

### **3 Case Studies: A Hybrid Educational Strategy for ART/SCI Collaborations**

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**Abstract.** In this paper we report on a transdisciplinary university course designed to bring together fine art/visual communication design and computer science students for the creation and implementation of collaborative visual/audio projects that draw upon the specialized knowledge of both these disciplines. While an overview of the syllabus and the teaching methodologies is undertaken in the introduction, the focus of the paper concentrates upon an in-depth discussion and analysis of 3 specific projects that were developed by 3 distinct teams of students comprised of one artist/designer and one engineer each.

**Keywords:** Education, transdisciplinary, collaboration, design, artistic output, bio-data, virtual architecture, data visualization.

#### **1 Introduction**

The work discussed in this paper, is the student's output of a hybrid course positioned between visual arts/visual communication design and computer engineering, initially developed in the spring of 2003, by a computer scientist, specializing in computer graphics and a graphic designer, specializing in electronic applications. Both were practitioners in their fields as well as academicians and both had encountered collaborative projects in their separate practices, giving them an insider's knowledge and appreciation of the need to develop common languages; a transdisciplinary understanding of disparate areas of expertise as part of the curriculum, both for artist/designers as well as engineers [1].

Thus the design of the course focused on bringing students from separate fields of learning together; neither party relinquishing their areas of expertise and most importantly, neither party being required to learn the other's skills. In other words the aim was not to make artist/designers out of engineers and vice versa. What was aimed at was the formation of teams, comprised of one artist/designer and one computer engineer, each of whom would bring their individual skills, expertise, talent, creativity and viewpoints into the development of one single project, from its conception to its implementation to its final presentation.

## 1.1 Instructional strategies

The course is a 3 credit undergraduate course, which 3rd and 4th year students from both the computer science as well as the art and design program can take, provided they have taken the prerequisite courses. For computer engineers this is an introductory course in computer graphics, for artists/designers basic design and typography. The student body is limited to an even number – not to exceed 20 in total, comprised of an equal amount of students from each discipline since the methodology relies entirely upon the formation of equal numbered teams.

## 1.2 Developing a Transdisciplinary Syllabus

*“A truly integrated curriculum entails the intellectual development of faculty as much as that of students, such that the two groups become reciprocal members of a shared, mutually self-critical learning community” [2].*

It was inevitable that during the collation of the teaching material as well as the actual teaching of the course both instructors made major discoveries, not only about each others fields of expertise but also about one another’s thought processes and approach. This is felt by both to be an ultimately enriching experience, which has also spilled over into general teaching activity.

The first 5 weeks of teaching is devoted to two activities which run in tandem: The first of these is the supervision of the development of the individual projects which students embark upon during the second week of classes, as soon as team selection has been made. The second is the transmission of a rigorous survey of the areas of study. Students are given joint lectures, presented by both faculty members. The focus of these lectures is a presentation of a diverse range of innovative new media projects, such as the output of information visualisation, wearable computing, networked installations and performances, shape grammars to virtual worlds; approaching this content both from a programming as well as an aesthetic point of view. Students are encouraged to investigate the shortcomings as well as the successful aspects of this presented output, determining for themselves to what extent collaborative enterprise promises success in new media output.

Along with the presentation and discussion of the above material the instructors also give lectures on specific subjects, relating them to their own areas of expertise. Thus concepts such as “colour”, “light”, “space” are investigated both from a scientific as well as an artistic perspective. Thus, when broaching the subject of “light”, during a three hour class, diverse names and concepts, from Caravaggio to Gouraud Shading, from bioluminescence to the absence of light in Islamic miniature paintings are tossed about and speculated upon, constantly creating multiple associations and new pathways, compelling both students and faculty to make new connections, seek new means of expression and communication [1].

### **1.3 Project development: Team formation**

The course depends entirely on successful teamwork and collaboration. To this end teams are formed by means of a lottery drawn during the second week of class, pairing one computer engineer with one artist/designer randomly, in a simulation of real work environments, where one is often compelled to collaborate with partners that one has no prior acquaintanceship with, that indeed one may not even particularly like and get along with.

The term project is then conceived of, formulated and developed jointly by the two team members. As stated above, it is not the intention of this course to make engineers out of artists and vice versa. Nevertheless during the conception and development of the joint project both parties are compelled to think along the same lines, to empathize, to understand, to implement their unique as well as professional creative and problem solving abilities to the same end.

