

Modelling for Eye Level Composition

Design Media Experiments in an Educational Setting

Jack Breen and
Terenja van Dijk

TU Delft, the Netherlands

Abstract

In order to simulate the visual effects of designs at eye level, it is necessary to construct *models* from which (sequences of) images can be taken. This holds true for both Optical Endoscopy *and* Computer Aided Visualisation techniques.

In what ways can an eye level approach stimulate spatial awareness and create insights into the workings of a design concept? Can Endoscopic methods be used effectively as a creative environment for design decision-making and teamwork and even to stimulate the generation of *new* design ideas? How should modelmaking be considered if it is to be of use in an ‘impatient’ design process, and how can students be made aware of the opportunities of both direct eye level observations from design models and of the more sophisticated endoscopic imaging techniques?

This paper explores the theme of eye level modelling by focusing on a number of formal exercises and educational experiments carried out by the Delft Media group in recent years. An attempt is made to describe and evaluate these experiences, in order to draw conclusions and to signal possible new opportunities for *eye level composition* for the benefit of both design education and practice...

The Dynamic Perspective in Design education

The most common form of notation for architectural or urban design proposals is two-dimensional: as a set of drawings showing different ‘flattened’ projections (plans, sections and elevations). This is however obviously not how a design is perceived or conceived.

A built design is not considered from one specific viewpoint, but as a spatial and material complex of forms, proportions, textures and colours. Built environments are ‘taken in’ while in motion, as sequences of visual (and other sensory) impressions: experienced from an eye-level point of view in *dynamic* perspective.

Similarly, the designer (hopefully) does not consider a plan in progress solely in terms of the reduced, two dimensional images which form the output of the design process, but rather as a *spatial* composition which will offer a certain variety and richness of spatial experiences to future users, visitors and passers-by.

Whilst working on a concept, a designer may choose a range of different hypothetical viewpoints, from which to 'approach' the design. Such virtual design views do not necessarily have to correspond with images of the plan as seen in 'real' life (typical 'other' views are for instance functional or structural schemes, axonometric projections or exploded views). Besides such specific techniques of design enquiry and presentation, imagined observations from a simulated *eye level* often play an important role in design development. According to certain architects, such design 'imaging' takes place exclusively in the *imagination*: in the designer's mind. However many architectural and urban designers make use of a range of different visualisation techniques which can serve as *media* (and as such *mediate*) in searching for - and *choosing* - different appropriate design solutions, which together shape the overall design result.

An important ambition of design education should be to familiarise students with the different techniques by which design concepts may be captured and communicated. This involves teaching students to use a range of different design visualisation techniques, including technical drawing, freehand drawing, model making and computer aided drafting and modelling. In professional design processes, such techniques are often used side by side or in different combinations. During their studies, future designers therefore need to come in contact with *all* kinds of different techniques so that they may develop the personalised 'handwriting' which suits each of them most and can be used in practice.

Aspects of the Media curriculum

The educational curriculum of the Media sector at the Faculty of Architecture of Delft University of Technology is involved actively in teaching design visualisation skills. From the beginning of the first year students are involved with integrated courses in *freehand drawing* (by the staff of the Hand Drawing section) and *model making* (in the faculty's central model making workshop). Exercises continue during the study trajectory both in basic educational Blocks of the first two years and in more specific Modules later on in the study.

In Media's Form Studies curriculum the emphasis lies on the study of different aspects of elementary *formal* composition and methods of creating spatial insight. Three dimensional modelling - both using elementary sketch modelling techniques and more sophisticated model making applications - play an important role in the Form Studies programme.

In addition to the two aforementioned courses there is a Design and Presentation Media programme, focusing primarily on latter year students, where multi-media techniques such as Video, Endoscopy and CAAD are utilised.

For the student who is particularly interested in design visualisation and presentation, these different educational lines come together in the Media sector's Differentiation Module D11 - 'Media'.

In this paper some recent activities in the direction of design *visualisation* and *simulation* by the Media are presented.

Form Studies - Educational Exercises

The first part of the Form Studies programme forms a course which runs through the whole first year of the basic study (the first six eight week Blocks which have as their titles: Space; Building Process; The City; Construction; Service Systems and Region). In each Block the

students pay *one* visit to the Form Studies department. The students participate in an exercise, developed by the Form Studies staff, which reflects on the scale and typical compositional aspects, concerning the subject of the specific Block. In most cases the students are confronted with the relevant terms and concepts (illustrated by examples from the built environment) in a lecture in the first week of the Block, which is meant as an *eye-opener* both for the following ‘practical’ exercise and for the Block as a whole.

