GENERALIST OR SPECIALIST?

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Abstract

The profession of the architect is closely tied to changes in society and correspondingly subject to ongoing deliberations on the changing demands of planning and building. Factors that influence this include technological developments, changing values in society and changes in the organisation and production processes of cities and buildings. Today, architects need a combination of technical, artistic and aesthetic, sociological, organisational and economic skills.

Ideally, the architect is a competent partner for all aspects of a project, representing the interests of the clients on the one hand and society and the community on the other. But above a certain size of project, a single architect is unable to assume responsibility for all the tasks of the master builders of old. He is, however, as a product of his training and interdisciplinary knowledge, the only person who is able to communicate and coordinate the project idea which he created. In such circumstances he acts as a directing coordinator, the lead manager of an interdisciplinary process – he uses his knowledge as a generalist. In other cases, architects are also involved as specialists responsible for a sub-aspect of larger interdisciplinary projects. For certain kinds of planning tasks, architects often specialise on such sub-aspects, for example on design, project controlling or supervision of construction works – professional niches within the profile of an architect.

The education of architects needs to respond to the breadth of different activities that architects undertake. Instead of specialist knowledge, education must actively communicate a broad range of general knowledge to provide a basis and strategies for students to pursue their own professional interests and skills in further education and life-long continuing professional development. Technological proficiency, creative and visionary skills and a sense of responsibility towards both the client and public in general are the central pillars of the profession. When used responsibly and conscientiously they lead to buildings that are well-planned and constructed and contribute in general to furthering architecture as a whole.

The changing context in which architects work has implications for the profession and the occupation of architects. Architects are increasingly being brought in as a part of larger, complex project management teams. Here architects need to actively pursue and shape collaboration with other partners in the construction process – to seek cooperation instead of competition. The fact that architects are increasingly called upon to work as part of more complex value chains requires a greater readiness to provide not only the entire range of services as detailed in the HOAI (the German fee and services scale for architects) but also individual services and fragmentary contributions.

The need for architects to concentrate more on particular services has led to the coining of a new understanding of architects as “generalists with core competencies”. While architectural offices may wish to clearly define their area of expertise and the direction they want to move in, market forces may require them to find a balance between specialisation and a breadth of services in order to flexibly react to market demands. At the same time the clients in the marketplace would prefer to deal with one partner who is able to offer a variety of integrated services. To be able to respond to this, architects will increasingly be called upon to offer their services as a network, both in the form of collaborations but also together with other related disciplines. Only then will they be able to tackle complex building tasks while remaining flexible enough to reach to changing demands in the market place. Lastly, the profession of the architect and his role in the construction sector is also changing as a factor of technological advances, both in construction as well as information technology.

The paper describes how teaching and research at the Faculty of Architecture of the TU München is responding to the changing profession and role of the architect. The article focuses on the different aspects of the curriculum of the diploma studies programme (currently being replaced by a bachelor and masters programme) and selected special courses on offer in the field of architecture informatics.

Keywords: education, computer science in aarchitecture, computer pool, digital production, parametric design, diploma

УНИВЕРСАЛ ИЛИ СПЕЦИАЛИСТ?

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Аннотация

Профессия архитектора тесно связана с изменениями в обществе и, соответственно, подчинена продолжающемуся обсуждению изменяющихся требований к проектированию и строительству. Факторы, которые влияют на это, включают технологические разработки, изменения в обществе и изменения процессов организации и осуществления строительства городов и зданий. Сегодня архитекторы нуждаются в комбинации технических, артистических и эстетических, социологических, организационных и экономических навыков.

В идеале архитектор - компетентный партнер во всех аспектах проекта, представляя интересы клиентов с одной стороны и общества и сообщества – с другой. Но выше определенного размера проекта отдельный архитектор неспособен принять ответственность за все задачи старых квалифицированных строителей. Однако он, как продукт обучения и междисциплинарных знаний, единственный человек, кто способен к коммуникациям и координированию идеи проекта, который он создавал. В таких обстоятельствах он действует как координатор направления, ведущий менеджер междисциплинарного процесса - он использует свои знания как универсал. В других случаях архитекторы также привлекаются как специалисты, ответственные за разделы больших междисциплинарных проектов. В некоторых видах проектных задач архитекторы часто специализируются на таких разделах, как, например проектирование, управление проектом или надзор за строительными работами - профессиональные ниши в пределах профиля архитектора.