As they develop ideas students are urged to think along lines of meaningful content, such as educational environments/applications, as well as those which take to task the representation/narration of artistic content, visualization tools and the like. Sole programming wizardry and computer gimmickry, devoid of meaning and content, are frowned upon and discouraged.

Engineers are urged to think creatively, while artists and designers are asked to be focused and pragmatic; both sides having to bring in considerable problem solving as well as problem formulating skills into the enterprise.

The efficacy of mindmaps in the conception and formulation of creative activity has been historically demonstrated by Roy Ascott [3], as part of his teaching methodologies of the Groundcourse, the renowned cybernetics based art educational system practiced in England and Canada during the 1960's. Thus, students are encouraged to develop collaborative conceptual digital mindmaps as creative strategy and problem formulation tools, as well as tools for creating non-linear, interactive scenarios/roadmaps. These mind maps contain subjects specific to the planned project such as sketches, inserted as images, problems adhering to a range of subjects from programming to gestalt, workflow and scenario issues, as well as inspirations, references, screenshots of comparable applications. They provide an excellent source of documentation and a platform for the collation of all material generated by both team members.

### **1.4 Implementation**

During the initial phases of development the mind maps are brought into class to be discussed by fellow students and faculty. Additions, subtractions and collations are made, culminating in a workable roadmap or ground plan upon which the work commences.

At this juncture the two team partners start working on individual aspects of the project, the artist/designer focusing on the visual/audio language components, such as 3D modelling, colour schemes, typography, sound and architecture. The engineer starts to develop the project in a programming environment. The close collaboration and the constant exchange of ideas, however, is expected to last during this crucial

phase of operations and weekly class reports demonstrating the progression ensure that it is indeed maintained rigorously.

At the end of the 15 week semester the projects are handed in as fully operational computer applications/environments. Accompanying these is the delivery of a 5 minute long demonstrational video and a 3000 word documentation of the work. Students are expected to provide references as part of this documentation.

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## 2 The Projects

### 2.1 Project 01: The Miro Avatar

This project originates from the desire to integrate an emotional presence into the Web by using EEG data to visualize personal emotions. However, since EEG data cannot have reliable or interpretable meanings concerning an emotional state, one may only speak of collecting the “idea” of an emotion rather than the accurate visual representation of an emotion. EEG is used to accumulate an individual’s brain signals; signals that occur each moment, unconsciously, in response to the interaction with the immediate environment. Since it was desired to interpret these signals as the idea of one’s emotional presence in virtual reality, a 3-D virtual world, Second Life became the platform to apply this metaphor of reality.



**Fig 1.** The Miro Avatar: shown here changing its appearance through the data of the incoming brain wave.

The collection of the EEG data has been done by an open source program, BrainBay, which outputs the biosignal as EDF files. These files are converted to ASCII text files with another open source program, Polyman. The content of these

files are integers between -4000 and 4000. The ASCII files are uploaded to a website from which scripts in LSL read the files that contain the EEG data. However, since the body of the HTTP request is limited to the amount of available free memory in the script –which is 2048 bytes–, the data files had to be subdivided into smaller ones in order to avoid stack/heap collision errors.

The Avatar changes according to the incoming brain wave upon user activation: The script begins reading data from the server and the Avatar changes its shape according to the incoming integer values. Thus the user's brain waves form a virtual manifestation that represents his/her Avatar which can also be considered as a metaphor for the representation of one's mind; since, figuratively, what is visualized is the person's "thoughts".

As far as the creative process is concerned, the visualization of one's emotional presence is inspired by the four dimensional painting ideas Miró had proposed in his late years. Thus, the avatar, composed of various visual elements featured in Miró's paintings, continuously changes its shape and is redrawn, transcending the two and three dimensionality of painting and sculpture. As expected, this representation contradicts with the regular tendencies of metaverse and MMORPG players who, usually, create a reflection of themselves by making an avatar corresponding to their actual appearance or giving it physical traits that they aspire to possess in real life.

The virtual spaces under consideration are simulations of real spaces which can solely be interacted and experienced through mental processes; via visual, audible, and cognitive stimulations in the brain. So, instead of creating an avatar based on actual physical traits, the output of the project offers an alternative visual entity, usable as an avatar, derived from the fact that users cannot have a real physical presence in virtual spaces and the fact that their mental input is the only factor that creates the illusion of presence in a virtual space. Other users can “see” them, not because they are physically there; but because there is an avatar that is shaped via their thoughts and desires with whom they may interact as if it were a real person. Thus, in terms of representation, virtual appearance may rely only on the output of unconscious thoughts mirroring the surrealist and expressionist approach of Miró's paintings [4].

