Zeitschrift: IABSE proceedings = Mémoires AIPC = IVBH Abhandlungen

Band: 8 (1984)

Heft: P-80: Using computers in the design of structures

Artikel: Choosing a CAD system for an engineering firm in South Africa

Autor: Witthaus, K.G.

DOI: https://doi.org/10.5169/seals-38346

Choosing a CAD System for an Engineering Firm in South Africa

K.G. Witthaus

1. Introduction

We have used computers as design tools in our practice since 1962. Today, many aspects of the analysis which we undertake could not be handled without computers. This applies particularly to more complex structures which lend themselves to finite element analysis. Virtually all our technical computation is at present carried out on two in-house HP9845B units. We have the finite element package "FESDEC" mounted on one of these units in conjunction with a 20 M bytes disc drive. In the last two or three years we have become increasingly involved in the dynamic analysis of structures subject to seismic loading, and in particular large hyperbolic cooling tower shells. For this type of analysis our existing hardware is really too slow, and we are considering acquiring a larger and faster machine. At present the front runner is the HP9000.

We have recently also entered the field of computer aided draughting and, after considerable research into the market, decided to acquire the CEADS-CAD system run on an HP1000f mini-computer. The system has nine work stations and the output is generated on an HPA1 size plotter.

As computer-aided draughting systems have made tremendous strides in the last few years with new systems appearing on the market in ever increasing numbers, and since the investment involved is substantial, anyone wishing to introduce CAD into his office is faced with a most formidable problem in deciding which system to adopt. It is felt that our experience in this regard may be of interest to others and this therefore forms the primary subject of this paper.

2. Choosing a CAD System

While South Africa is a comparatively small country, it is nevertheless well served by most of the major computer firms and approximately 40 CAD systems were available to us at the time that we contemplated entering the field.

After attending demonstrations of numerous systems, the only firm conclusion which we could come to was that they all drew lines and circles and calculated dimensions etc. with apparent ease. Despite extravagant claims of increased productivity, speed, etc., the major questions to which we needed answers were, would any of the systems perform economically with our particular type of work, and how would our staff react to the introduction of the system. Although all the systems appeared to perform essentially the same function, prices ranged from approximately R100 000 to R500 000 for a single terminal installation, with the more expensive installations offering considerable sophistication. However, a simple analysis of existing manual draughting costs indicated that it would be very difficult to make the more sophisticated systems cost-effective in the particular environment which we were considering which was primarily civil engineering structures associated with power stations and industry.

An analysis of existing drawing office production showed that a typical drawing took 36 hours to produce on average. This time was made up of approximately 24 hours actual draughting time and 12 hours for engineer/draughtsman liaison, coordination of data to be shown on the drawing, checking of the drawings, drawing registration, etc. It was concluded that whether drawings were being produced manually or on a CAD system, the latter 12 hours period would remain virtually unchanged and that if an increase in productivity was to be achieved by the introduction of a CAD system, this would only relate to the draughting period of 24 hours.

Discounting some of the more extravagant claims, and taking the conservative approach that draughting time would not be reduced to less than half of the equivalent manual time, this meant that our total time for producing a typical drawing would become 12 hours for input of information etc., plus 12 hours for CAD draughting, i.e. a total of 24 hours, which represented a 33% reduction in overall draughting production time and not a reduction of 50% or more as claimed by most of the systems salesmen.

Using the symbols:

M = Average hourly cost rate for draughtsmen and/or CAD operators, including overheads.

C = Hourly cost rate per terminal for the CAD for a full 8 hour working day.

F = CAD utilisation factor (e.g. if F = 0,75 the actual number of hours for which the CAD terminal is used = 0,75 x 8 = 6 hours per day)

it follows from the assumptions above that for the CAD to be cost effective in our environment,

$$(12 + 12)\, M + \frac{12C}{F} \ngtr 36\, M$$

or $$C \ngtr FM$$

Although this approach is over-simplified, we believe that it gives results of the right order, and some very important conclusions follow. In our environment, M (including overheads) was likely to be in the range of R15 to R25 per hour, with an average of say R20/hour (R1 = US $ 0,9 approx.). Allowing for training and down-time, F was not thought likely to be much higher than 0,7. It followed that for the CAD system to be cost effective, the cost should not exceed about R14 per terminal per hour.

This conclusion directed our attention away from the very sophisticated and costly systems and resulted in the field being considerably narrowed to those systems which were capable of being profitable in terms of cost per terminal hour while at the same time providing an acceptable level of sophistication.

We next decided that the only way to answer the remaining questions as to how effective a CAD system whould be in our particular environment, whether the staff would accept the system etc., would be to get actual hands-on experience in our own offices. By this time we were really only looking at two four-terminal systems as far as cost competitiveness was concerned. Although we had assessed both systems as being potentially cost-effective and they had similar specifications, the one system had the advantage that it could be expanded to take up to nine terminals with very little additional expense, which would make this particular system even more cost-effective. In this regard, we had concluded that two or three terminals would merely scratch the surface and that a minimum of four terminals was necessary. With training requirements etc. an installation having 6 to 9 terminals would be required in the longer term.