Образование архитекторов должно соответствовать широте различных действий, которые архитекторы предпринимают. Вместо знаний специалиста, образование должно активно обеспечивать широкий диапазон общих знаний, чтобы создать основу и стратегии для студентов с целью обеспечения их собственных профессиональных интересов и навыков в дальнейшем обучении и долгосрочном непрерывном совершенствовании профессионала. Технологическое мастерство, творческие навыки, навыки предвидения и ощущение ответственности перед клиентом и публикой вообще – главные опоры профессии. При их ответственном и добросовестном использовании они воплощаются в сооружениях, которые хорошо спроектированы и построены, и вносят вклад в развитие архитектуры в целом.

Изменяющийся контекст, в котором архитекторы работают, имеет значение для профессии и рода занятий архитекторов. Архитекторы все более и более привлекаются как часть команд управления большими, сложными проектами. Здесь архитекторы должны активно заниматься формировнием сотрудничества с другими партнерами в процессе строительства - чтобы обеспечить сотрудничество вместо соревнования. Факт, что архитекторы все более и более призваны работать как часть более сложных цепочек, требует большей готовности обеспечить не только полный объем услуг как

детализировано в HOAI (Немецкая шкала гонораров и услуг для архитекторов), но также и индивидуальных услуг и фрагментарных вкладов.

Потребность архитекторов больше концентрироваться на специфических услугах вела к монетаризации нового понимания архитекторов как “универсалы с основными компетентностями”. В то время как архитектурные офисы могут желать ясно определить свою область экспертизы, и направление, в котором они хотят двигаться, рыночные силы могут требовать, чтобы они нашли баланс между специализацией и широтой услуг, чтобы гибко реагировать на требования рынка. В то же самое время клиенты на рынке предпочли бы иметь дело с одним партнером, который способен предложить разнообразие объединенных услуг. Чтобы быть способными ответить на это, архитекторы будут все более и более призваны предлагать свои услуги как сеть, как в форме сотрудничества, так и вместе с другими связанными дисциплинами. Только тогда они будут в состоянии заняться комплексом строительных задач при сохранении достаточной гибкости, чтобы удовлетворять изменяющиеся требования рынка. Наконец, профессия архитектора и его роль в строительном секторе также изменяется как фактор технического прогресса, как в строительстве, так и в информационной технологии.

В статье описывается, как обучение и исследования на Факультете Архитектуры ТУ Мюнхена отвечают на изменения профессии и роли архитектора. Статья сосредотачивается на различных аспектах учебного плана программы занятий дипломников (в настоящее время заменяемой программой для бакалавров и магистров) и отобранных специальных курсах в области информатики в архитектуре.

Ключевые слова: образование, информатика в архитектуре, компьютерный класс, цифровое изготовление, параметрическое проектирование, диплом

1. A short retrospective history of the TU München

In 1868 King Ludwig II founded the newly structured Polytechnische Schule München, which was accorded the status of a university. With the beginning of the academic year 1877/1888, the university took up the name Technische Hochschule.

The college was originally divided into five faculties: I. General Department (Mathematics, Natural Sciences, Humanities, Law and Economics), II. Engineering Department (Structural Engineering and Surveying), III. Department of Architecture, IV. Mechanical/Technical Department, V. Chemistry/Technical Department. In 1872 a sixth Faculty of Agriculture was added.

In 1901 the Technische Hochschule was granted the right to award doctorates, and in 1902 the election of the principal by the teaching staff was approved. With an average of between 2,600 and 2,800 students, the TH München was, for a while at least, the largest German Technical College ahead of the TH Berlin. 1905 marked the enrolment of the first female undergraduate in architectural studies after the Bavarian government officially allowed women to study at a technical college in the German Reich.

Its current designation – the Technische Universität München – was conferred in August 1970. With the introduction of the Bavarian Higher Education Law in 1974, the six faculties were replaced by eleven smaller departments, which soon resumed the designation of Faculties: 1.Mathematics and Informatics, 2.Physics, 3.Chemistry, Biology and Geosciences, 4.Economics and Social Sciences, 5.Structural Engineering and Surveying, 6.Architecture, 7.Mechanical Engineering, 8.Electrical Engineering and Information Technology, 9.Agriculture and Horticulture, 10.Brewing, Food Technology and Dairy Science, 11.Medicine. In addition, several interdisciplinary central institutes were established, initially for regional planning and environmental research, as well as sports sciences.