Typical themes in the exercises are: form and space; dynamic perspective; context; wholeness and contrast; size, proportion, dimension and scale; detail, material expression and colour.

The sessions only last one half day per Block, but are experienced as intensive by the students (and also by the teaching staff). A typical session will begin with the reading of an illustrated text prepared by a member of the staff (as a kind of ‘starter’), followed by an explanation of the task and the (previously prepared) set of materials. The students work directly in working models, a method comparable to *sketching* in three dimensions, working individually while being supervised and stimulated by the teacher. The work is compared during the session and is documented and analysed afterwards - in two dimensions - in an individual folder which is marked together with the three dimensional exercise results and which is kept during the whole first year.

In all of these exercises, impressions of the composition from (an imaginary) *eye level* play an important role. Students are encouraged to view their work in progress from different sides and angles, in order to get an impression of what the spatial design would look like in reality, to check what is not yet in order and needs to be altered, needs to be removed or ‘fine tuned’. Apart from looking *at* the model, the students are stimulated to imagine what one would experience in those places in the model where the eye cannot actually penetrate (a kind of ‘mental Endoscopy’).

Some examples of first year exercises:

- Block 1: a composition using a maximum of nine pieces of white cardboard, which can acquire the qualities of a ‘reduced’ pavilion, comparable to Rietveld’s Sonsbeek pavilion or Mies van der Rohe’s Barcelona pavilion (in Block 2 there is a follow-up where a selected student’s work is used as a starting point for an exercise where variations in proportion and dimension are coupled to the expressive qualities of a ‘palette’ of different material tones and textures);
- Block 3: an urban ‘infill’ exercise (comparable in scope to a simplified version of the Imaging Imagination task of the 3rd EAEA conference workshop), using a removable inset piece per student, working in a simple Styrofoam and cardboard model, which allows the students to ‘look in’ via the different entrances but needing to imagine the dynamic perspective sequences one would encounter when moving around the newly designed (sub)urban space;
- Block 5: alteration of an imaginary loft of 1000 m² by introducing three types of relatively abstract service elements which together add up to 100 m² (which means that 9/10 of the space will remain ‘open’), working in a basic 1 : 50 model which allows the student to ‘look in’ through the entrance and openings in the facades, allowing for a surprising ‘sense of place’.

This method of studying composition by approaching working models from different viewpoints is continued in longer exercises later on in the study programme, which allow for a more in-depth approach.

Findings

The experience of these first year practical exercises is that students are greatly stimulated by

such an ‘eye level’ approach and that this method is very effective in creating insights which are quite new for young people who have only recently left secondary school and have not previously considered the built environment from such a perspective. An added value is that this approach stimulates an *inquisitive attitude* to design and familiarises students with the technique of constructing relative *simple* 3D design ‘testing’ models and makes them aware of the ‘dialogue between 3d *form* and 2D *notation*’.

Design and Presentation Media - Educational Exercises

A latter year exercise, where active use is made of eye level modelling for the development and presentation of design concepts, is the SV Module exercise offered by the Design and Presentation Media section.

The educational programme of this section focuses on the active implementation of different media techniques, such as video, Endoscopy and computer visualisation for the benefit of design *communication*. As such the Design and Presentation Media curriculum is concerned with (multi media) productions intended to highlight the context, image quality and conceptual meaning of a design.

In previous years a number of video based design communication exercises have been offered which documented building projects in progress.

More recently, in the SV Module the method has been to assist students throughout a design evolution process, from the first analysis and design concepts to the final presentation and documentation.

The theme of the ‘combination’ Module SV is the interaction between Urban Design (S: for “Stedenbouw”) and Housing Management (V: for “Volkshuisvesting”). The students’ task concerns the development of large housing projects, consisting of entire neighbourhoods at a time. The chosen sites in recent years have been a number of locations on the old, changing harbour front of Amsterdam (such as the peninsula of Borneo and Sporenburg) and an exchange project organised by the ‘Architects Without Frontiers’ group, focusing on the redevelopment of Sarajevo.

