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CONTENTS

INTEGRATIVE MODEL OF CAD SOFTWARE IN STEEL DESIGN

Sanjay G. Khirwadkar

There are hundreds of Computer Aided Design (CAD) software packages developed in the last 30 to 40 years. In 1960s and 1970s, when the computers were mainly text-based and were used for number crunching, the CAD packages were predominantly, analysis packages. As far as, the field of civil engineering is concerned, in those years, computers were mostly used for analysis of complex structures such as multi-storied frames, large slabs with different end conditions, various types of shell structures, plane and space trusses etc. To some extent, computers were also used for analysis of seepage through earthen dams, heat transfer through containers of hot material and dynamic analysis.

Nineteen eighties saw rapid advances in the computer technology. More and more powerful computers were made available in less and less price. With development of personal computers, the computing power became affordable to small companies and even individuals. Along with text and numbers, computers started handling graphic information effectively. In the field of CAD, many software packages were developed for two-dimensional and three-dimensional visualization of objects and for drafting engineering drawings. In fact, for many people, CAD became synonymous with Computer Aided Drafting. Many engineering design companies, the world-over, switched from manual drawing process to computer-aided drawing process, during this period. Also, there was trend to convert important paper drawings to electronic form by digitizing or scanning.

From the Nineteen nineties, large and versatile CAD packages have come in the market, where input of data can be directly in the drawing form, (the package itself can extract numerical data out of it), its analysis is done using sophisticated techniques such as Finite Element Method, and the results are produced in text as well as in graphics format. For example, in the field of building design, packages are available where architectural drawing is input, the package analyses the data, produces detailed structural drawings and gives out estimates of RCC, steel, and form work involved.

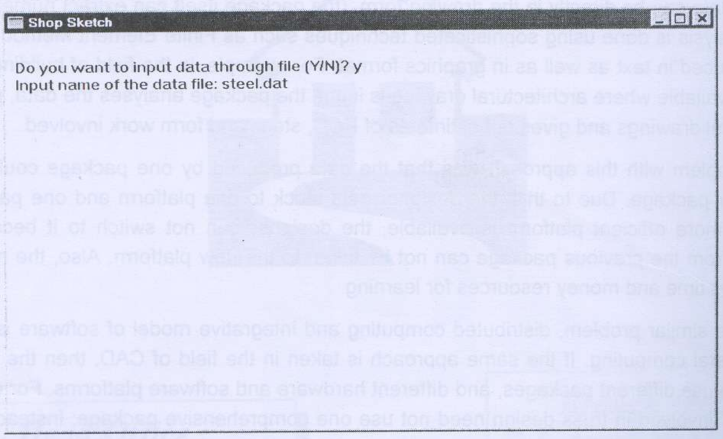
One problem with this approach was that the data produced by one package could not be used by another package. Due to this, the designer gets stuck to one platform and one package. If some another, more efficient platform is available, the designer can not switch to it because the important data from the previous package can not be taken to the new platform. Also, the new CAD package requires time and money resources for learning.

To solve similar problem, distributed computing and integrative model of software is used in the field of general computing. If the same approach is taken in the field of CAD, then the designer becomes free to use different packages, and different hardware and software platforms. For example, a steel designer involved in truss design need not use one comprehensive package; instead, he/she may create line diagram of the truss using some self-developed utility program on DOS, send the data generated out of it to a structural analysis & optimization program on UNIX/Linux, get the results of this into Windows-based drafting packages to produce structural drawings & shop sketches, and finally, over the net to some computer aided manufacturing (CAM) program to produce instructions to C.N.C. Machine to manufacture the pieces. This integrative process is graphically shown in flow chart in the following figure.

Truss Line Diagram using keyboard and mouse from a DOS-based utility. → Analysis, Design, & Optimization on UNIX based software → Assembly & Structural drawings on Windows based drafting package → Program to make Shop sketches for printing and CNC machine instructions

The present paper discusses one such utility program which prepares shop sketch for a steel angle. The program can be easily integrated in the design model as it can take the input data from a text file in pure ASCII format, and most of the CAD packages can output the design information in this format. The program has been written in C++ programming language. It can be easily understood and modified for fine tuning to specific design organization by a designer, as nowadays C and C++ programming languages are taught as under-graduate subject. It is compiled using 'Bloodshed Developer C++' compiler, a free (G.N.U. License) Windows-based compiler. It uses K.I.T.E. Foundation Class Library for generating graphics.

The program starts in window by asking the question to the designer whether the data is to be input through file (which may be generated by some structural analysis and design package) in an integrative mode or through keyboard (where by the designer is running this package as a separate entity). If the designer chooses to extract the data through a file, then the program asks him/her to input the name of the file. If the file is in the same folder as that of the program file, then only the file name need be given. However, if these two files are not in the same directory, then complete path name of the data file is to be given. The dialog screen looks as follows-



The data file should be ordinary ASCII text file consisting of data fields separated by at least one space. The following line shows an example of a data file contents.