In 1992, the former Faculty of Mathematics and Informatics was divided into two to create an own Faculty of Informatics. Ten years later a Faculty of Sports Science and a Faculty of Economics followed.

The Weihenstephan campus was restructured for the start of the winter semester 2000/01 and realigned to house the sciences: the former Faculties of Agriculture and Horticulture, Brewing, Food Technology and Dairy Science, as well as the Forestry Faculty that previously belonged to the Ludwig Maximilian University, were collectively accommodated in the newly established Weihenstephan Science Centre for Life & Food Sciences, Land Use and the Environment (WZW).

Numerous other reforms have been realised since 1995, such as the introduction of efficient guidance and decision profiles, continued moves to increase the university's autonomy in keeping with the new philosophy of an 'entrepreneurial university', university-wide core competences in the field of informatics, the establishment of central institutes and research platforms with an interdisciplinary focus, the introduction of numerous, attractive Bachelor and Masters degree courses, strategic internationalisation, enhanced collaboration with industrial and social partners, the stepping up professional fundraising and the inauguration of the Carl-von-Linde Academy to house the Humanities, Cultural and Social Studies. In 2002, the TUM founded the 'German Institute of Science and Technology' (GIST) in Singapore, the very first subsidiary of a German university abroad.

In 2006, the German Council of Science and the Humanities and the German Research Foundation (DFG) awarded the TUM the status of a University of Excellence. Teaching and research at the TUM aims to be of the highest academic standards and is on a par with the best international standards.

In 2009, the TU München was selected by the Stifterverband innovation agency for the German science system as one of ten higher education institutes from a total of 108 applicants to be part of the “Excellence in Education” funding programme alongside four other colleges and five universities.

2. The Technische Universität München today – the role of computer science in architecture studies

The ‘New Polytechnic School’ was erected between 1864 and 1868 directly opposite the Old Pinakothek (Art Museum) as a Neo-Renaissance building according to the plans of Gottfried von Neureuther. This was the first time in Bavarian history that architects and engineers were to be trained separately.

Following World War I, the ‘Schools of Style’ were gradually transformed into ‘Schools of Construction’. From 1924 onwards, a 24-month period of practical building experience became compulsory in Munich.

The Technical University took up its teaching function again in the summer of 1946 after the end of World War II. The total number of students of Architecture rose from 680 in 1950 to 850 in 1968. Up until well into the 1970s, architectural education at the TUM was characterized by headstrong individuals: initially, during the fifties, by Gerhard Weber and Gustav Hassenpflug, both renowned stalwarts of the Bauhaus style who upheld aspects of modern architecture and later by Josef Wiedemann and Johannes Ludwig who stood for a more moderate style of modern architecture.

The focus and strength of architecture studies at the TUM has always been, and still is, a sound, structurally-grounded approach to architectural design.

In the nineties, the Faculty honed its profile and improved its reputation by appointing several internationally recognised architects to Chairs in Architectural Design. The founding of a Technology Centre and the Museum of Architecture reinforced the construction and technical focus as well as the historical focus of the Faculty respectively.

The paradigm shift towards the information society has had a major impact on the profile of the architect, the production of architecture and, perhaps more than anything, the medium of the computer has revolutionized the design process. The establishment of the Department for CAAD in 1995 responded to the changing demands in teaching and research and marked the introduction of computer science and architect courses to the curriculum. The necessary IT infrastructure followed with the appointment of Professor Junge. The Faculty of Architecture now has computer pools with 70 workstations, 6 plotters, a large-format scanner, a rendering pool with four render clusters, a seminar room with a further 30 workstations, a VR stereo projector, a Digital Design Lab with two laser cutters, 2 milling machines and a 3D plotter.

The machinery park and workstations will be expanded in the near future to a total of 140 workstations to accommodate the increasing demands of teaching and research.

3. CAAD in architectural education

Because the profile of architects is still changing, research and teaching should focus increasingly on medium and long-term technologies and systems. Emphasis should therefore be given to communicating the fundamentals and underlying principles of the individual programs to communicate a broad common basis. It is nevertheless additionally necessary to learn the operation of software systems currently available on the market as students need to able to experience their use in practice and not just in theory.

To address these different issues adequately, teaching should be multifaceted: it should cover the communication of theoretical principles and the practical use of available tools as well as foster an ongoing discourse on progressive technologies. Collaboration with other chairs within the faculty as well as with other disciplines is essential. Integrated teaching concepts allow students to explore the boundaries as well as common ground between analogue and digital tools. Architecture education needs to be interdisciplinary and realistic on the one hand and research oriented on the other – it should deal with both theoretical and practical aspects. In this way, the next generation of architects will not only be able to use the available tools appropriately in the work process and to critically assess their relevance, but will also be able to explore new means and solutions – to shape their tools and not just use them as an end user.