## **2.2 Project 02: “Hairogram”**

The second project concerns the representation of the statistics of nations using the concept of human hair and its style, an attribute vastly differentiated from person to person. In “Hairogram”, demographics and socio-economic data sets are mapped to different hair properties.

In Hairograph, the statistics of a nation, such as education, economy and population data are shown by using hair strands as the feature for representing multivariate data. In general terms, Hairograph is an interactive tool for people who want to know about the statistics of a nation through the representation of a human head where each person or a group of people is shown by hair strands.

In the area of representing multivariate data sets a commonly used method is combining differentiated volumes into one visualized/cohesive volume, such as is the case in Woodrich and Shen's work which uses this technique by using contextual cues

to create a visual volume for representing multivariate data [5]. In Hairograph, a hair strand is capable of visualizing different variables by simply modifying its default parameters such as color and length.

For the study of visualizing national statistics, Worldmapper, uses morphing techniques to demonstrate how a country evolves for the given parameter such as migration, population or tourism [6]. The land areas of all countries in the world map are morphed into new areas by regarding the statistics chosen. In Hairograph, different hairstyles are generated for different countries regarding the selected statistics by using the combination of hair strands. Thus the motivation underlying the project is the similarity of the role of a single person or a group of people with homogenous characteristic within society and the similar contribution of a hair strand or a bunch of hair to the entire hair style. Although only one hair strand may not change the hairstyle, the combination of multiple hair strands may significantly affect it. Therefore, hair style is a powerful differentiating feature, which can be adapted to national differences. Moreover, hair is an effective feature for multivariable representation since every hair strand carries multiple properties such as branchiness, length and color.

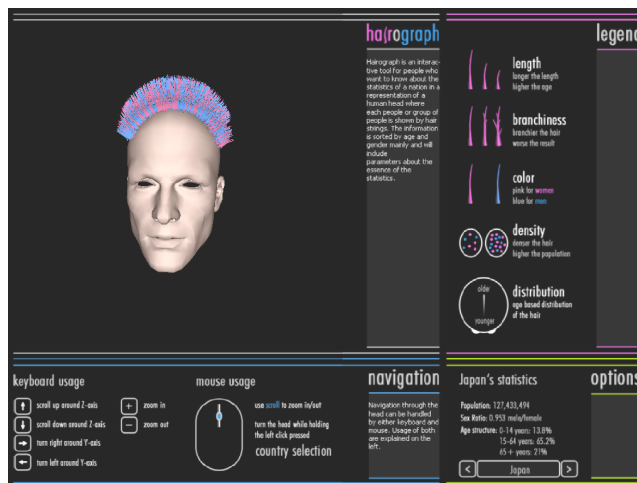


Fig 2. Snapshot of “Hairogram” featuring the educational statistics of Japan.

Ordinary graphs such as bar graphs or pie charts do not show significant differences than the mere reporting of numerical comparisons about the distribution of the population with respect to the emphasized statistics. Moreover, they do not have artistic representations whereby a person may get influenced by only looking at these visuals. With Hairograph, a country is visualized as a human head where its hairstyle gives a brief and yet comprehensive overview information about the highlighted statistics. Realistic hair models were discarded in favor of an abstraction since a data visualization application would require to be comprised of abstractions for the optimum conveyance of the data.

The first variable used for hair strands is branchiness. Having more branches makes hair appear unhealthy and as such branchiness is a variable showing the

corresponding statistics in such a way that when comparing two national economies, the country which has less branched hair strands is the country with the better economy. The second variable is length: For representing people's ages, length was used as a variable where longer hair represents age and shorter hair stands for the young. Thus, length was used as a common variable which did not interfere with the information concerning well-being; whilst it gave information about overall statistics such as the distribution of old/young people in the country. The third variable used is color: Blue and pink were assigned to represent sex in accordance with the standard representational convention. The fourth parameter, density of hair, gives information about the population of the country.

Apart from these variables, the distribution of the hair is fixed in such a way that longer hairs are placed on the back of the head, whereas shorter hairs are towards the front, enabling users the comparison of two countries in regard to their younger and older population since during this location the strands are placed under a consideration of the percentage youth versus age within a population.

