CASE STUDY

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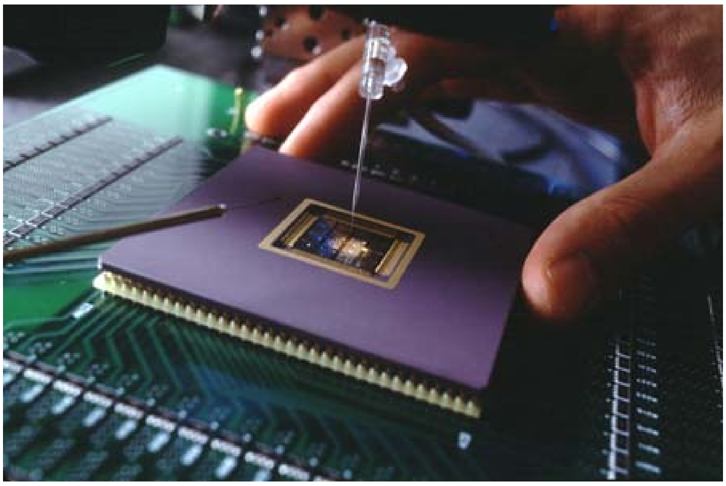
WITNESS Saves £5 Million for Lucent

By Paul Wu, Senior Consultant, Lucent Technologies

A single simulation saved about £5 million by helping engineers develop a more efficient printed circuit board manufacturing process that eliminated the need for a third shift. Spreadsheet analysis originally showed that three shifts would be required to meet the manufacturing schedule to build new processors for the switch that serves as the backbone of the AT&T network. Hoping to improve the process, Lucent Technologies engineers performed a WITNESS simulation that provided a much more realistic model of the process and allowed them to quickly and inexpensively evaluate a wide range of alternatives. Working with the simulation, Lucent engineers improved routing logic and test mixtures and made other changes that increased productivity by about 50% without any additional expenditures.



"The company met all of its key metrics including every shipping date while substantially reducing labor costs."
- Paul Wu, Lucent Technologies

Lucent Technologies was created in 1996 as part of AT&T's decision to split into three separate companies. Lucent Technologies combines the systems and technology units that were formerly a part of AT&T with the research and development capabilities of Bell Labs. Lucent provides both the hardware and software that run the world's global communications networks. Lucent produces local networks, business telephone systems and consumer telephones that access the global networks. The company also builds microchips and related components needed to run a host of products and systems, ranging from digital cellular phones and answering machines to advanced communications networks.

- Company: Lucent Technologies
- Industry: Communications Networking
- Application: Plant Productivity Improvement
- Benefit: £5 Million Cost Avoidance

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The backbone of the AT&T switched network is the 4ESS switch. A few years ago, network planners realised the growth of basic traffic, a shift in traffic mix towards calls that required more real-time computer resources, and more complex routing and billing schemes would require more processor real time and memory. To meet this need, the 1B processor was designed to provide twice the memory and 2.4 times the real time capacity of the incumbent 1A processor. An aggressive plan allocated one year for deploying the new processor in 134 AT&T central offices and several non-AT&T local exchange carrier offices. This deployment schedule was three times faster than those used for any previous product.

It was manufacturing's responsibility to have the 1Bs ready, when and where they were required for deployment. Due to this stringent deployment schedule, a single manufacturing organisation was created to span both engineering and operations. The three key parameters were 1) achieve high yields ahead of the production ramp 2) have contingency plans for potential obstacles and 3) miss no ship dates. An independent manufacturing operation in Lucent's Columbus Works was dedicated to the program. The main manufacturing operation occupied 30,000 square feet of contiguous space.

The majority of the manufacturing cycle consists of building and testing 90 different surface mount and through-hole circuit packs. Most of the components are inserted by machine, a number of testing steps are performed, additional components are inserted manually, the circuit packs pass through wave soldering and finally extensive testing is performed. After the circuit packs are tested, they are inserted into the cabinet and a complicated wiring process is performed. Then one more testing cycle is performed and the processor is ready for shipment.

