

CAAD: Education-Research and Practice
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A CAAD CURRICULUM

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Abstract:

This paper is about the backgrounds, the present state, the results and the future expectations of the curriculum of Calibre, at the Faculty of Architecture and Building Science of the Eindhoven University of Technology. It will also touch upon the relationships with project work in our field but also in other fields of our Architectural (and Building) education. In the paper it is emphasised that teachers need to create a need for the use of certain features of computer systems. To make students aware of their (possible) CAD needs and answering to those needs at a more or less individual way asks a high level of understanding of the underlying concept and features of the CAD systems. Because of the flexibility (amongst other qualities), we, and so many others, have made a choice to use AutoCAD as a kind of thread that runs through our curriculum continuously and that exists out of 6 main parts. These parts vary from an introduction to Integrated Data Processing via CADD, Graphics and Data Structures and Expert Systems to System Development Methods. Half of our curriculum is compulsory for all the faculty students, the other half is facultative but very well attended.

INTRODUCTION

The Eindhoven University of Technology is a young university that was founded in 1953. The EUT has 8 faculties or departments and one of them is the Faculty of Architecture and Building Science.

The Faculty of Architecture and Building Science puts an emphasis on development of methodological and technical instruments to support design decisions. This faculty has approximately 600 students and 200 staff-members, organised in sections. One of the sections is Calibre.

The Calibre section (Computer Application Laboratory In Building Research and Education) has been in existence for 11 years.

It has two professors and 10 staff members on the planning board and the working area is very broad; from word processing to computer generated holography.

The Facilities that are available for training are:

- Compaq 286 configurations with tablets, central disk and a network, plotters and printers;
- MAC Plus configurations which are mainly used for document processing;
- DEC VAX system with Westward terminals, which are scarcely used.

CALIBRE

The main activities of Calibre are, of course, research, development and teaching. The research is aimed at computing techniques themselves.

The development work is often aimed at the development of "tailor made"-systems for practice. AutoCAD is playing a central role in our development work.

More than half of Calibre's time and effort is spent on teaching. AutoCAD is also playing a central role in that teaching.

Let us focus on our teaching activities, not as a solution, but as an approach in progress.

Studio Projects:

Studio projects are mostly focussed on architectural and/ or building problems and take place under the responsibility of other sections.

Calibre tries to participate in different projects and tries to initiate her own projects. In all honesty; we are not always successful in this area of teaching.

Curricular teaching:

By curricular teaching we mean lectures, instruction and practical exercises.

We strive to teach methodological and/or technical instruments, in our case: computer systems.

The curricular teaching in first and second year is compulsory to all the faculty students and the teaching in third and fourth year is optional for a part of them.

Let us then focus on curricular teaching.

CURRICULAR TEACHING

Our contribution to the faculty curriculum consists of six different parts called BIT 1,2,3,4,5 and 6.

BIT stands for "Bouw Informatica Technieken", which means:

Application of Computer Science In Architecture and Building.

The reason for the use of abstract names like these is that we want to be able to make constant changes (updates) to our courses.

In this case we will make use of this year's curriculum.

The following listing sums up the different BIT parts and other information, (kind, length, content, act up, student numbers and average grades, on a scale from 0 to 10 [10 is best]). (Figure 1: a summary of the BIT listing)

BIT CURRICULUM	KIND	LENGTH	START/ FINISH
BIT1 COMPUTER SYSTEMS	Exercise	18 hrs.	150/120 st.
BIT2 COMPUTER SCIENCE IN ARCHITECTURE AND BUILDING	Lectures	9 hrs.	120/100 st.
BIT3 CAD SYSTEMS	Exercise	18 hrs.	100/75 st.
BIT4 COMPUTER GRAPHICS	Working- lectures	27 hrs.	30/25 st.
BIT5 EXPERT SYSTEMS	Working- lectures	27 hrs.	20/15 st.
BIT6 SOFTWARE ENGINEERING	Lectures	9 hrs.	?
BIT TOTAL	Courses	108 hrs.	430/335

Figure 1: A summary of the BIT listing

BIT1: COMPUTER SYSTEMS

Exercise, 9*2 hrs. (compulsory)

Emphasis on differences between system-components:

- system-hardware (MAC versus DOS);
- system-software (Word Processing, Data Bases, Spread Sheets, Data Integration, Business Graphics, Sketch, Draw and Design). Instructions (6 hrs) and Practice (Lab Time) (12 hrs). 150 students started, 120 students finished. Average grade is 7 over 10.