In Grundstudium, the first part of the diploma studies, the fundamentals of CAAD are taught in semester 3 in conjunction with practical exercises that allow the students to anchor and deepen their knowledge using commercial programs. In Hauptstudium, the main course of studies, additional, more detailed topics are dealt with, for example BIM modelling, rendering, parametric design, scripting and rapid prototyping.

Diploma projects are typically allocated centrally at the TU München with common project briefs. Students can, however, choose a special diploma project in order to pursue a topic of their interest, for example digital building surveying, parametric design or VR in the design process.

4. Diploma study programmes and computer science in architecture

The greater part of all IT-related teaching in the context of architecture is undertaken by the Chair for Architectural Informatics (former Chair for CAAD) | www.caad.ar.tum.de (see figure 1/2)

Fig. 1 Computer room

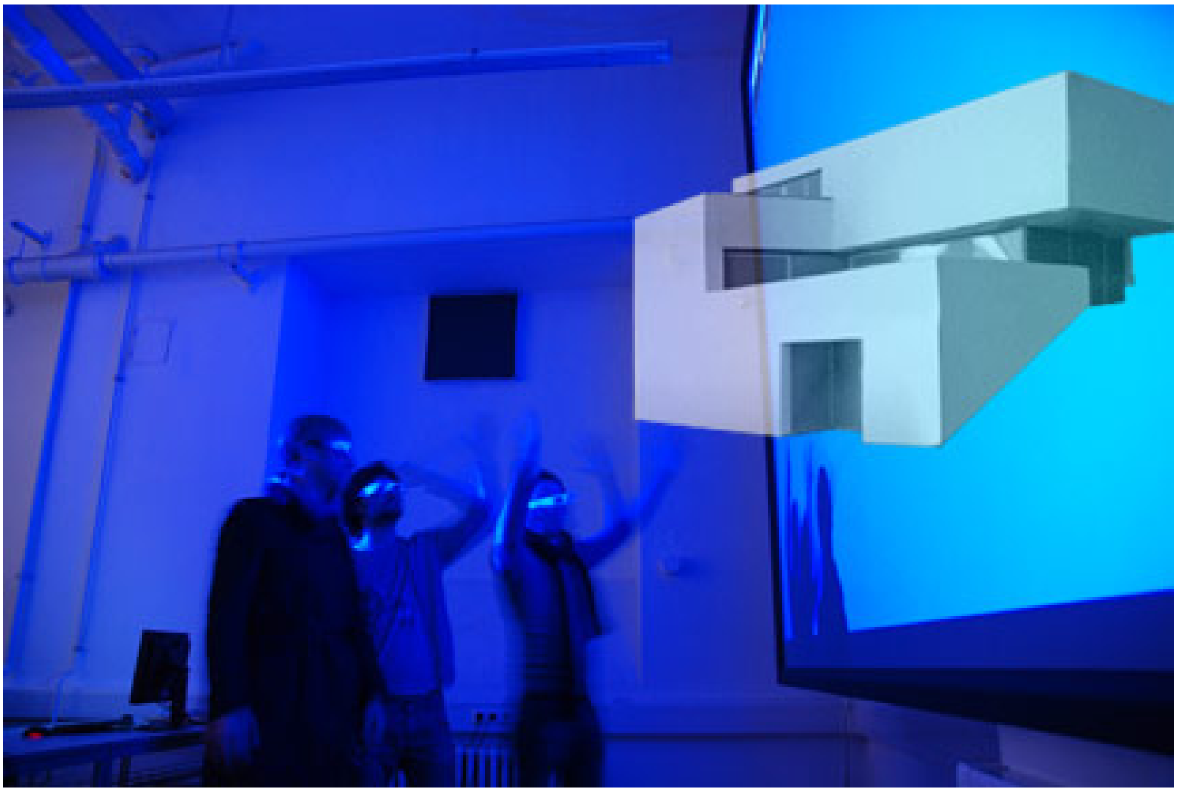

Fig. 2 Seminar room with VR projection

The foundation is laid in the third semester of Diploma studies with an obligatory series of lectures on the theory of “CAAD Principles” (3 credit points).

