WORLD CLASS ENGINEERING
THE NEW AGE AND USE OF CIM

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ABSTRACT

In the competitive world we now live in, Engineering must provide the thrust of innovation, reduced development time and lower cost products. Engineering will be restructured and will use new tools to meet these objectives. All of the best concepts are needed to transform Engineering from time consuming trial and error, manual methods to the new age of CAE, CAD and CIM.

Top Level Management must foster new management concepts and stimulate a forward thrust. In this way, U.S. Industry can regain a leadership role.

INTRODUCTION

To many of us with some years or decades of work experience behind us, a transition to the new age of the 1990's and beyond is very exciting. We have been in work environments that are very controlled and over managed. We have been burdened by manual calculations, and "cut and try" methods to prove our designs.

In order to reach a world class status this must change. Management must be more participative; become more of a coaching role; and let people be innovative. It is now well understood that we learn and move forward by experimenting and making mistakes.

I am fortunate to be employed by a forward looking, pro-active company that is working diligently to make the transition — a transition from the controlled, directive environment; to one of self-commitment. Upper management is highly dedicated to this wave of the future.

Through leadership from upper management at Zytec, many concepts that are new to U.S. industry are being implemented. Some of these include: JIT, SPC, TQC, QFD, and CIM. As part of this strategic movement, the guidance of Dr. W. Edwards Deming is being used. His fourteen points are being applied and they include these ideas:

- Training must be available to all for their present job and future growth.
- Ever improving quality is required in every area, including engineering.
- Breaking down barriers between departments and functional areas.
- Never ending search for problems in the system or process and continual improvement of these.
- Allocate resources to provide for long range needs instead of short term profitability.
- Mistakes, delays, rework and resulting costs must be continually reduced.
- Help people do a better job by providing better tools. This includes the newer tools, instruments, hardware and software that are emerging.

All of these principles apply to Engineering as well as Manufacturing and all other functional areas. It is time for Engineering to move forward and by using these philosophies and emerging technologies drive out waste, scrap, rework and long development cycles.

STRATEGY FOR SUCCESS

How will we move forward and make dramatic improvements in our development process? We will use the overall guidance already mentioned and we will use the emerging technologies.

A typical western company today uses a product development process that includes considerable rework. The product is developed through many re-try steps or "cut and try" steps. Once the product is released for production, Engineering Change Orders (ECOs) are required to make a change. ECOs continue well into the manufacturing phase. "Fire fighting" or bug fixing produces heroes that

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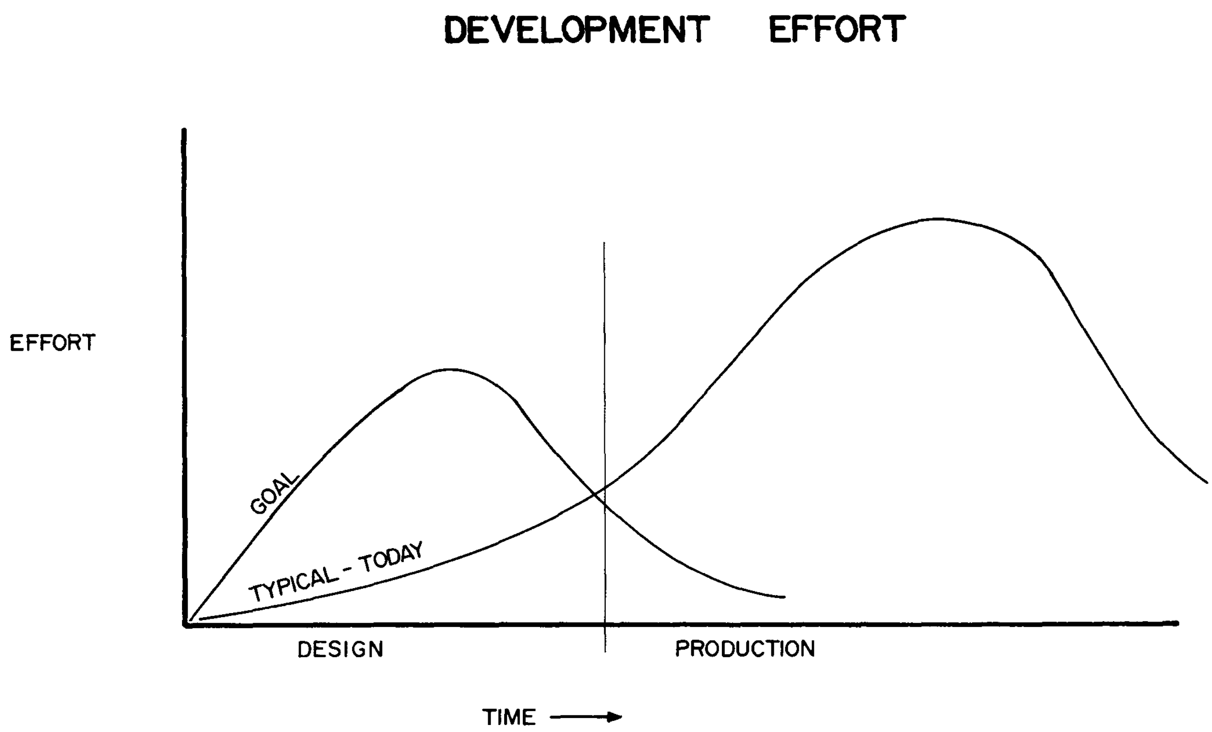