BIT2: COMPUTER SCIENCE IN ARCHITECTURE AND BUILDING

Lectures, 9*1 hrs. (compulsory)

Emphasis on state of the art techniques and applications.

An inquiry pointed out that 75% of our second year students want to become Architects and do not want to use computer systems for their design work.

Lectures (9 hrs).

120 students started, 100 students finished.

Average grade is 7 over 10.

BIT3: CAD SYSTEMS.

Exercise, 9*2 hours. (compulsory)

Emphasis on the efficient and effective use of CAD systems.

(To be continued further on)

Instructions (6 hrs) and Practice (12 hrs).

100 students started, 75 students finished.

Average grade is 9 over 10.

SIT4: COMPUTER GRAPHICS.

Working-lecture, 9*3 hrs. (optional)

Emphasis on Computer Graphics and Data Structures, making use of DXF, IGES, AutoCAD/LISP.

Lectures (3 hrs), Instructions (6 hrs) and Practice (18 hrs).

30 students started, 25 students finished.

Average grade is 7 over 10.

BITS: EXPERT SYSTEMS.

Working-lecture, 9*3 hrs. (optional)

Emphasis on Artificial Intelligence and Expert Systems, making use of AQUINT, LISP and AutoCAD/LISP.

Lectures (3 hrs), Instructions (6 hrs) and Practice (18 hrs).

20 students started, 15 students finished.

Average grade is 7 over 10.

BIT6: SOFTWARE ENGINEERING.

Lectures, 9*1 hrs. (optional)

Emphasis on a System Development Methodology, System Analysis and Design Techniques and Prototyping.

Lectures (9 hrs).

Next year will be the the first time it is offered in this format.

BIT TOTAL:

Courses in total: 108 hrs.

Lectures (24 hrs), Instructions (24 hrs) and Practice (60 hrs).

430 students started, 335 students finished.

Average grade is 7 over 10.

BACKGROUND FOR BIT3, BIT4 AND BITS

Let us now focus on the Backgrounds for those parts where AutoCAD plays an important and explicit role: BIT3, BIT4 and BITS.

Our starting point is that there is a big difference between Computer Application and Automation.

Computer Application aims at Product Development (design, drawing, calculation).

Automation aims at System Development (routines, programs, libraries).

Different learning-curves can and should be drawn for Application and Automation.

The application learning curve shows that a student can be productive in a relative short period of time but that his progress will slow down.

The automation learning curve shows that a student that gets the opportunity to really understand the system will need more time to be productive. After a period of time however he will be able to tailor his system to his needs and pass the automation curve. (figure 2: Learning Curves)

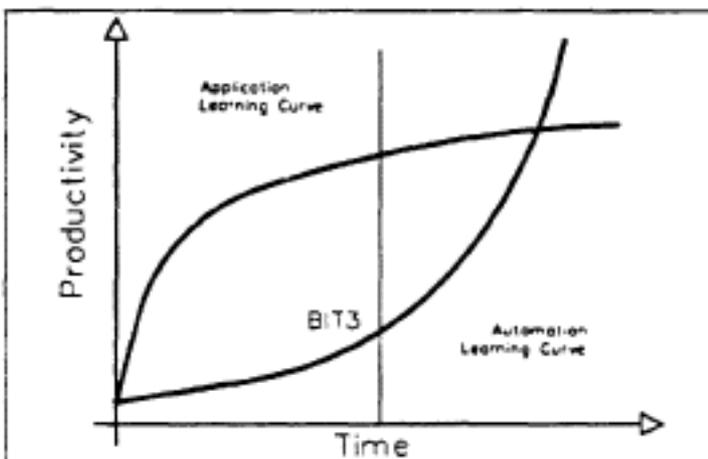


FIGURE 2: learning curves

Because of the specialism of our group we put an emphasis on the automation learning curve. We do not put an emphasis on Productivity at first. There exists a strong preference for a solid basic foundation. Therefore we put an emphasis on awareness of system capabilities and personal needs and on fast up-gradable effectiveness and efficiency. We also do not put an emphasis on Third Party Software at first. Other sections within the faculty will integrate the use of third party software from the beginning. We put an emphasis on examination of third party software and on productive contributions to third party software development. We have a preference for groups of two students working together. An implicit learning process of a student is not verifiable or improvable. A cooperative approach with groups of two students makes an explicit parallel processing of program and manual possible. We also prefer a self help approach with a stimulus to the use of manuals, documentation and knowledge of other students.