The lecture series examines the process of architectural design and planning in construction practice and how digitals tools support the different aspects. Students are taken through the typical process of a designing and planning architect who needs to develop designs and plans for the construction of a building or of urban environments. Fundamental principles such as the building model, data exchange formats, modelling and animation principles are explained as well as current progressive techniques such as Virtual Reality. The lectures are complemented by three practical exercises, such as BIM, rendering and layout, undertaken on the computer so that students are given the opportunity to apply their knowledge and get to grips with software applications (see figure 3/4).

The focus here is not on particular software products. The practical exercises serve to practice the basic principles of computer aided architectural design and object-oriented building construction.

An introduction to building object-oriented software systems such as Nemetschek Allplan, Graphisoft Archicad and Autodesk Revit provides an ideal introduction to the use of such systems. Specially schooled tutors help the students grasp the building-object-oriented approach to construction and the basics of creating three dimensional models on the computer. In addition to the guided introduction in the chair’s own computer pool, a series of online tutorials are also available to students. This approach to communicating software skills to many students at once was established long before the various e learning platforms started to emerge.

Fig. 3 Rendering, Engelhardt

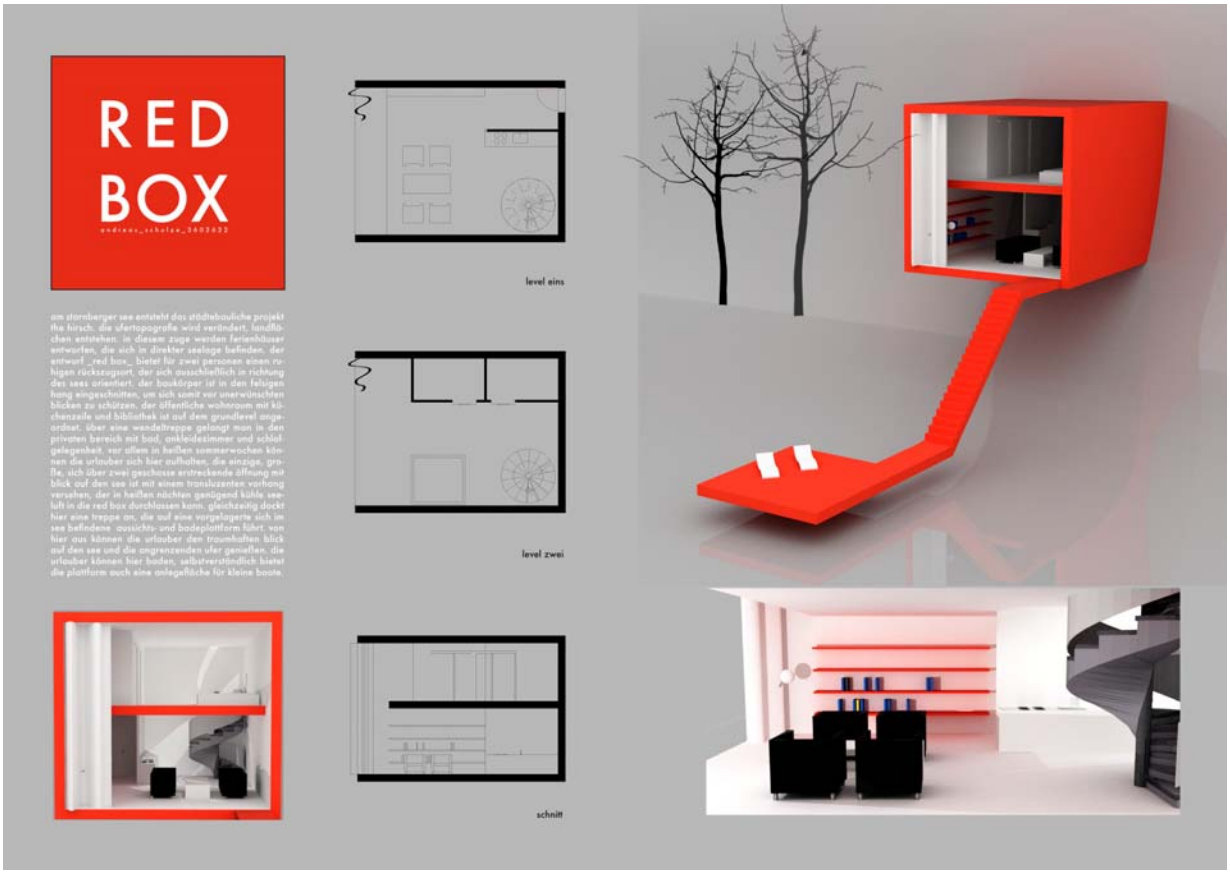

Fig. 4 Layout, Schulze

In core studies students can pursue more detailed topics to do with information technology and architecture in one or two semester long courses.