The Media contribution is integrated into the full eight week cycle of the Module. Running parallel to the general progression of the project as a whole, two Media teachers offer exercises combining different techniques, reflecting the central themes of the Module and furthering the development and documentation of design concepts.

In the first four weeks, the endoscope is used in the Media sessions to study different design options for low-level, high density housing proposals.

The first Media session is an introduction to the workings of the video studio and the endoscope facilities, following which in the next three to four sessions, the students, working in groups, experiment directly in the endoscope laboratory by creating and analysing different configurations of fragments for the proposed urban plan, using specially made wooden blocks.

In this way several types of street *profiles* and housing *clusters* can be composed and altered very easily. Different options can be viewed directly on the video screen and registered on videotape.

Each group chooses a variant and in the following sessions the students are busy making their proposals communicable, using selections from recordings made previously, adding new images, schemes, spoken text etc.. These video documents are shown during the Module’s final presentation sessions as part of the total result. They are marked separately by the Media staff. Criteria are group effort, quality of the storyboard and the way in which

video is used in the working process and the presentation.

Findings

This exercise demonstrates convincingly that working directly in the endoscope can be rewarding in an educational project. By trying out *different* possibilities and impulsively trying out variations and introducing sudden, novel impulses, the design imaging process may be activated, often in unexpected ways.

Working with a new technique, such as video, is in itself often an exciting experience for students and the studio atmosphere can be beneficial in ‘focusing’ the group activity. Each student has a clear role to play, yet can contribute freely to the creative process.

Working with the relatively simple wooden blocks which create a sense of scale yet are very easy to manipulate, also has made it clear that it is not necessary to use sophisticated models in the endoscope. On the contrary, this very basic ‘game’ situation has proved to be very stimulating in design decision making and for the benefit of communicating design ideas.

Design Modelling for Endoscopy

One of the problems with scale models is that they generally tend to take such a lot of time to make - often more time than foreseen. This has at times also been a problem in the Media sector’s Differentiation Module D11. Students often tend to ‘lose themselves’ in a model they are busy constructing to such an extent, that they can easily lose track of other planned activities aimed at a project presentation. The fact that the model is often only ready at the very last moment is also often a problem when wanting to use Endoscopy for a presentation. The model is by then so ‘fixed’ that there is no time to alter things even when views using the endoscope indicate that something ought to be altered.

Another experience is that students seem to forget *all* the video lessons they have had previously, concerning camera standpoint, movement, timing, editing and the use of sound (background noise and/or music) when bringing their model into the endoscope laboratory. Endoscopic video presentations are all too often long, rambling, sweeping motions though and around the model, with someone’s favourite piece of music put indiscriminately on the soundtrack. Often the viewer completely loses track of what is happening due to a lack of *orientation* (this is a phenomenon which is not unique to optical Endoscopy but is also a problem with many computer animations).

Planning is of paramount importance. If a student knows beforehand that he or she wants to use moving endoscope sequences, it is important to create a *storyboard* well in advance. In this way the model is considered as a scenographic instrument: as a *film set* in a movie. This means that only the parts which are of importance for the presentation need to be made and the *level of detailing* can be reduced to a large extent, so long as the subject matter will come across well (enough) in the final video production (again a similar situation holds for students preparing computer animations).

In view of the experiences with modelmaking ‘bottlenecks’ in the D11 Module, an exercise was set up in the first part of the module with the aim of studying how simple, yet suggestive, a model can be for it to work well in an endoscope environment. For this a link was created between the modelmaking exercise and the video exercise in the module. The students were confronted with a design situation using a 1 : 200 scale model. The design task called for the addition of a number of new buildings in a ‘set’ situation. In a video exercise in the studio the students first of all made a small film explaining the assignment.

Subsequently, each student created a design for the facade for one of the types of buildings to be included in the plan. Next, a model was made with the explicit intention of presenting this in the endoscope. The basis for each of these models was a piece of transparent plastic bent into shape to form the front facade and two side facades of the new building. Only the most necessary information was worked out. Using relatively simple materials, such as thin plywood, coloured paper, wire mesh and even structures or patterns copied on (coloured) paper, the models were made. The different design solutions were then viewed in the endoscope and - in a group process - were incorporated into a dynamic sequence registered on video.