Fig. 1 - Development Effort/Time. Typical-Today and the Goal

get production going again, but fixing problems so late in the process does not lead to good company profitability.

Processing an ECO is a difficult, lengthy process and involves the time of many people. It is therefore a costly process and needs attention.

A typical U.S. development effort and cost is depicted in Figure 1, by the curve labeled "Typical-Today". This shows that we try to go through the design phase quickly and with minimum effort. Many problems are unwittingly saved until the preproduction or production phase. The effort and cost is much greater in these later phases due partly to a greater number of units to rework and a greater quantity of scrap. A significant delay in the schedule also occurs.

Our goal then is to pull more effort to the beginning of the design process. Providing more tools and help during this phase will pay back 10-100 times, according to some estimates. The curve marked "Goal" is where we want to be. This moves effort to the beginning of the process where it is less costly to make changes. Development during the production process is then greatly reduced and the savings are immense.

Due to the nature of the product and the exacting demands of some customers, many products now require more than two years to become relatively stable. We need to reduce this by 50%, to a one year timeframe, as a first step.

A unique way to view the design/development process is to use an actual process flowchart. Figure 2 shows such a chart which depicts the process up to a first production phase. Only the core development steps are shown.

A key observation from Figure 2 is to note all the decision points and "loop backs". If requirements are not met, the process returns to a previous step and the work is done over again. In order words, rework is performed. This is how additional time, effort, and cost is encountered in Engineering.

Our goal is to reduce these "loop backs" closer and closer to zero. In other words, "Do It Right The First Time" is also a good motto for Engineering. Refer to Reference 12 for more discussion.