The topics of the courses vary from semester to semester and range, for example, from the practical use of planning-oriented CAAD systems to 3D building modelling (BIM), model presentation techniques and digital model making.

The necessary software skills are taught in additional weekly training sessions with around 30 students per course. Practical exercises that relate specifically to the topic of the course are practiced in teams of 2 or 3 students.

In summer semester 2009, for example, the “Design + Production” course provided students with the opportunity to deepen their knowledge and skills in digital production and manufacturing. Particular focus was laid on the possibilities and potential of using cutters, lasers and 3d-plotters which were explored using a practical task.

Different construction methods and techniques were first examined using a series of smaller practical exercises. The students then applied this knowledge in practice to solve a small architectural design task. In this case, students were asked to design a market stall for the Viktualienmarkt, Munich’s speciality food market, using conventional 3D modelling software such as Rhino, Cinema 4D or 3D Studio Max. In a second stage, part of the building was then elaborated on and optimised and finally realised at a scale of 1:20 using the department’s laser cutter and milling machines.

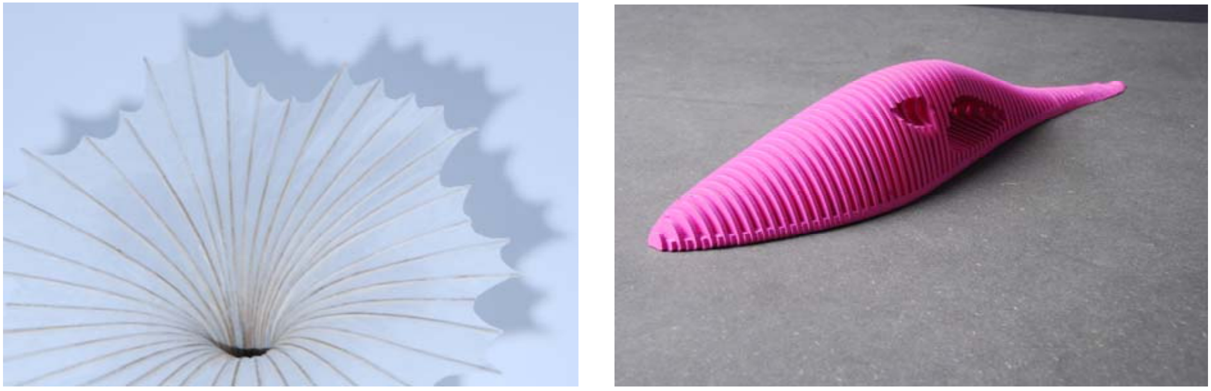

Fig. 5 Design + Production

Another course focussed on the topic of “parametric design” using wood as a material. Together with the chair for timber design and construction at the TU München under Professor Hermann Kaufmann, the students were asked to develop six designs using parametric software and to realise them using digitally-controlled woodworking machines at life-size. The seminar was divided into two parts. In summer semester 2009, the students were schooled in parametric design software and digital production techniques by the Chair for CAAD. In the following winter semester the students were then able to apply their skills to a design task at the chair for timber design – an item of street furniture.

This design task was chosen as a vehicle for the students to explore the variety and possibilities of parametric software from the design phase to final production. The intention was not to produce a single item of street furniture but through the appropriate choice of design parameters to produce different variants that react to the respective location and its environment in order to demonstrate the potential of using parametric software for designing.

Thanks to a completely digital chain from design to detailing to final production in a specially-equipped carpenter’s workshop, the students are able to realise their designs for street furniture and have them produced. In March 2010 the students will assemble their finished products. By choosing a scale of 1:1 the students are confronted first-hand with the difficulties as well as the possibilities of this approach.