The approach to teaching can be characterized by the following steps:

- Create a need for the Application of Computer Science in Architecture and Building.
This is not very difficult for BIT3 because it is compulsory.
- Build curiosity for the possibilities of CAD systems, by showing the best results of last year.
- Gain confidence in the accuracy of CAD systems, by digitizing, plotting and checking a drawing as soon as possible.
- Get enthusiasm for the use of CAD systems, by letting the students experience the added value of CAD systems by using inquiry functions.
- Stimulate creativity for solving problems or improvement of shortcomings, by exercising the flexibility (open architecture) of the CAD system.
- Learning persistence for the learning process, by motivating the students and by not giving in to demands for less or easier exercises.
- Generate Interest for follow-up courses or projects, which is important for the registration to those courses or projects.

The theoretical part of the instructions is based upon two schemes:

The first scheme is a scheme of the Design/ Drafting processes. Here the relation is shown between the different main activities. This scheme is used to indicate the different roles of computersystems to support different activities. The activity of "Presentation" is explicitly added to this processcheme. (figure 3: Design and Drafting process)

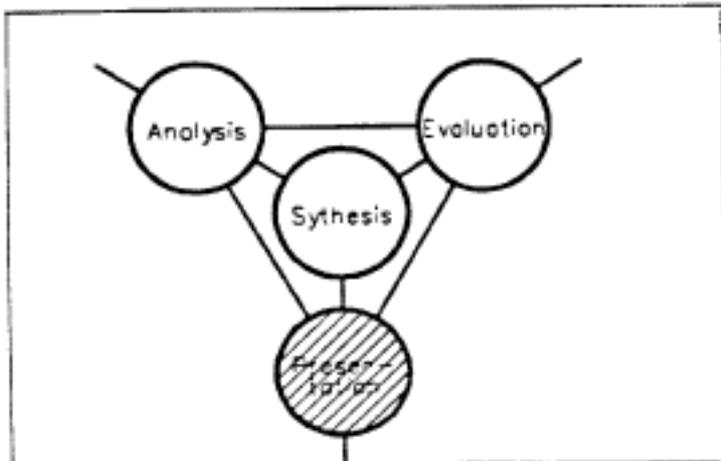


FIGURE 3: Design an Drafting process

The second scheme is a scheme of Electronic Data Processing. The most important items in this figure are the ?'s and !'s, because they cause the process to run. (figure 4: Electronic Data Processing)

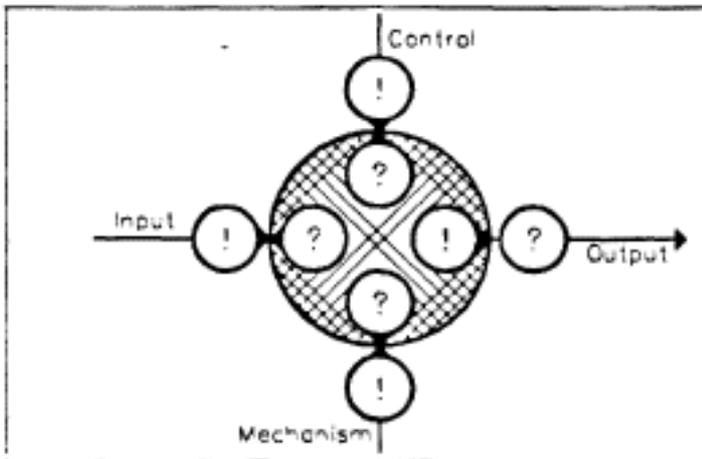


FIGURE 4: Electronic Data Processing

ORGANISATION OF BIT3

Now let's focus on the most intensive part in our curriculum: BIT3 CAD Systems, with a loading role for AutoCAD.

This course consists of:

- Instructions: 6 Hrs, classroom Instructions.
- Practice: 12 Hrs, 9 groups of 12 students.
- Assignments: Complementary assignments every week.
- Documentation: Put together and handed out every week in response to the average progress.

CONTENT OF BIT3

The content of BIT3 will be presented in the following summary and in another table.

In this table the parts that make up BIT3 are mentioned vertically in time sequence.

The start, run-through period or frequency of these parts are implicitly mentioned in the summary and will be marked on a horizontal time-scale in weekly periods in the table. (figure 5: Content of BIT 3)

WEEK 1: OPERATING SYSTEMS AND SYSTEM CONTROL.

DOS commands, ACAD Main Menu;

- Screen, Tablet and Key's, Help Functions, Coordinates, Documentation
- Introduction to Draw (Lines, Text as groups of lines and Blocks), Edit (Erase, Copy and Move (Copy and Erase)), Display (Zoom and Pan) , Tools (Osnap, Last, Window, Previous and All).