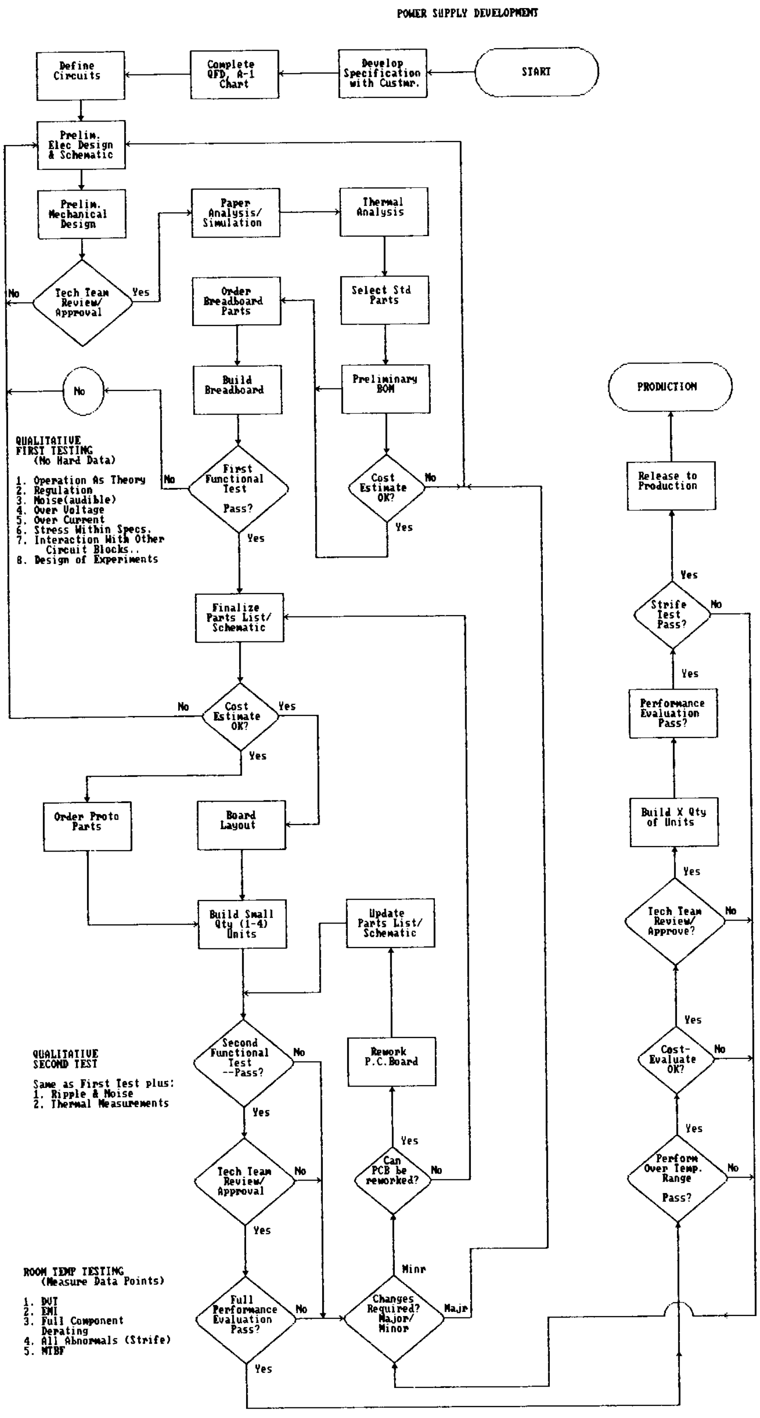

Fig. 2 - Development Process Up To Production Start

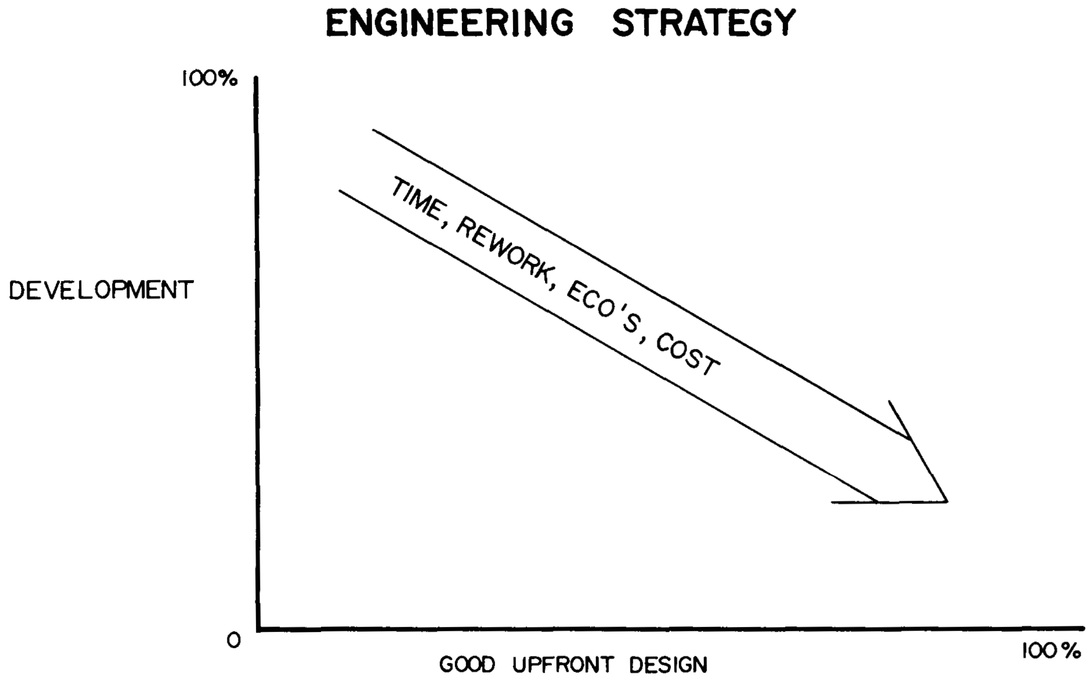

Fig. 3 - Engineering Strategy. Reduce Development Time, Rework, ECO's, and Cost by Using Good Upfront Design