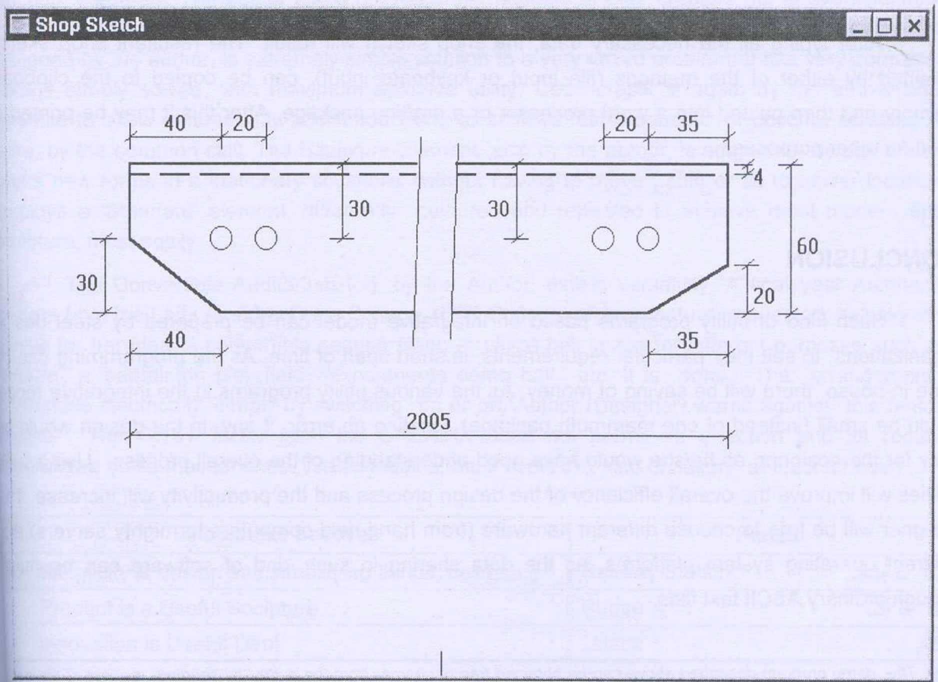
2005 60 4 30 40 35 20 10 3 40 3 35 30 0

The fields in the data file are as follows (all dimensions are in mm)-

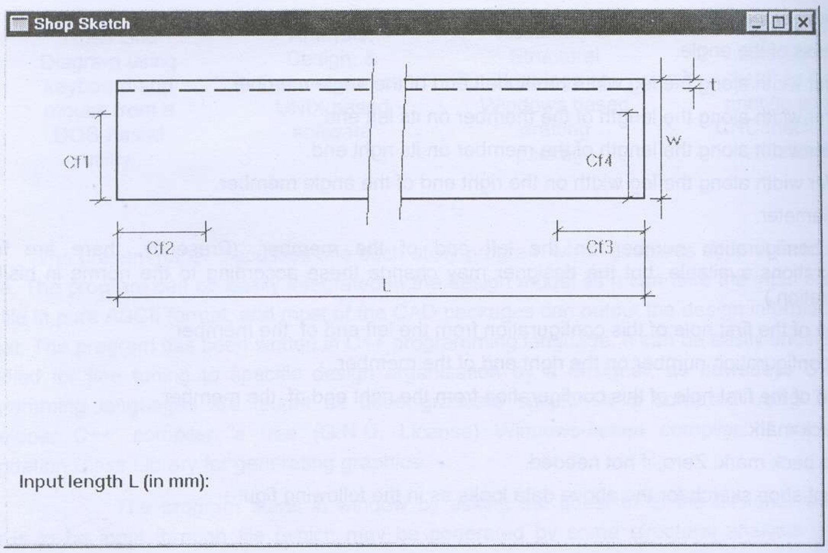
1) Length of the angle member.

2) Leg width of the angle.
3) Thickness of the angle.
4) Chamfer width along the leg width on the left end of the angle member.
5) Chamfer width along the length of the member on its left end.
6) Chamfer width along the length of the member on its right end.
7) Chamfer width along the leg width on the right end of the angle member.
8) Hole diameter.
9) Holes configuration number on the left end of the member. (Presently, there are four configurations available, but the designer may change these according to the norms in his/her organization.)
10) Position of the first hole of this configuration from the left end of the member.
11) Holes configuration number on the right end of the member.
12) Position of the first hole of this configuration from the right end of the member.
13) First back mark.
14) Second back mark. Zero, if not needed.

The resultant shop sketch for the above data looks as in the following figure-



If the designer chooses to input the data through keyboard, then the following data entry window appears on the monitor. It also shows the legend of the data being input..



After typing all the necessary data, the shop sketch will result. The resultant shop sketch, obtained by either of the methods (file input or keyboard input), can be copied to the clipboard memory and then pasted into a word processor or a drafting package. After this it may be printed or used for other purposes.

CONCLUSION

Such kind of utility programs based on integrative model can be prepared by steel design organizations to suit their particular requirements, in short span of time. As the programming can be done in-house, there will be saving of money. As the various utility programs in the integrative model would be small (instead of one mammoth package), locating an error, if any, in the design would be easy for the designer, as he/she would have good understanding of the overall process. Using such utilities will improve the overall efficiency of the design process and the productivity will increase. The designer will be free to choose different hardware (from hand-held computers to mighty servers) and different operating system platforms, as the data sharing in such kind of software can be made through ordinary ASCII text files.

Note: The demo program described above can be obtained free of charge from the author by sending request at his e-mail address- khirwadkar@hotmail.com .