WEEK 2: STANDARD DRAWING

- Set up: Based upon available plotting area and chosen plot scale.
- Settings: Based upon chosen plot scale and drawing standards. Axis, Grid, Snap, Style and Units (UCSicon).
- Layers: Based upon an Introduction to classification of design and/ or drawing elements.

	1. systems	2. standard drawing	3. digitizing	4. drawing/library	5.	6. hatch/dimensioning	7.	8. macro's	9. modelling/isometrics
DOS commands, ACAD Main Menu Screen, Tablet and Key's Help Functions, Coordinates, Documentation. Draw, Edit, Display, Tools									
Set up. Settings. Layers.									
Digitizer Tablet. Inquiry. Plot.									
Floor Plan Drawing. Block Library.									
Hatch. Dimensioning.									
Macro's									
Isometric views. Thicknesses and Elevations.									

Figure 5: Content of BIT3

WEEK 3: DIGITIZING

- Digitizer Tablet: Digitizing as putting information into a optical archive and adding inquiry possibilities to the drawing.
Deals with the difference between a location on earth and a position on a drawing. (necessary rotation of North Arrow symbol block).
- More about Draw, Edit, Display and Tools: (Trace, Pline, Offset, Extend, Fillet and Break).
- More about Layers: (Colors by layer for checking purposes).
- Inquiry: (ID, Dist, Area)
- Plot: (Pen table, plot size and plot scale).

WEEK 4: STANDARD DESIGN DRAWJNG/ BLOCK LIBRARY

- Preparation of floor plan drawing.
Identify an existing floor plan. Make a standard drawing, A3, scale 1:100.
Make a trade-off between the existing floor plan and the settings of the drawing. Make layers and add administrative information.
- Preparation of block library.
Define and build different kind of blocks based upon the block input procedure, with an insertion point, x and y scale and rotation.
Overview of Block library on separate drawing with administrative information.
- More about Draw, Edit, Display and Tools (Blocks, Wblocks, Oops, Explode, redefine Blocks and Change layer and or color).

WEEK 5: DRAWING

No instruction this week.

- Start with the floor plan drawing. Start to recognize repeating command sequences (routines).
- Edit and expand the Block library drawing.

WEEK 6: HATCH/ DIMENSIONING

- Proceed with floor plan drawing.
- Hatch.
Check if polygons are closed. Start with User-definable Hatch patterns. Continue with available Hatch patterns (watch out for density control).
- Dimensioning.
Introduction of an automated routine. Using default dimensioning. Change the definition of dimensioning settings, Dimvars. (Dimasz, Dimtsz, Dimtxt).

WEEK 7: DRAWING

No instruction this week.

- Proceed with floor plan drawing.

WEEK 8: MACRO'S

- Insert Macro's on Tablet Template.
Design and define an expansion of the Tablet Template with Block insert routines, based upon the Block Library .
Understanding of ACAD.MNU to be able to read, edit and test it.
Load and edit (add to) ACAD.MNU with Works' Word Processor.

WEEK 9: MODELING AND ISOMETRIC VIEWS

- Isometric views.
Definitions of View Points and standard Focus Point.
- Thicknesses and Elevations.
Show the need to add Thicknesses and some Elevations, by generating an isometric view of the flat floorplan.
Change the thickness and some elevations of some relevant plan elements.
- Introduction to Draw, Edit, Display and Tools In 3D.
Difference between 3D space and 2D projections. Importance of Osnap tools. (Trace, Solid, 3D Line and 3D Face).

EVALUATION OF THE EFFECTIVENESS OF BIT3

The students were asked to identify the commands they really used for the floorplan drawing.

They marked these commands on the Primary Screen Menu Hierarchy figure.

This figure (the primary screen menu hierarchy), a figure with the commands that were used by the students, a figure that shows the commands that were used during the instructions and a figure that combines the figures of the used commands with the figure with the instructed commands, are added to this paper separately. (Figures 6, 7, 8, 9)

EVALUATION OF THE ORGANIZATION OF BIT3

The students were also asked to give more general comments to the BIT3 exercise.

The most frequently mentioned ones are listed below:

- Little time scheduled and available. The average student needed twice as much time to complete BIT3.
Students don't, however, ask for less assignments, but for more time and credit for this course.
- Insufficient documentation in the second part of BIT3.
- Appreciation for the constant possibility of getting extra support, of mainly two staff members, during the week.