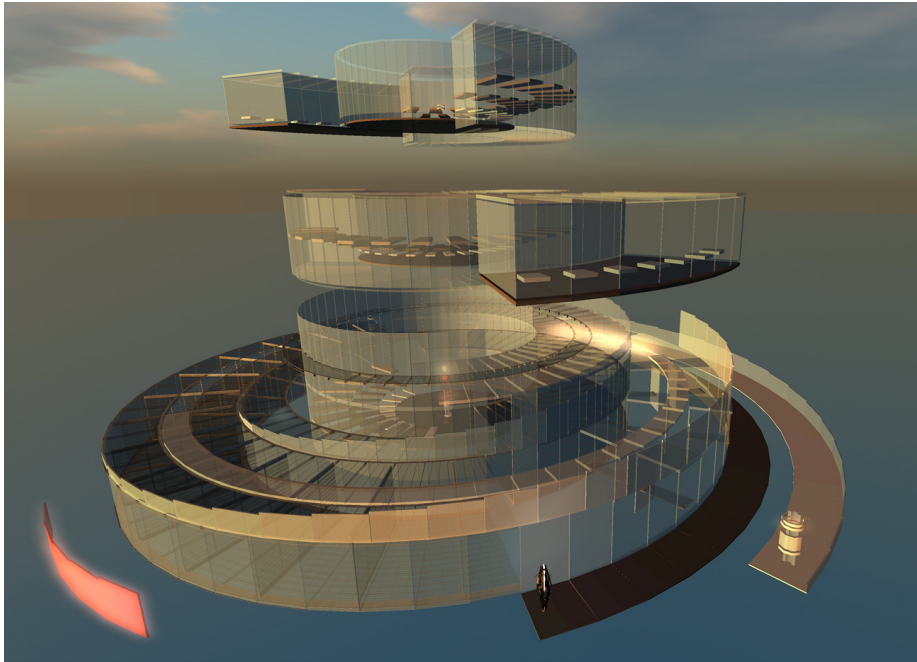
The application is implemented in OpenGL the models are designed in Carrara software package as deformed three variable functions and imported as wavefront objects. For handling large sets of models, display lists were used to improve performance [7].

### **2.3 Project 03: The Reflexive Campus**

The third project involves the creation of a generative, emergent architectural construct destined to become the virtual campus of a Real Life University on a dedicated island in the metaverse of Second Life®. Designed around a core spiral structure the virtual building re-configures itself based upon user demand, adding classrooms, exhibition and meeting areas as well as conference halls and auditoriums, as and when required. Thus, a user-centric, emergent, dynamic construct has been implemented for the creation of a virtual campus, which evolves and changes over time and based upon usage. The ensuing design system also attempts to configure itself based upon the nature of activity undertaken within it: Thus spaces required for survey based learning spread themselves out over the "shallow" horizontal axis, whereas areas of research and deeper levels of inquiry utilize the "deeper" vertical axis in a visual representation of different strategies of learning and levels of epistemological inquiry.

Inspired by two buildings, one real – the Spiral Minaret of the Great Mosque at Samarra, built in 847 AD, and one imaginary - the Tower of Babel as envisioned by Brueghel the Elder, in his so called painting from 1563; a spiral was decided upon as the primary building module around which the entire construct would be generated. However, it was not solely the fascination with these buildings that further prompted this decision: When formal investigations commenced it was found that the continuity inherent in the circular and yet ever expanding shape of the spiral was uniquely suited to the demands of the task at hand, which was one of creating a construct capable of infinitely enlarging itself, capable of rendering parts of itself over and over again, and yet capable of maintaining its holistic structure throughout the generative process. An examination of Morphogenesis and Architecture provided validation for the

implementation of a spiral as the primary form of architectural growth, from which the campus would flourish, since the spiral is a shape also found in patterns of natural growth. [8]

