive advantage. Their software products and industry solutions help customers and partners create an effective, experiential and high-impact approach to professional and personal development.

Meetings are underway with this company to explore the use of computer games platforms in future research and commercial projects.

VASCUTEK, is based at a custom built facility in Scotland and is one of the world's leading designers, manufacturers and marketers of vascular products for the treatment of cardiovascular disease. Originally formed in 1982, the company is guided by an ethos of technical excellence, stringent quality control and total customer service. It has a continuous programme of Research and Development and maintains communication with surgeons around the world in order to deliver innovative products trusted by surgeons. Vascutek is a leading manufacturer of vascular prostheses used by cardiovascular surgeons in the treatment of aneurismal or occlusive arterial disease.

Meetings have been held with this company to explore future commercial projects.

Picsel Technologies is a dynamic mobile solutions provider, whose pioneering software brings content on mobile to life. Established in 1998, the company now employs over 300 staff at its headquarters in Glasgow, Scotland and in offices throughout Japan, China, Korea, Malaysia and the US. The company's technology is found on 125 million devices worldwide, with a customer list that includes KDDI, Motorola, Nokia, NTT DoCoMo, Palm, Samsung, Sony Ericsson and Sharp. Picsel's aim is to empower operators, OEMs and content owners to create visually stunning and interactive applications that drive uptake of new content services.

Meetings have been held with this company to explore future commercial projects.

MidTECH is one of a network of nine English regional NHS innovation hubs, established by the Department of Health to identify, protect and commercialise innovative ideas from within the NHS. This includes helping to patent or otherwise protect ideas, linking up with industries that may help to commercialise; this could take the form of a licence, joint venture, or spin out. MidTECH works on behalf of the client Trust to evaluate an idea and ensure any associated intellectual property is protected.

MidTech is already involved in the Designing Out Infection project detailed in Section 8.1.