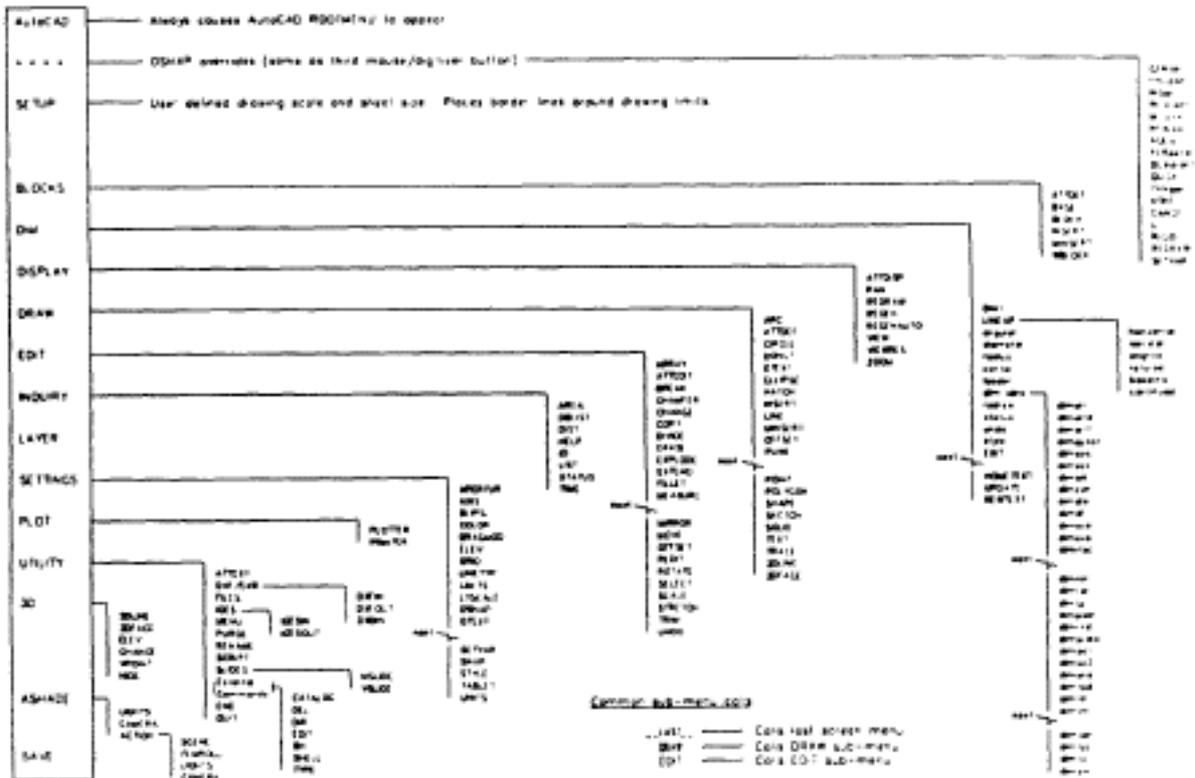


Figure 6: Primary Screen Menu Hierarchy

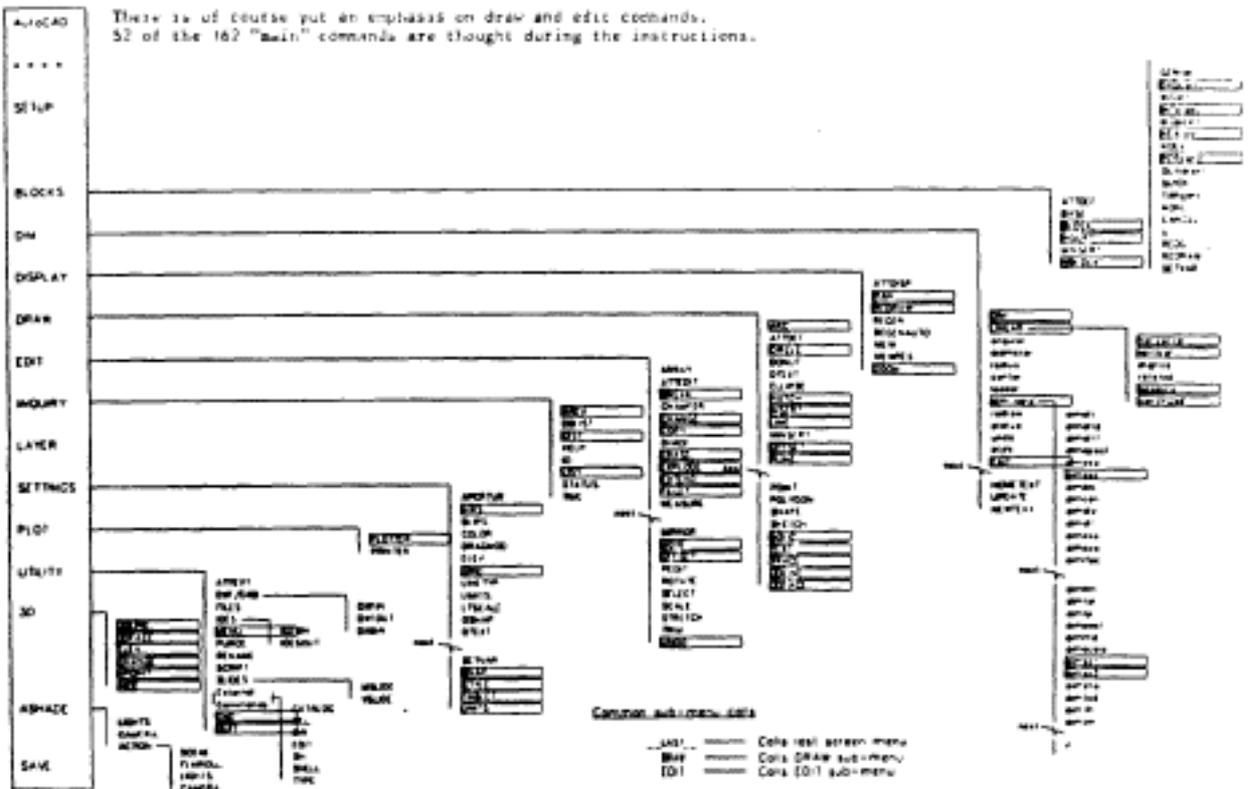


Figure 7: Commands Taught during Instructions

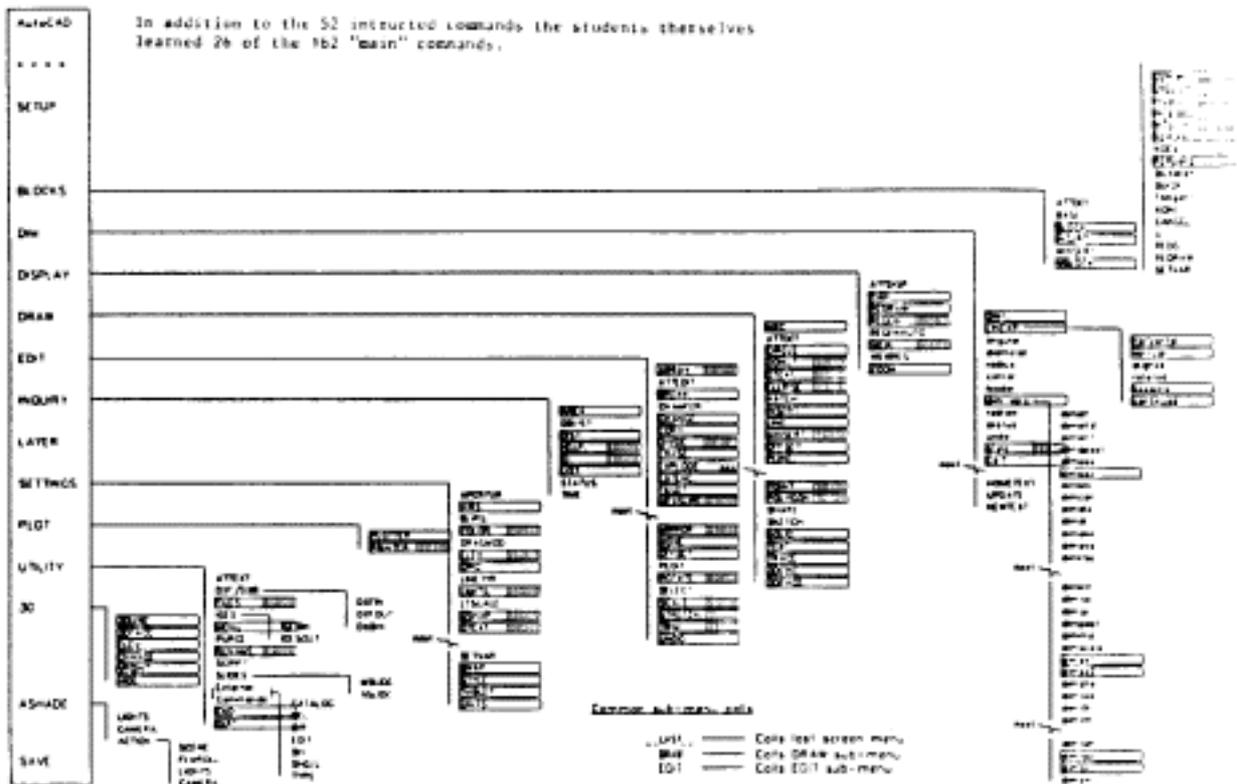


Figure 8: Commands learned by Students themselves