One part of the overall strategy is shown in Fig. 3. This shows development time, rework, ECOs and cost dropping; due to good, upfront design. Good upfront design means doing a complete job of:

- Use of Quality Functional Deployment (QFD). Helps develop the specification and "real" requirements.
- Analysis by calculations. This is sometimes called modeling or simulation.
- Worst case circuit design or Monte Carlo analysis.
- Thermal analysis.
- Analyzing stress and assuring parts are properly derated.
- Testing to specification and beyond specification limits by strife testing.
- Use Design of Experiments (Taguchi).

Tools are becoming available to simplify and improve the design process. Computers and piecemeal software are available but are cumbersome and limited in capability. A more complete Analog Design Software is also available and is constantly improving. This software tool does almost everything needed for circuit analysis: stress, derating, temperature analysis and even a simulated production run (Monte Carlo).

This simulation technique allows circuitry to be built and tested in the computer before any breadboards or prototypes are built. As confidence increases in this approach and as the parasitic effects are accounted for, then the process of Figure 2 can be greatly simplified. "Loop Backs" can be reduced and the breadboard step can be eliminated. So there is a double effect and enormous time savings will be realized.

Confidence will be built by simulating circuitry, then testing actual circuitry, comparing results, then improving the simulation model, running the simulation, compare results, etc. So, a big part of the simulation process is to improve the model of the circuit.

Using a computerized design simulation also yields far more information about the circuitry than hand calculations do. Even early sample testing does not reveal as much. Only after a large, long production run and time in the field is as much known about the product.

Other ways to shorten the development cycle are to use standard circuits and standard parts. The "standards" are pre-developed and only slight modifications are needed to meet a new application.

Other areas of error generation, delays, and costly rework also exist in industry today. Most of these deal with clear, concise, accurate communication of information. Some of these areas are:

- Mechanical Drawings and Layout - The design engineer creates this but it is recreated by Manufacturing Engineering for the assembly processes. Or factory equipment is manually programmed with information that already exists in the CAD database.

- Electrical and Mechanical Design Calculations are not readily available to the Manufacturing Engineer when a problem occurs.

- Bills of Material are entered manually into the business computer system from CAD parts lists. This is time consuming and errors are created.

- Out of date copies of drawings are sometimes used, thus creating errors.

- Long ECO creations, approval, implementation time, creates confusion, errors, ECOs on top of ECOs, etc. The principles of JIT apply here.

- Customer Feedback is needed sooner by more people so that corrective action can be taken.

- Other important information about factory yields, repair results, financial analysis are all needed sooner in order to reduce scrap and waste.

"Haste Makes Waste" sometimes applies, but <u>Delay of Action</u> also makes waste. A delicate balance is required.

The principles of JIT apply to many aspects of the development process just as well as they do to the manufacturing process.

The basic concept of a Computer Integrated Manufacturing (CIM) System with electronic documentation and information system added will solve the problems listed previously. The addition of this system will also tend to break down departmental barriers and provide information sooner to everyone.

ZYCIM PROJECT

Part of the strategic Zytec plan for the future was to start a Computer Integrated Manufacturing (CIM) project. This project is named "ZYCIM", which stands for Zytec's version of CIM.

The primary objectives of the project are to:

- Get the concept started.

- Develop an overall "Big Picture" plan to interconnect computers and equipment in manufacturing, engineering, and other areas.

- Provide new, better tools for doing our jobs faster and better.

- Study Information Systems and how Electronic Documentation fits in.

Some major implementation concepts are:

- Use the team approach to determine needs. Involve the users of the system on these teams.

- Plan to implement the system as we need it and can afford it. In other words, "Think Big, Start Small".

- Study each process that we plan to automate. Be sure it is simplified and correct before automating it. Do not automate garbage!

Modern project management techniques are used to run the project. A key ingredient to any project is to have a good plan and then follow it. The plan consists of a gantt chart, a system chart, and a spreadsheet to track hardware, software, cost, status, etc. A portion of the computerized gantt chart is in Figure 4. It shows the initial activities to get the project started.

The "Big Picture" of the system is in Figure 5. This is a network of PCs, workstations, servers, departmental computers, mainframe, peripherals, gateways, etc. This is an ethernet system and is expandable.