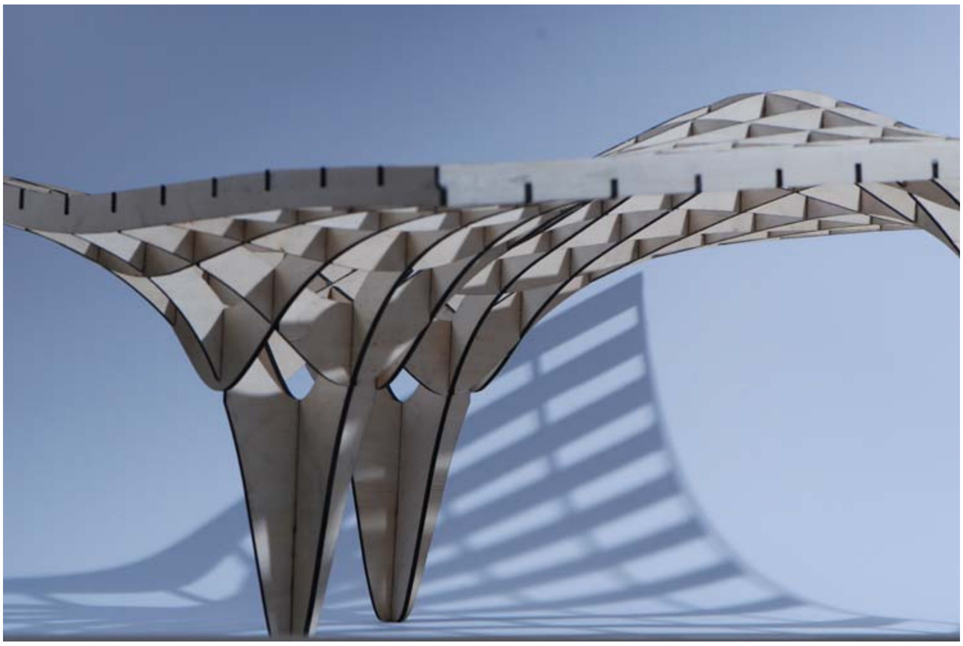

Fig. 6 Parametric design (Aderhold, Mühlhaus, Seifert)

Fig. 7 Timber design project (Mühlhaus, Seifert)

In addition to tutoring students in Grundstudium and the parametric timber design project in the winter semester, students also had the opportunity to take a third course:

Winter semester 2009/2010 | Parametric Architecture

In this course, students also have the opportunity to explore the possibilities of computer-aided planning and production methods. To begin with, the basis principles of parametric modelling are communicated in an intensive workshop. In a series of successively explorative thematic lectures and practical exercises, various architectural issues were explored such as aesthetics, light, colour and production. A series of parallel “finger exercises” enable the students to anchor these as software-specific skills alongside the theoretical principles.

Finally a small architectural design task serves as a vehicle for the students to apply their knowledge and realise it in the form of a 1:1 model.

Diploma project topics are typically announced centrally by the Faculty of Architecture. Students can, however, elect to undertake a special diploma project in order to pursue a topic of their interest. The topics are agreed together with the respective chairs and can have either a design or theoretical emphasis.

In winter semester 2009, two special diploma topics were undertaken at the Chair for Architectural Informatics. Using two different design tasks, the appropriate use of digital CAD design tools was examined. In both cases the digital chain from a parametric 3D-model to computer-aided production methods plays a crucial role.

5. Computer pools and the Digital Design Lab

Currently the Faculty of Architecture operates two computer pools, a seminar room and the Digital Design Lab.

Pool I has 60 modern workstations with common software, 6 plotters (HP Designjet Z6100), black and white and colour laser printers, A0 and A3 scanners as well as a cutting machine. The pool is open 24 hours, 365 days a year.

Pool 2 is conceived as a rendering cluster – 12 8-core high-end rendering computers each with 12 GB RAM and 64-bit operating systems can be networked so that using Netrenderer, a total of 96 CPU cores simultaneously compute complex animations, photorealistic renderings or real-time simulations.

The Digital Design Lab at the Chair for CAAD is a digital workshop for researching computer-generated forms in architectural contexts. Researchers and students of the Faculty of Architecture can explore computer models using a wide variety of different peripheries. In addition to intuitive input devices for modelling, a laser cutter, fused deposition modeller and 3-axis CNC-cutting machine are available for rapid prototyping. The Digital Design Lab makes it possible to realise a closed digital process cycle where the architectural design process can be followed through from idea to 1:1 prototype. For presentation purposes there is also a Virtual Reality facility for the stereoscopic presentation of data models in real time.

In all the teaching work, emphasis is given to a close connection with the DDL. By making practical use of the available facilities and the ability to realise the design directly in model form or as a 1:1 prototype, the use and relevance of digital tools in the design process or for production can be explored. It is only through own experience of this kind that students are able to assess the appropriateness of their use and to reflect on and learn from the experiences gained.

