CAD ED

International Conference on Computer Aided Design Education

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13-15 July 1977

Edited by S. A. Abbas, A. Coultas and B. S. Lee

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Conference organised by Teesside Polytechnic, Middlesbrough, England, in association with Whessoe Heavy Engineering Limited, Darlington, England

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at Teesside Polytechnic

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ACKNOWLEDGEMENTS

Since this is an account of the CAD ED conference, we first of all would like to acknowledge our debt to all individuals on the Organising Committee and Planning Panel whose names appear on the facing page. To the Planning Panel who selected the papers and constructed an overall framework for the conference and to the Organising Committee who additionally were responsible for the practical realisation and smooth running of the event, we extend grateful thanks for their contribution to the success of CAD ED.

The support we received from the Director of Teesside Polytechnic, Dr. J. Houghton, and the Chief Administrative Officer, Mr. D. Clarke, was important to us. In particular, the Assistant Director, Dr. M.D. Longfield, encouraged and backed us from the start of our planning for this ambitious effort.

We wish to thank also the Directors of Whessoe Heavy Engineering Limited, Darlington, for encouraging the full participation of many of their staff in the planning and running of CAD ED, so ensuring a truly joint academic/industrial collaborative venture.

Some of the administrative staff at Teesside Polytechnic put in an effort considerably in excess of normal expectations. In extending our gratitude to all of them we want particularly to mention Mr. S. Foster and Miss P. Speed. We should also add the name of a Research Student, Mr. R.A. Remedios, who helped in running the Conference (and took a while to recover afterwards and get back to doing research in CAD).

For preparation of these Proceedings we are mainly indebted, of course, to all the authors whose contributions are included. We wish to thank also all contributors to the Discussions, especially those who submitted their editing suggestions before our deadline.

Finally, we are grateful to our wives Valerie, Ann and Barbara, who helped in innumerable direct and indirect ways during the organisation of CAD ED and the preparation of the Proceedings.

S. Ahmed Abbas
Alan Coultas
Brian S. Lee

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INTRODUCTION

In the decade or so since the term "computer-aided design" first became widely known it has been used to cover a multitude of applications of computers. Techniques involving the computer analysis of a structure or a component; the interactive design of a printed circuit board; textile pattern graphics; car body design; design automation of standard industrial procedures; ecological systems simulations; these are just a few of the topics which may come under the general heading of computer-aided design. Industries, beckoned by the promise of competitive advantage by, for example, reduction of design-tender-manufacture times and better performance and utilisation of materials by more sophisticated analysis techniques, and encouraged by the ever-decreasing costs of using computers, are investigating with much interest the possibilities of CAD in their environments.

Who are the people who are going to work in this rapidly expanding field of CAD? What background and training will they have? Is industrial on-the-job training sufficient? If there are fundamental, common principles in CAD underlying all areas of activity from, say, electronics to shipbuilding, can they be taught formally? At what academic level? How does one distinguish between the needs of a person who will be a CAD systems designer and someone who will use a CAD system? Is it enough to teach computing, with applications, in courses in engineering and architecture? Should some computer science courses incorporate elements of Design? Do we need link men, intermediaries between, say, engineers, and computer professionals?

A group at Teesside Polytechnic involved in developing and teaching CAD were deeply concerned with these and other questions. Contacts with other academics had established that such concerns were universal; contacts with industry established that the educational implications of CAD were of considerable interest to them, and that, indeed, in some sectors of industry some significant initiatives had already been taken in this direction. The idea of holding a first-ever conference on computer-aided design education was conceived, with the overall aim of bringing together CAD workers from industry, government, and academic institutions across the world to attempt to resolve some of the important issues.

From the start it was recognised that CAD is a field in which industrial relevance is vital, and of crucial importance in organising the conference was the fruitful partnership established initially with Whessoe Heavy Engineering Limited, who had many years experience of developing and using CAD in the area of process plant engineering and manufacture. This academic/industrial collaboration was of much significance for the conference, and it influenced the proceedings to a very considerable extent. A conference on educational needs was much enhanced by the interplay between educators and practitioners, which came out especially in the discussions.

In planning this book, the Proceedings of the conference, we, as Editors, had to decide on an approach to the discussions that took place in the conference theatre. We felt that a formalised or cursory incorporation in the orthodox question and answer style would not do justice to the debates and spontaneous interchanges that went on throughout. The field of CAD is still new as an academic topic; it is ill-defined, open to many interpretations, and a gathering of CAD teachers and practitioners invariably covers many diverse backgrounds and disciplines. An element of controversy was present, and manifested itself particularly in the discussions. We therefore decided to include all the discussions, edited as necessary, but preserving as far as possible a sense of spontaneity.

The Keynote Speaker was John J Allan III, who gave the wide-visioned opening address which set out to unite all the various features which make up CAD/CAM, and suggested general guidelines for education to meet industrial needs in CAD/CAM for the future. The book opens with this Keynote Address, followed by a Discussion.

The formal Proceedings are presented in four major themes:

- Design Education and the Place of CAD;
- The Development of Teaching Systems;
- The Industrial View;
- Academic Experience in Teaching CAD.

Within each of these themes the contributed papers are grouped together in the Sessions as occurred at the Conference. A Discussion of the group of papers follows the formal papers in each Session.

Towards the end of the Conference an Open Forum was organised in the evening, to discuss in a less formal atmosphere some of the issues that, it seemed, were boiling up. The proceedings of the Open Forum form the next part of this book. This consists of a discussion on what should comprise a CAD curriculum, initiated by an international Panel, an analysis of the discussion by Ernest Warman, and a summing up by John Allan.