The system has developed into a specialized version of CIM, especially for Zytec. There is no CIM vendor that will provide a turnkey system that is complete and meets all of a companies' needs.

There are three major databases in this system. Two technical databases, one at each facility, and one business database. There are interconnections between all of the databases and computers. A good Data Base Management System (DBMS) must be used and macro programmed to make it specific to the business. It must handle ASCII and graphical/vector data, be relational, and update all related files when a change is made — back annotate.

Electronic Documentation is at the heart of any information system. This means that all drawings, CAD files, and other documents will be stored and retrieved electronically. This will allow up to date documents to be displayed instantaneously. It leads directly to the "Paperless Factory" idea and provides the better, faster, more accurate communication that we are looking for.

There are many older documents that are only on paper. These must be converted into an electronic form. The first step is to get a video photograph or raster format file of them. This file can be stored and used for display only. If any changes or other manipulation is needed, then a conversion to vector format is needed for drawings and graphics. An ASCII format is needed for Alpha numerics.

To completely convert a drawing, with notes and special shapes, to a CAD vector file; requires manual cleanup. To completely convert thousands of drawings is an awesome, time consuming, and expensive task. Errors are often introduced during this operation.

The best approach is probably to:

- Create raster files for all active documents and store them in this format.

- Compress these files to save space.

- Convert these old documents to vector and ASCII files as they are needed.

With all the networking, hardware and software requirements in mind; there are least three ways to implement a CIM system:

- Hire a large staff and do all configuration and software development. - Long time to complete.

- Work with one or two systems integrators. Hire smaller staff but be prepared to do some experimenting. Pay some system development costs. Medium completion time.

- Work with large computer firms (i.e., CDC, HP, DEC, IBM ...). Hire a very small staff. Pay sizeable system development costs. Shortest completion time.

Implementing this entire plan and keeping up with technology will continue well into the 1990's. For instance, a new concept that may apply to Power Supply Design is the use of Expert Systems for guidance during this complex design process. There are so many factors to account for and remember that a design engineer finds it nearly impossible to remember them all. Manual checklists become too cumbersome and long.