Fortunately, the suppliers of the system which we favoured agreed to hire it to us for a trial period of six months with no obligation to buy. As mentioned previously, this system was the CEADS-CAD system developed by Holguin Associates of El Paso Texas.

Initially it was decided that we would try and introduce as many people to the system as possible. However, we soon found that there were some who did not want to become involved and who regarded CAD as a threat to their own particular livelihood. There were others who were excited by the system's potential. Only about 50% of those who had the opportunity of getting hands-on experience were found in the end to be suited to the work and enthusiastic about it. We soon found that anybody who was not enthusiastic was not going to make a good CAD draughtsman and we therefore decided to concentrate on those that showed the potential.

In general we found that these were the younger members of our staff and as a rule of thumb we concluded that anyone who was over 40 was unlikely to succed. Although the system can be mastered in 10 hours it takes a least a further 1 1/2 to 2 months for a person to become reasonably proficient. We found that some of the younger members of staff were as fast on the system as they were on manual draughting after a period of about two months. At the end of our six-month's trial period, the stage had been reached where we had four reasonably good CAD operators and were starting to produce drawings rapidly enough to be satisfied that we should purchase the installation. Other factors which influenced us were the consistently high quality of drawings produced by the plotter and the efficiency of system as a whole. With a good CAD draughtsman we found that it took as little as 5 to 6 hours draughting time to produce a typical drawing. This convinced us that the potential was there to do more than break even with the manual draughting operation and thus justify the cost of such a system.

With our decision to proceed, we decided to expand the system to nine terminals, since to get the system introduced into the organisation as rapidly as possible, we would need to embark on an extensive training programme while at the same time maintaining a reasonable flow of drawing production with four terminals for training in this initial period. Again, just as in our trial period, we found that our older draughtsmen were reluctant to adapt, and our younger draughtsmen took more readily to the system. This in turn introduced a further problem to CAD draughting, in that the younger CAD operators often lacked the overall draughting experience to be able to work up drawings from scratch, so that the work preparation required for the CAD became a more stringent requirement than for manual draughting. We also found that because computer aided draughting is extremely efficient and rapid, anybody in-putting information into a terminal for the production of a drawing had to know exactly what he was going to do. In other words, terminal time could not be wasted with having to think about where to put the next line, etc.

Preparation of work had therefore to be in far more detail and far more extensively done than was the case with manual draughting. We generally tend to operate on a system whereby one senior draughtsman keeps two or three juniors busy with work. Now in the context of manual draughting, he can prepare work and organise what each of his juniors is going to do in a reasonably leisurely fashion. If he takes 12 hours to do his preparation, checking, co-ordination etc., he can comfortably keep one, if not two, juniors busy, because they tend to take 24 hours or more to translate his information on to a drawing and then give it back to him.

We found that the junior who would take 24 hours to do the drawing manually could now produce the drawing on the CAD in 6 to 8 hours. Our work preparer was now being flooded with his drawings coming back to him at such a rate that he could no longer keep two or three CAD operators busy. Having got a number of skilled CAD operators trained, we found that our problem now shifted to a different area, namely, that of the person preparing the work for the CAD. It was essential that he had a good grasp of the way the system operated and the way that work was prepared for efficient use on the system. We found that some people tended to overdo their preparation of work and spent as much time preparing sketches in great detail as they would if they were doing the drawing manually and this obviously had to be changed.

The training of people to prepare work for the CAD has in fact proved more difficult than the actual training of people to use the CAD and we still find that this is where we have most of our bottlenecks and problems. While there is no doubt that drawings can be produced more rapidly on a CAD system, we now find in the overall context that whereas our average time for drawing preparation, co-ordination etc. for manual draughting was 12 hours, this time has now increased to anything up to 18 hours. The breakdown of time for producing drawings on the CAD now looks something like 12 to 18 hours for work preparation, checking etc. plus, say, 6 hours for draughting on the CAD giving a total of 18 to 24 hours. It is quite clear to us that in order to improve this time, it is not so much an improvement in CAD operating time that is required, but an improvement in the time required for work preparation to be fed into the CAD system.

We have also concluded that the success of the system is heavily dependent on good management, which is virtually a full-time function for one man, and adds to the running costs accordingly. We are considering the possibility of setting up a separate service company within our organization to won and operate the CAD system.

On balance, we consider that the introduction of the system has been a success. However, we know of others who have gone for more sophisticated systems who question the financial viability of changing to computer-aided draughting at the present time, and we believe that the watchword should be caution (if not cynicism!) when listening to the claims of the salesmen.