Static models miss a lot

Engineers developed spreadsheet models to estimate cycles times as a tool for producing manufacturing schedules. Based on the original static models, they estimated that continuous three-shift operation would be required to meet the deployment schedule. The engineers recognised that while spreadsheet models are easy to use and understand, they have inherent problems that oversimplify such things as linearity of work flow, behaviour of insertion equipment and true capacity. In order to locate a more viable method of evaluation, Analogue Devices' engineers began experimenting with discrete event simulation software. Simulation adds an important dimension by adding the dynamics of time-based material flow that cannot be represented in a spreadsheet model.

Lucent engineers selected WITNESS to optimise the 1B manufacturing process. They selected the software because it offered a simpler and more flexible user interface than the other tools they examined. The interface is completely graphical, so the user can model a manufacturing process in rapid prototyping fashion without writing any code. The model can also be easily changed, even in mid-simulation to examine the effect of changing a buffer size, altering routing logic or changing the skill profile of staff. A click of the mouse can force failures at any point in the process to evaluate recovery plans.

Initial high level model

Lucent engineers began the simulation process by building a high-level model that was used primarily as a communications tool. This model highlighted problem areas in the process and was used in discussions with design engineering and management to demonstrate and evaluate these problems. The model was used to graphically view the impact of changes in factory operations to determine the effect of various design modifications. As a result, changes were made that significantly improved the manufacturability of the 1B process. The decision was also made to alter the nature of the change process so changes were made in groups rather than one at a time. The nature of the animation made it possible to involve many more people in the design process, including

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managers that were not used to dealing with detailed engineering drawings.

The next step was adding more detail to the model so it could be used to fine-tune processing alternatives. Engineers generated production data such as the set up, downtime, dropout, manufacturing process times and process flow. Engineering estimates were entered into the model and later verified and modified using preproduction data. Because the output of a computer model is deterministic, engineering intervention was added to develop the manufacturing lot size rules and circuit-pack mixes that were eventually implemented. The result was two lot sizes of 10 and 25.

Detailed model improves routing

Perhaps the biggest impact that simulation had was its use to improve routing. Because of their dynamic nature, spreadsheet simulations assume that the circuit pack will always push from station 1 to station 2 to station 3. WITNESS, on the other hand, is capable of evaluating the effect of more sophisticated routing schemes. Lucent process engineers built intelligence into the model so it understood the fact that the part could actually be processed by station 1, 2 and 3 in any order. They then developed routing schemes that would, for example, process the part through station 3 first if station 1 was tied up. Engineers evaluated a range of routing options and determined the optimum routing logic for the plant. This routing logic was then build into machine controllers or provided as instructions to supervisory personnel.

Circuit pack test mixture was another important aspect of the process that was optimised using simulation. The mix of boards that are tested in a given batch is important because testing operations take hours or even days. Circuit pack testing needs to be scheduled in such a way that the right circuit packs finish testing at just the right moment for cabinet assembly. Lucent engineers developed a complex logic that based the test mixture on buffer levels at various stations and the operating status of production machines. The simulation showed that this logic nearly eliminated the situation of having to hold up assembly of a processor because a few missing boards hadn't passed the test station.

Eliminating bottlenecks

The challenge for process engineers was to design the manufacturing shop with the capacity to ship four systems per week and to allow for both contingency and predicted design changes. Simulation enabled the process specialist team to integrate their individual processes and create a streamlined material flow. The capacity of each manufacturing process as well as the entire integrated process could then be analysed. Modifications were made to eliminate bottlenecks and optimise the process. The data provided by modelling allowed all process engineers to more easily view and understand their impact on the big picture.

When they had finished the simulation process, the results showed that Lucent engineers had increased productivity to such an extent that they could eliminate one shift and still meet the manufacturing schedule. They used this final run as a guide for their final process plans. Soon after production got underway it was clear they were right. They had predicted an average of 8.25 working days to move on average a mix of 800 circuit packs from pre-form through functional test. The actual production results were very close to this figure. As a result, the company met all of its key metrics including every shipping date while substantially reducing labour costs. Based on this success, Lucent has begun to use simulation as an integral part of the manufacturing engineering process.

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