Findings

This exercise showed that an effective urban model could be made relatively quickly (basically one half day for making the model) which yielded video images of surprising quality. This experience proved to be an effective introduction to the opportunities of eye level design exploration and presentation using optical Endoscopy and video, and at the same time introduced a number of time saving modelling techniques, which proved a valuable lesson towards preparing the final presentation for the D11 Module in the next weeks.

The (in)visible city Experiments

A specific study by members of the Dynamic Perspective research group and the Form Studies staff concerns the '(in)visible city' projects. This study was carried out in two parts: a first step as part of the workshop sessions of the 1995 EAEA conference in Vienna and second step in which the models prepared for the conference were worked out further in an experimental educational exercise as part of the sector's D11 Module.

The central theme of both exercises was to explore how *optical* and *digital* Endoscopy can be employed in an active, creative design process and how these two techniques compare. The following is an overview of the most significant experiences and findings.

The EAEA Workshop Project

The Dynamic Perspective research programme of the Delft Media group is concerned with the study of composition and perception and of methods and effects relating to design visualisation and communication techniques, including Simulation Technology (Breen, 1996).

In this particular study an attempt was made to explore the possibilities and boundaries of existing imaging techniques and, where possible, to attempt to shift the boundaries and find new methods for indicative design visualisation on the scale of the urban ensemble. The study explored the potentials of simulation techniques (which are generally implemented in the concluding phases of the design process) as creative tools in the *idea* phase of design. The study aimed to include both optical endoscopic techniques *and* computer aided techniques. The ambition was to not only compare the two types of environmental simulation technologies, but where possible to attempt to employ them in combination, in a form of creative *symbiosis*.

The study was prepared for the Workshop 'The (in)visible city', which was a part of the second conference of the European Architectural Endoscopy Association (EAEA) held in Vienna, Austria in September 1995. For this workshop a number of European universities, active in the field of architectural simulation, were invited to prepare contributions which would be presented and discussed at the conference (Martens, 1996).

Starting point for the projects was a masterplan by the Viennese architect Rüdiger Lainer for a city extension on a former airfield at Aspern. A scale model scale 1:500 travelled around the participating universities.

Inspired by a preliminary study of a number of recently completed urban plans, the TU Delft Dynamic Perspective research group developed a critical reaction and translation of the original, somewhat 'restless', deconstructivist masterplan. The design simulation focused on the segment of the general masterplan indicated in the travelling scale model. Whilst attempting to maintain the dynamic qualities of the original plan, the number of directions was reduced, an attempt was made to structure and diversify the qualities of different public spaces and the qualities of a number of visual axes was intensified.

If one wants to simulate impressions with an endoscope one needs a model. After initial experimentation, a 1:500 model proved unsatisfactory and the decision was made to build a model scale 1:200. Because of the size of the site, this eventually amounted to a physical model of approximately 2 by 4 metres! Because of the design character of the study, the model had to be relatively simple, quick to build and easily to manipulate. After preparation of the underground, simple strips of Styrofoam in different dimensions were prepared be used for the building blocks.

A number of technical rounds were carried out to test cameras, lighting, backgrounds, effects of colours and of different basic facade patterns. To apply facades onto the building blocks a method of visual '*sampling*' was used, comparable to techniques used in contemporary music production. In the initial steps, simple geometric patterns, made on the computer, were applied. Subsequently a distinction was made between open and closed parts in the elevations by introducing a tone difference, which greatly improved the effect. In the next steps samples were taken from realised projects. This involved scanning parts of buildings into the computer from photographs and then 'straightening' the perspective using a photostyler program. Such basic patterns were then multiplied into greater patterns. In this way a number of types of 'urban wallpaper' scale 1:200 was created. These could be glued onto blocks in a very similar fashion as the application of *texture maps* in the computer. The prints could be made on different sorts of paper suggesting different kinds of materials, coloured stucco etc. when seen through the endoscope. Based on design precedents a number of facade textures was also worked out graphically. The effects of different elevations could in this way be compared relatively simply. By adding other elements suggesting scale or secondary boundaries, impressions roughly approaching a realistic image could be created. By using the model as a kind of film set, moving sequences of different routes through the design were explored and recorded on video.

The computer formed the counterpart of the physical model and endoscope. It was essential in creating the 'textures' for the scale model. These could naturally also be used in the 3-D digital model being 'built' in the computer itself. The computer model made use of the same basic floor layers of standard height (3 metres) as in the physical model.