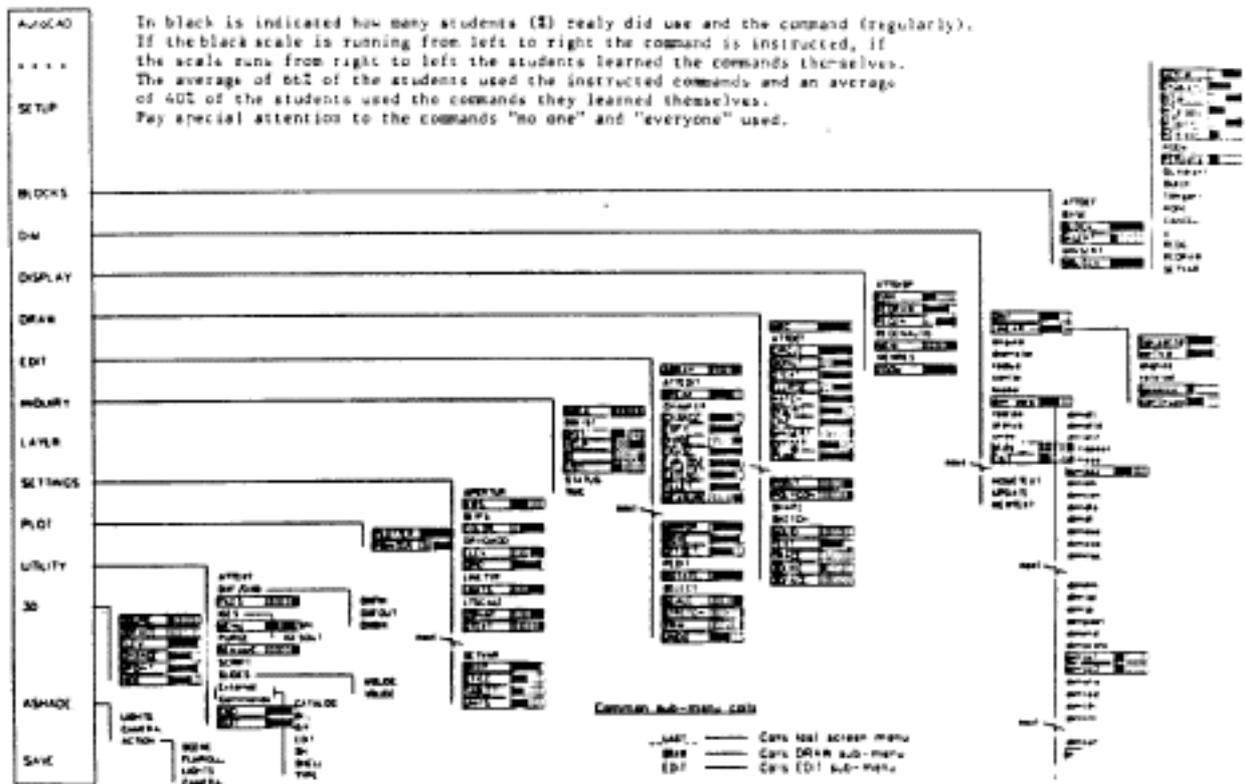


Figure 9: Used and Instructed Commands

EVALUATION OF REPORTS.

75 % of the students that started finished their report before the dead-line date.
70 % of these students handed in a perfect report and earned a 10 (on a scale from 0 to 10).

This means a big turn-around for a lot of students that expressed their preference to become an architect without the use of CAD systems during the lectures of BIT2.

We are confident of upgrading our course with the next release of AutoCAD.

EVALUATION OF AUTOCAD.