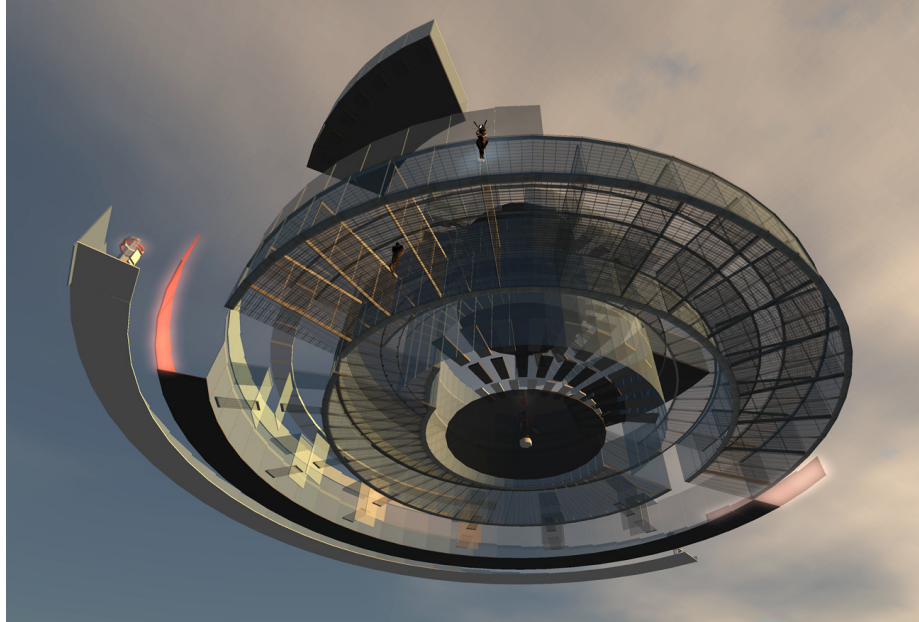


**Fig 3:** The Reflexive Campus: Global view.

Challenging Goethe's statement that "architecture is frozen music", the creators of the Reflexive Campus built the construct around a core atrium, comprised of three half rings slowly rotating around a pivot, forming a spiral of proportional radiuses, calculated by their individual distances from the pivot. Each of these rings fulfills a separate function: Orienting the visitor, creating a catalyst for interaction and providing exhibition spaces for the university's activities. The complex emphasizes the tenets of dynamic/reflexive architecture [9] by expanding and shrinking, where the size is proportionate to the current occupant population and the shape corresponds to the usage that this population is demanding of the space at that time. Thus, while a day of intensive teaching of undergraduate courses will see a campus spread out over a wide horizontal axis accomplished through the rendering of dedicated modules/classrooms for each of the individual course taught; a day of intensive research activity or conferences will see a campus rising along a vertical axis through the rendering of dedicated auditoriums and meeting areas and seminar rooms. Finally, days of mixed activity and maximum usage will see a campus spreading on both axes.

Generating modules for classes or conferences is accomplished through clicking on a red sphere located in the central atrium by persons given the proper administrative





**Fig 3:** The Reflexive Campus: View from below.

authority to do so. Students and visitors can then access their desired location by clicking on a white sphere whereby they can also find out their destination through a menu and can then teleport to the appropriate location by using unique hashed passwords, which are required for each attendant to gain access to the desired destination. The modules which create the spaces of learning/research activity can be categorized as the fully circular large auditoriums for 49 users each which render themselves one above the other directly aligned to the core of the construct, thus causing the building to rise vertically and secondly the pie shaped outer, smaller modules designated for 7 users, which spread outwards from the center in a sunray like manner, causing the construct to expand horizontally, allowing for a virtual, structural re-interpretation of the Platonic diagram of epistemology in the allocation of types of knowledge in relation to one another placed spatial axes as visual metaphors for the acquisition of knowledge.

### **3 Future Work**

After its initial teaching in 2004 the course revealed the urgent need for extended faculty and thus a third instructor, an architect joined the initial team of engineer and graphic designer in 2005. The course has proven to be a success in that a considerable number of student's projects have been written up and presented as research output by the students themselves at various international conferences. Thus, given the scope of some of the student output and the appended research, it is obvious that even further

extension is called for: Thus, faculty from all disciplines throughout the university which is home to the course, ranging from Cultural Studies and History to Mechatronics and Telecommunications; have been invited to bring in their input, on an advisory level, particularly during the inception of the projects, i.e. the “mindmap” phase discussed above.

To utilize the findings, experience and output of the course in the creation of a transdisciplinary graduate program, as well as to integrate the results and findings of the course into the development of novel art and science curricula, both on the graduate as well as the undergraduate level, are other avenues pursued rigorously.

**Acknowledgments:** Heartfelt appreciation of, and thanks to all the students, whose creative as well as academic rigor have made this class into the success that we believe it to be, is in order; starting with those whose projects have formed the substance of this particular study: İsil Demir, Can Sen, Yigit Yuksel (The Miro Avatar); Berkay Kaya, Can Cecen (Hairograph): Bulut Sakcak, Fethi Ozdol (The Reflexive Campus).

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