The book concludes with the Closing Address given by Arthur Llewelyn, in which he identifies with considerable vision and insight the key issues raised during the Conference, and their importance for the future.

We dedicate the book to all the people in industrial, governmental and academic institutions, who, like us, are in the painful process of converting themselves from professionals in established fields - engineering, computer science, architecture - to being educators and practitioners in the exacting, ill-defined and rapidly-changing area of computer-aided design.

S. Ahmed Abbas, Alan Coultas, Brian S. Lee

OPENING SESSION

OPENING SESSION

Chairman : A.I. Llewelyn (CAD Centre, Cambridge, England)

Keynote Address :

CAD Education to the year 2000
J.J. Allan III (Southern Methodist University, Dallas, Texas, U.S.A.)

Discussion

CAD EDUCATION TO THE YEAR 2000

Dr. John J. Allan III, P.E.

Professor of Mechanical Engineering; Director, Center for Special Studies
Southern Methodist University, Dallas, Texas 75275 U.S.A.

Mr. Chairman and distinguished colleagues. Our first responsibility as we begin this milestone international conference is to recognize our unique place in history. I hope to assist this by relating our motivation, and the scope of our activities, to our dynamic co-existence with the Information Processing Revolution. I also hope to instill a sense of urgency, because as you will see, we must quickly assume our new role. I will make some observations that should help us use our knowledge of economic, political, and social forces to discuss our pedagogy in a meaningful way. All of this is of course said realizing that our ultimate goal is to contribute to the betterment of mankind.

OUR MOTIVATION

We all have a basic motivation that is independent of our national origin. That is, we want our students to learn fundamental concepts that they can later apply to increase industrial productivity. Examining the production of goods and services, we clearly see that there are planning functions and execution functions. And we realize that there are two keys to productivity improvement: (1) performing as many production activities as possible in parallel, and (2) identifying similarities among production elements, and executing the required activities at minimum cost. [1]

In practice then, we must educate our students to change the structure of the basic information and material processing components of our means of production. We must teach principles that will allow a customer's goods and services to be produced with due attention, but with a functional focus on "groups" of production elements.

The Industrial Revolution contributed many ideas for increasing productivity. The foremost of these ideas was assembly line production. Now, we are in the Information Processing Revolution. And I submit to you that during our professional lifetime, CAD/CAM will emerge as the major contributor to increased industrial productivity. This implies that what we teach and the way we teach it will influence the singlemost important aspect of our nations' means of production.

This awesome responsibility could be a very frightening prospect. However, while we are prepared intellectually for this challenge, we are not completely prepared. As citizens of the international engineering community we must work together, prodigiously, to educate the people in our charge to be a new breed of professional. And we cannot approach this task in a lackadaisical manner, for we are utilizing a most transient technology.

You have probably all felt the change in peer attitude during the last five years. Prior to 1972, engineering educators who emphasized CAD/CAM were generally considered "lower class". We were the ones who ostensibly couldn't handle "analysis". However, a new age of awareness has developed. More than ever, engineering problems require the integration of many concerns other than technical. Teaching the fundamentals of CAD/CAM is unique in our lifetime from a pedagogical point of view. In his book The Sciences of the Artificial, [6] Herbert A. Simon eloquently explains how the sciences of the artificial have almost been driven from the engineering schools.

> Historically and traditionally, it has been the task of the science disciplines to teach about natural things: how they are and how they work. It has been the task of engineering schools to teach about artificial things: how to make artifacts that have desired properties and how to design.
>
> Engineers are not the only professional designers. Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so construed, is the core of all professional training; it is the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools of architecture, business, education, law, and medicine, are all centrally concerned with the process of design.
>
> In view of the key role of design in professional activity, it is ironic that in this century the natural sciences have almost driven the sciences of the artificial from professional school curricula. Engineering schools have become schools of physics and mathematics; medical schools have become schools of biological science; business schools have become schools of finite mathematics. The use of adjectives like "applied" conceals, but does not change, the fact. . . .
>
> The movement toward natural science and away from the sciences of the artificial has proceeded further and faster in engineering, business, and medicine than in the other professional fields. . . .
>
> Such a universal phenomenon must have a basic cause. It does have a very obvious one. As professional schools, including the independent engineering schools, are more and more absorbed into the general culture of the university, they hanker after academic respectability. In terms of the prevailing norms, academic respectability calls for subject matter that is intellectually tough, analytic, formalizable, and teachable. In the past, much, if not most, of what we knew about design and about the artificial sciences was intellectually soft, intuitive, informal, and cookbooky. Why would anyone in a university stoop to teach or learn about designing machines . . . when he could concern himself with solid-state physics? The answer has been clear: he usually wouldn't.
>
> The problem is widely recognized in engineering and medicine, today, and to a lesser extent in business. Some do not think it a problem, because they regard schools of applied science as a superior alternative to the trade schools of the past. If that were the choice, we could agree.
>
> That was, in fact, the choice in our engineering schools a generation ago. The schools needed to be purged of vocationalism; and a genuine science of design did not exist, even in a rudimentary form, as an alternative. Hence, the road forward was the road toward introducing more fundamental science. Karl Taylor Compton was one of the prominent leaders in this reform, which was a main theme in his presidential inaugural address at M.I.T. in 1930:
> "I hope . . . that increasing attention in the Institute may be given to the fundamental sciences; that they may achieve as never before the spirit and results of research; that all courses of instruction may be examined carefully to see where training in details has been unduly emphasized at the expense of the more powerful training in all-embracing fundamental principles."
>
> Notice that President Compton's emphasis was on "fundamental," an emphasis as sound today as it was in 1930. What I am urging . . . is not a departure from the fundamental but an inclusion in the curriculum of the fundamental in engineering along with the fundamental in natural

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