An evaluation (or the Perspective) of AutoCAD brings the following points to light:

- The reliability lets the teacher and the student focus on what to do instead of what to prevent.
- A well paced upgrading runs parallel to the development of the average needs and the average knowledge level in Architecture and in the Building industry.
- The open architecture makes it easy to disconnect unnecessary commands or options and to add something personal.
- The alphabetical structure of the primary screen menu is an illustration of an objective approach to different industries, applications, procedures and routines. At the same time however it introduces the need for customizing. (Who is working in an alphabetical sequence?)
- The customizing possibilities have different levels of difficulty or complexity for customization (Setvar, Macros, Scripts and LISP routines).
- AutoCAD as a CAD Language. It is possible to use AutoCAD as a basis for a CAD treasury, CAD dictionary or a CAD language (Syntax, Semantics and Pragmatics). An accepted CAD language is of great importance for teaching and is necessary for the teaching of CAD Theory.

TEACHER TRAINING.

Earlier training of students influences the starting level and direction of the different learning curves. (figure 10: Learning curve development)

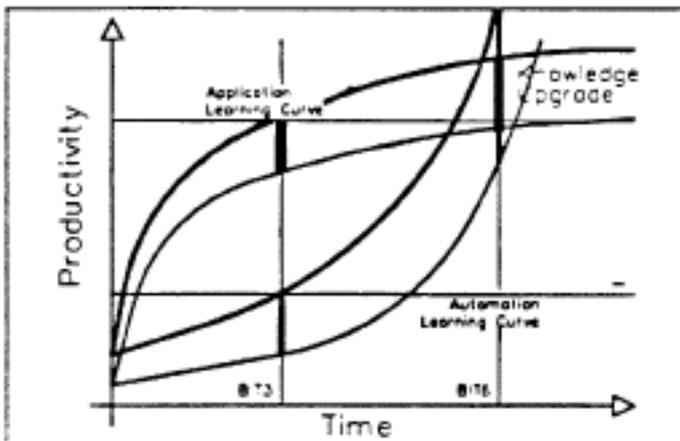


FIGURE 10: Learning curve development

A changing learning curve represents a change of the relationship between time and effectiveness/ efficiency.

It will not be difficult for teachers to keep up with students that only apply the software in their design projects (the Computer Application learning curve).

It will however be a more significant difficulty for teachers to keep up with students that are developing personal systems (the Automation learning curve). Teachers need to have had a proper base to upgrade their knowledge of the software.

A lot of Architectural or Building teachers would really appreciate it if the development of CAD software and hardware would slow down a bit for a while.

A change from the Computer Application learning curve to the Automation learning curve can be made along a third upgrade/conversion learning curve. (figure 11: Upgrade/Conversion learning curve)

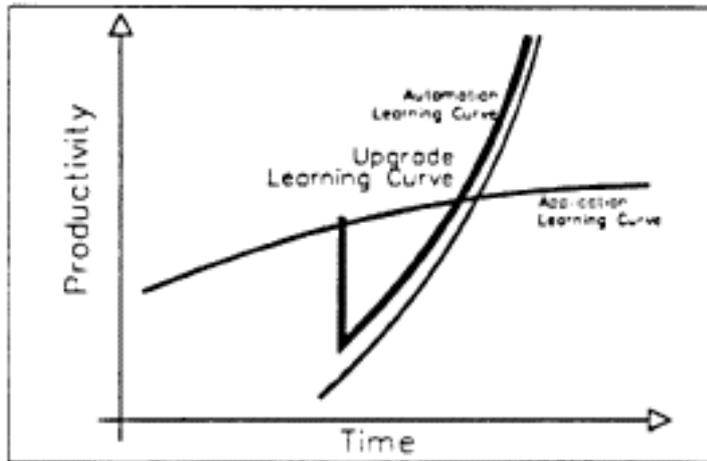


FIGURE 11: Upgrade/Conversion learning curve

ECAADE/ AUTODESK TEACHER TRAINING PROJECT

A joint project of the ECAADE association (Education in CAAD in Europe) and Autodesk aims at proper teacher training for teachers of architectural schools and faculties in Europe.

The ECAADE starts this summer with the organization of the first teacher training/ upgrade courses in the U.K. and the Benelux countries.

Autodesk contributes to this project by making experience, software and courseware available.

CLOSURE

The title that was given to this presentation was: AutoCAD-The Teaching Perspective.

For the generation of this perspective you not only need a teaching model, you also need to specify a view-point and a focus-point at least.

In our case the level of available knowledge acts as our view point and the horizon of possibilities acts as our focus point.

As in every perspective view you can see that in case of an increasing view point the horizon will move away.

For now and for the future this means that:

THE MORE YOU KNOW ABOUT AUTOCAD, THE MORE THERE IS TO LEARN.

Or:

THE MORE STUDENTS KNOW ABOUT AUTOCAD. THE MORE THERE IS TO TEACH.

Eindhoven, 30 June 1989.

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