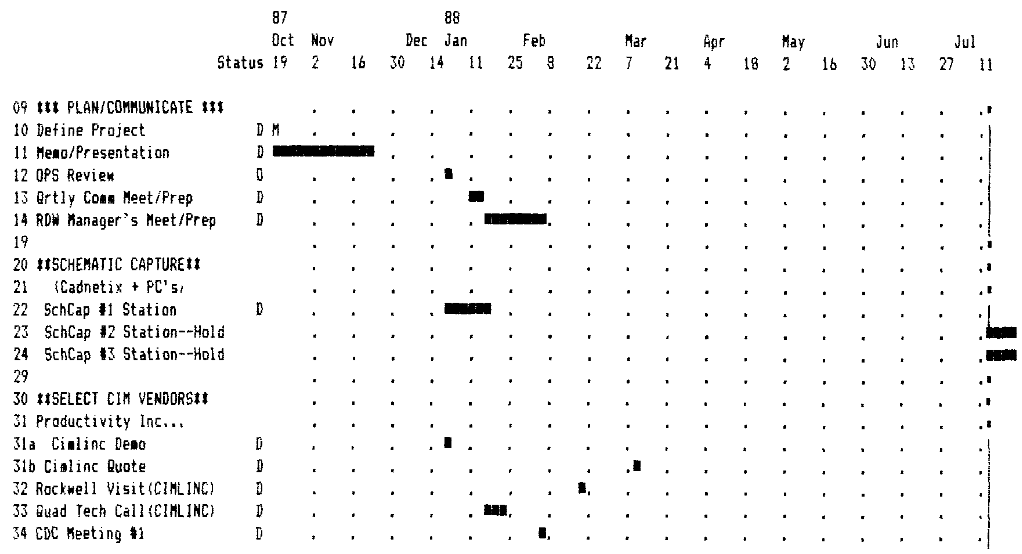

Fig. 4 - Gantt Chart for ZYCIM. Zytec's version of CIM

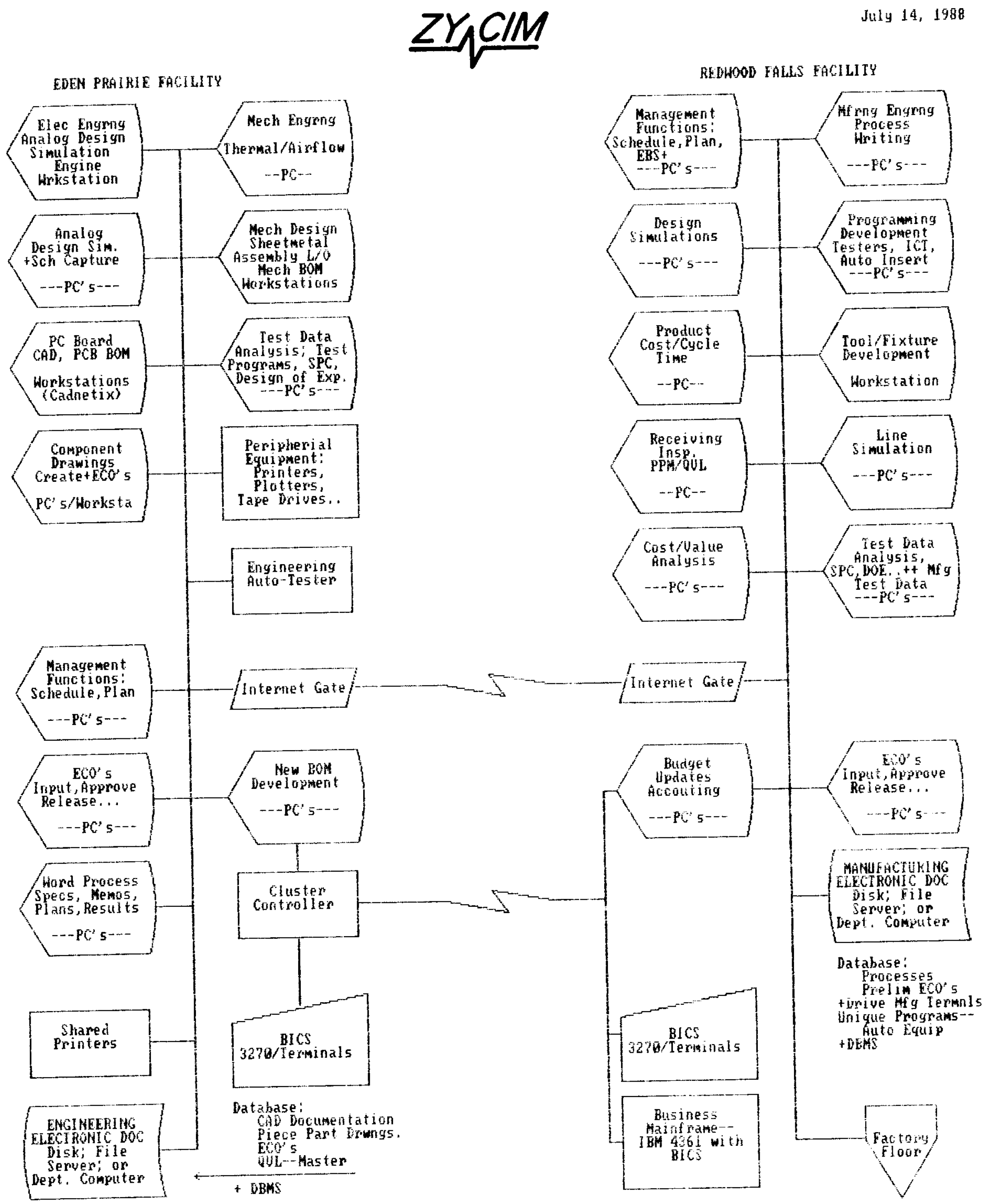

Fig. 5 - "Big Picture" of Zytec's CIM Project - ZYCIM

Many new advances are announced every day in the CIM arena. It is a very active market and certainly fits the philosophy that "anything is possible".

SUMMARY

This paper has covered the dynamic movement that western industry and engineering must make in order to reach World Class stature. Once this level is reached, we must continue toward even greater perfection.

Customized CIM systems will provide a large portion of the time reduction in the development process. Tremendous payback and competitive advantage can be realized if CIM is implemented properly.

All of the tools and knowledge are available to carry us into and beyond the 1990's. Good plans must be made that mesh with the overall company strategy. The latest and best project management techniques must be used to help make it all happen in a timely fashion.

Top management must support the endeavor and provide resources.

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