Besides creating the samples for the elevations, other computer tests included making 'trees' (almost always of embarrassingly poor quality in computer renderings) from 2-D illustrations.

Besides being used for several types of animation, the computer was also used in a try-out using 'real time' Virtual Reality software. The same geometric model was used, but now d

of the elevations were not considered as continuous surfaces to be ‘mapped’. Instead the facades were divided into regular ‘facets’ of 3 by 6 metres. Sets of fitting ‘fronts’ were stored in a project library to be accessed via a menu. By clicking on specific frames and choosing different fronts, the visual impression could be altered ‘in situ’ with relative ease.

Findings

The method used in this study obviously does not produce finished building designs, but it did prove very useful in creating an *indication* of the types of facades and other elements proposed within an urban ensemble. Created in a relatively short time, the study proved worthwhile although it was obviously limited in its scope. The exercise left a number of open ends that could each be developed further. Even though it can not truly be evaluated objectively, some notable items were brought forward by this explorative study:

- The two types of model built ‘side by side’ proved to have distinct qualities, each with specific advantages and disadvantages.
- The physical model was big and cumbersome, building it was physical work and the condition of assembling the model within the confines of the available endoscope space proved a distinct limitation.
- Lighting such a large model proved difficult and generated considerable heat, colours of materials might look different in normal lighting than in the studio.
- The texture-mapping of facade patterns worked well in both models. Because of this method, the scale model not become too complex and could easily be changed. The computer was indispensable in making the patterns. Applying textures in the scale model could be done more precisely and creatively than in the computer, but was messy.
- The overview of the ‘real’ model (not necessarily the endoscope views) proved stimulating in itself and generated ideas for variations which were incorporated in the computer model.
- The Virtual Reality experiment proved interesting. However, the set-up used was too limited. For creative manipulation an extended library and more flexibility are necessary.
- Colour in the computer needed extra attention. This experience lead to a number of try-outs and a follow-up using more subtle ‘atmospheric’ perspective.
- Animation in the computer was relatively simple but remained a time-consuming affair and tended not to be changed afterwards. With the endoscope, motion was more improvised, but a number of ‘takes’ could be made relatively easily and the best one selected.
- The experience plus the availability of the two types of model after the workshop, stimulated an educational follow-up. The endoscope model proved vulnerable and had to be restored before the educational exercise.

The Delft Educational Project

The results of the pilot study became the basis of the subsequent educational workshop offered by the Media group. It took place in the first four weeks of the eight week ‘Media Module’, parallel with a number of other exercises meant to acquaint the students with several types of design visualisation and communication techniques.

In the exercise, three groups and their tutors were brought together into one big group. The metaphor of the design office was used to create the proper atmosphere: the three teachers acting as the managing directors, the students as the design staff members. The ‘office’ had received a commission and an initial plan would have to be ready in four weeks time. The staff would split up into groups of three to four designers. Each group would work out a ‘scenario’ which would be presented in four weeks time, the deadline was set. The winning proposal would in theory be adopted by the office and worked out further...

The site was a tricky, triangular area, a 'wedge' bordered by two routes and with another cutting across it (the central triangle in the (in)visible city 'design', which had been removed for this purpose). Reacting to the different directions present in the adjacent parts of the masterplan (which *had* been 'realised' by others and as such were set) and the system of the visual axes would be required. An indication of elevations and material expression would have to be presented and elements such as trees would have to be incorporated into the presentation if they were important for the design concept...

A 'previous proposal by another office' had failed to become a success. The floor space of that plan was given as an indication, but as this had not worked out, there was considerable freedom in creating a new proposal...

The student teams were stimulated to visualise and discuss different design strategies and to document these. They could use any traditional techniques they wished such as sketches, scale drawings, collages and models. In addition they were able to use the endoscope and computer aided visualisation techniques. During the first three weeks the students were also be acquainted with CAD texture mapping techniques in a separate course, practising in the same digital model, which they could subsequently use as a basis for their plan presentation. The facade patterns created for the Vienna workshop were available to the students, both in the computer and as prints which could be copied and used in endoscope proposals.

Findings

The students set about their tasks with considerable enthusiasm and the workshop produced results of surprising quality and originality, considering the limited time which was available.