6. ar:toolbox

The introduction of tuition fees for students at German universities in winter semester 2006/2007 made it possible for the TU München to introduce new services for the students from summer semester 2007 onwards. In the Faculty of Architecture the Chair for CAAD started the ar:toolbox project. The ar:toolbox is a “service pool” for students of the Faculty of Architecture and is divided into two parts.

Lending pool

The lending pool is a free service for the 1200 students of the architecture faculty that lends out a wide variety of essential study equipment.

Alongside model-making equipment such as circular saw benches, sanding machines and tool boxes, the students are able to hire a variety of different multimedia equipment. Several digital SLR cameras, HD video cameras, HD-digital projectors and Wacom tablets can be hired out for free.

A particular highlight is the notebook pool numbering over 70 machines, each pre-installed with the most important software – Adobe's Creative Suite 4, Cinema 4D, Rhino 3D, Allplan, Archicad, Vectorworks… The Dell notebooks can be hired out for free for a month or a semester at a time.

Software courses

Course for learning the necessary software skills are provided at regular intervals for both beginners as well as advanced users. The product-specific training courses are an additional service over and above the chair's regular teaching programme. Many of the programs needed for studies are taught as part of the ar:toolbox programme. This includes Adobe CS4 basic and advanced courses. Typical workflows and problems such as "Using Cinema 4D and Photoshop to achieve the perfect rendering" or "Colour management and workflow planning" are also addressed along with model making courses. All provide skills that the students need for their studies.

Fig. 8 ar:toolbox Software courses

7. Résumé and future prospects

The computer has now become a natural tool in the field of architecture. The changing form of professional practice due to the increasing application of computer-assisted working methods results in the need, currently being addressed in the education of future architects, to bring these new mediums into the realm between architecture / art and construction / science.

The students should be made capable of using computers as a working tool, instead of just being able to operate a computer. Building on this fundamental principle, we teach not just the use, but also the processes, principles and models of the uses of computers in architecture and regional planning.

The acquisition of knowledge and familiarity with the computer is a process that is hard to speed up artificially as it is relatively alien to daily life. Continual contact with the computer as a medium and a tool from day one onwards contributes most to the quality of knowledge acquisition.

The basic aim was to develop a teaching concept that links the individual subject areas of architecture with their current developments in computer technology, that is to say, integrated course content for all courses of studies which are taught, in part, in inter-disciplinary teaching sessions.

The core area from which integrated course content is derived, is computer-supported planning and design with special emphasis on the following areas:

- the inclusion of current developments in technology (hardware) and computer systems (software).
- the influence that current developments in computer-supported systems have on the different subject areas of architecture and town and regional planning.
- the conception and realisation of the application of computers in response to demands from the individual subject areas.

Experience has shown that, during the course of studies, three major target groups develop:

- Target group A: the “traditional” architect

  The designing, planning architect, who possesses a basic knowledge of designing and planning software packages as a tool;

- Target group B: the IT-specialised architect

  Architects who, in the process of planning become experts in designing and planning software packages;

- Target group C: the system architect

  Architects who become involved in the conception and development of designing and planning systems.

For the university, it is fundamental that the education of all three target groups is addressed. In accordance with the aforementioned premises, the importance of a proficiency-graded system of differentiated course content becomes clear.

Within each target group a clearly pre-defined minimum knowledge level must be reached in the context of their corresponding course of study. The actual minimum levels for each target group are defined by the expected “destination” in professional practice and the corresponding proficiency levels demanded.

From winter semester 2009 onwards, a new 8-semester long Bachelor of Arts in Architecture has been introduced. The bachelor course in architecture at the TU München imparts knowledge and skills that provide a sound footing in the main activities of professional architectural practice.

The planned consecutive 4-semester long masters study programme in architecture extends the bachelor studies with a stronger focus on individual ways of working, more integrated and networked conceptual and design skills, and more complex architectural tasks. The study programme will be available either as a modular system of topics assembled together with a mentor, or as a specific specialisation extending the full 4 semesters.

Students can also elect to pursue one of two further masters study programmes – ClimaDesign and Industrial Design – with a specific mix of interdisciplinary skills. Further study programmes are planned.

Through the introduction of a bachelor / masters study programme it will be possible to tailor course offerings to better prepare the three aforementioned target groups for their respective fields of work.

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