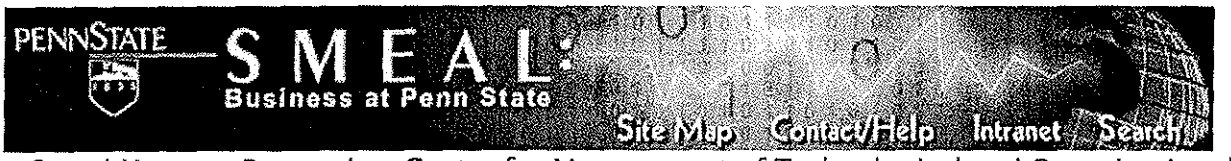

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"Integrated Product Development Techniques and Practices to Meet an Aggressive Schedule"

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Fore Systems, Inc. was founded in 1991 by four researchers from Carnegie Mellon University, and became a public company in 1994. The company produces high technology network communications products. Approximately 70% of all Internet traffic is transferred over Fore Systems products. Fore Systems employs over 1,900 people worldwide, and is expected to have revenues of $650 million in 1999. The company is growing at an annual rate of thirty percent.

Fore systems builds high reliability, high performance silicon communication switches that range from 2.5 to 40 Gbits in capacity. The switches are rated to have less than 0.0001% downtime, and the company is obligated by contract to meet those specifications. The internal goals set by engineering for the design and manufacture of new products include a target of no more than 0.00001% downtime. The ASX line of products are core ATM switches. The ASX-1000 is a 10 Gbit ATM switch, and the highest volume product of the company. The ASX-4000 is the latest switch in that product line and has a capacity of 40 Gbit. Fore Systems also creates the software for their switching products. Forethought is the control software that runs the switch processors. The software consists of over 1.2 million lines of code mostly written in the C language. This code base supports all Fore System switches, and is capable of operating on two different types of processors.

The ESX-3000 project, also known as the "Hydra", was started in 1997. The ESX product lines of switches are used for wiring closet applications, and the ESX-3000 is the newest member of this group. The project took 17 months from inception until the product was first delivered to customers in March of 1999. There were approximately 33,100 hours of engineering time devoted to the development of this system. In addition, over $1 million in Research & Development, and $2.1 million in labor were required to complete the project. The ESX-3000 is a 20 Gbit ATM switch consisting of two switching fabrics, two control processors, and eight line interface cards.

Fore Systems follows an established product development structure to conceive and build new products. Roadmaps define the products for a specific market segment. The roadmaps are owned by marketing, but are generated through combined efforts of marketing, engineering, sales, and manufacturing. The new products are defined through product requirements documents created by marketing and engineering, and include cost targets. The documentation is also reviewed by program management and manufacturing, with final approval granted by the vice presidents of engineering and marketing.

The Fore system's engineering structure consists of six engineering facilities worldwide. Each engineering facility performs site specific functions. Some worldwide functions common to all facilities are also performed at each of the sites. Cross-functional product teams perform all development. Teams consist of representatives from each of the vertical organizations within the company. Each project has an engineering technical lead that is responsible for technical details. There is a program/project manager that handles the details of running the project. Fore Systems became ISO 9000 certified in October 1996. Formal project management systems have been in place for approximately 18 months.

Several key factors contributed to the success of the ESX-3000 Hydra project. The goals were clear and well defined, and there was a strong commitment to the project from the onset. The priorities were established as follows: The first priority was to maintain the high level of quality that Fore Systems builds into all of their other products. The second priority was to minimize the time of the ESX-3000 to market. The third priority was to maintain a reasonable cost of goods sold margin. The fourth priority was to keep development costs within target. The product requirements did not change during the entire development phase of the system. Corporate management considered this project to be very important and supported the project by adhering to these commitments.

Fore Systems created a single project team that included all cross-functional areas, and was staffed with the senior most experienced people. The management selected the best design engineers, software engineers, and manufacturing people from within the company to participate on the team from the start. The team members were given clear areas of responsibilities, and were co-located in the same facility. Where necessary, the selected team members were relocated. The team was insulated from the daily distractions and "fires" of manufacturing and customer problems. Manufacturing was made part of the team from the start, and subcontractors were also made part of the team. Team meetings were conducted on a weekly basis, and more often when important issues became critical. The ESX-3000 utilized existing technology from the ASX-4000 and other Fore Systems products. There were no new ASIC's for the ESX-3000. The software simulators originally designed for the ASX-4000 were modified and used for the ESX-3000. The software simulated the behavior of the switches, and permitted system software to be developed prior to actual hardware being available. The reuse of existing technology allowed for the overall reduction of risk in the project.

The project employed formal risk management procedures. Risk management plans were created and implemented. Potential problems were identified, plans were outlined to react to them, and trigger points were set to alert team members of problems. The largest risk element was completing the project within schedule. The project was micro-managed to the smallest detail. There were multiple project managers who had phases overlapping each other, with the vice president of engineering development overseeing the operation. Risk management to this level of detail was in large part made possible by the clarity of goals and up-front establishment of priorities.

The project was controlled from multiple perspectives. All project documentation was centralized to a single database. This included all design documents, schematics, bills of materials, and other important subject matter. Engineering had daily stand-up meetings to discuss and plan the immediate activities. Meetings were conducted three times a week with both purchasing and contractors. The same subcontractors were used for both prototyping and production of assemblies. Manufacturing technicians were used to bring up the first run alpha products. The team was committed to staying on the project for three months after the first customer shipment.

Additional factors contributed to the success of the project. The importance of the project was stressed from the beginning, and management established team buy-in with all individuals. The team created the schedules and re-worked them until management was in agreement. The schedules were published, then updated on at least a weekly basis. The schedule was posted and everyone was aware of the status of the project. All critical paths less than two weeks were tracked closely. The reuse of technology allowed first-pass prototypes to be used by the software development engineers. The ESX-3000 project was completed within two days of the 17 month time-line. This was the first project that incorporated all of these existing Fore Systems management techniques in a single project.

Last modified Sunday, 07-Oct-2001 21:52:39 EDT