Nine different teams presented a proposal, each with its own motto.

The results were eventually a reason for the 'managing directors' to commend not only one plan but four, each of which excelled in a particular way:

- an elegant and compositionally strong 'landscape concept';
- a realistic and compact plan with articulated spaces and facade treatment;
- a plan incorporating theatrical effects and an impressive use of video;
- a proposal making innovative use of computer visualisation techniques.

For such a limited number of groups the results were surprisingly varied, both in content and presentation. Some tendencies worth noting:

- The different group-structures of the teams influenced their progress, some teams were good at organising and dividing tasks, for instance splitting up into sub-groups of two, other groups got collectively 'stuck' in the first phase, only getting out of the deadlock with difficulty.
- Although both endoscope and computer were actively utilised, a number of other techniques were used in unison, specifically in the initial development phase, collages and sketch models scale 1:500 were used rather than going straight into the 1:200 endoscope model. In a survey held among the students about their preferences concerning media techniques via a questionnaire, there proved to be considerable differences amongst them.
- Other techniques being taught at in the Module at the same time also proved a stimulus for the presentation of proposals, notably Video production.
- The use of texture maps proved to be a success. However not enough different types were available and the same sorts tended to be used extensively. Nobody took the time to create their own patterns!
- The textures offered standard with the texture mapping computer software did not prove stimulating. On the contrary they could lead to missteps (like the use of bricks of 1 by 2

- metres or worse). In an exercise like this they should ideally be ‘removed’ from the menu.
- The lack of computer experience and particularly the lack of available computer time formed a handicap for those students who had decided using computer visualisation.
 - The computer option attracted both students already proficient at CAD (which in one instance led to the kind of semi-transparent volumes floating in the air with which we have become so familiar) whilst for others this was the first real experience in the creative use of Computers. The experience stimulated a number of students to continue with CAD in the second phase of the Module, leading to further creative applications.
 - The ‘real’ model, being vulnerable, was completely ‘finished’ after the educational workshop, while the digital model survives on the hard disk, new renderings and animations can in principle be made whenever needed.

Conclusions and Opportunities

As is argued in the previous chapters, it is extremely important for students to be made aware that their designs will be appreciated in real life through dynamic visual experience, and to keep this in mind whilst designing.

Models (both scale models and computer models) can offer very useful information to the designer and to others involved in the design process.

A model can be extra effective if it enables one to view the design proposals *as if from eye level* (the way in which we would also experience the finished product). This can be achieved relatively easily by constructing a model in such a way that it is possible to look into (parts of) it, or by making certain parts removable so that one is able to glimpse inside. This is possible by viewing the actual model or by taking photographic images from it, in which case special attention can be paid to lighting, creating an optimal impression of the designer’s intentions.

A very useful method is to employ (optical) Endoscopes. These can either be mounted directly on a photographic camera or connected to video equipment. Advanced Endoscopy facilities allow for flowing motion through the scale model.

If motion is required it is important to view the undertaking as a *video production*. In this case a well thought out - scenographic - approach and creative planning is essential, if the result is going to be interesting (and indeed acceptable) to a critical (and often spoiled) audience.

The quality of the model and ‘secondary’ information, such as ‘meaningful’ elements placed in the model environment plus, for instance, background sound will enhance the effect of an endoscopic production.

If models are made *specifically* for the endoscope, this can potentially limit the amount of time and work needed to make the model. This is an extremely important factor as modelmaking is notoriously time consuming.

If Endoscopy is to be effective in *creative design*, the models have to be kept as simple as possible and have to be easily changeable, in order to test different options, take in changes in direction and facilitate group decision making. Texture mapping techniques can be particularly useful in creating - interactive - urban design models, both in scale models using *optical* Endoscopes, but also in models created using *digital* Endoscopy. Interesting opportunities for enhancing more traditional visualisation techniques through the introduction of computer based techniques are still developing.

Lastly, the physical relationship between scale model and endoscope is an important one. The endoscope should be as ‘available’ as possible during a modelmaking process. Just as it

is both practical and stimulating for someone creating a model in a computer to make intermediate 3D views, and one always has one's eyes available for eye level observation when working on a Form Studies exercise, so the ideal situation would be to have a (perhaps simpler) endoscope readily available at all times in the modelmaking workshop.

Notes and References