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Step Change at Du Pont's Camden Plant

By the end of the summer of 1993, a "Step Change" effort undertaken by the Camden, South Carolina, manufacturing plant of Du Pont's Nylon Business had reached a new turning point. A new nylon spinning test cell introduced as a result of the Step Change effort had led to a dramatic reduction in process breaks, generating, in turn, significant improvements in manufacturing yields, product quality, and break-even times for new product introductions. The success of the Step Change project at Camden had caught the attention of Roger Sharp, vice president of Manufacturing for the Nylon Business (see **Exhibit 1** for an organization chart). He was now pushing to get this innovation adopted in all of the business's other plants.

Though the managers who had led the Step Change effort at Camden were delighted with the attention and credit they were getting from senior management, they were also nervous about this new mandate. Dr. Warren Easley, the BCF Technical Manager, was concerned that higher level expectations were a bit unrealistic. It had taken him and his team at Camden almost two years to implement the Step Change initiative. Yet Sharp was expecting the other Nylon plants to embrace similar changes and show substantial improvements in manufacturing yields in less than a year. Easley knew he had to manage Sharp's expectations, while still trying to get the other plants to expeditiously adopt the changes pioneered at Camden. He had already asked Dick Dommel, the team leader and champion of the Step Change initiative at Camden if he would head up a team charged with the task of leveraging similar changes throughout Du Pont Nylon.

Dommel was an unbridled champion of the Step Change at Camden. He led the team that had developed the spinning test cell and took great pride in its success. In recent months he had, on his own initiative, been going to other plants across Du Pont Nylon to present the results of the changes they had initiated at Camden. He felt the best way to diffuse the innovation was to advertise its benefits and thereby generate a ground swell of demand from those who felt the innovation could help them solve their own problems. He felt that a top-down corporate mandate might simply lead to a half-hearted show of adoption by the other plants. On the basis of his experience at Camden, he knew that it would take nothing less than full commitment on the part of those who wished to adopt the innovation for it to succeed. To bolster his view, he pointed out that he was already hosting a colleague from another plant who had approached him to see if the spinning test cell could help solve a problem he had been struggling with. Dommel wondered if this type of spontaneous horizontal exchange of information was not the most effective way to diffuse

Professor Nitin Nohria prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

the Step Change idea across Du Pont Nylon. Despite his misgivings about the high-level mandate, Dommel was excited about the opportunity to lead the effort to leverage, throughout Du Pont Nylon, the Step Change project he had championed at Camden.

Background: Du Pont and Nylon

Origins of Nylon (1920-1936)

In 1920, Du Pont purchased the technology for making artificial silk from the French. Later that year the Du Pont Fibersilk Company was formed and began the manufacture of an artificial silk later known as rayon. With that start in synthetic fibers, the stage was set for the invention of nylon.

For Du Pont, the invention of Nylon began in 1928 with the wooing of Dr. Wallace Hume Carothers from Harvard University. Carothers agreed to come to Du Pont's Experimental Station with the promise that he would only have to do research in pursuit of science and the advancement of knowledge in the relatively new field of polymer chemistry. In 1930, within an extraordinary span of one month, Carothers' group of eight scientists had produced the first samples of Neoprene and the first laboratory synthetic fiber. However, from a commercial standpoint, the fiber still had a couple of unfortunate deficiencies such as melting in moderate heat and dissolving in dry cleaning solvent.

The Great Depression and a change in Du Pont's laboratory leadership put pressure on Carothers' research group to "pay more of its way." This caused Carothers considerable anxiety and even led him to inquire about returning to Harvard. Then, on May 24, 1934, at the suggestion of Carothers, one of his assistants drew a sample of synthetic fiber that overcame the melting problem of earlier attempts. This fiber, remarkably like silk, was nylon! Ultimately, a "cousin" of this fiber (known technically as nylon 6,6) became Du Pont's most celebrated product. It was first prepared on February 28, 1935, during the process of trying all 81 possible variants of nylon.[1]

Commercialization of Nylon (1937-1942)

From these beginnings, the commercialization of nylon continued rapidly from feasibility to practicability to repeatability, each phase taking roughly 18 months. Early on, Du Pont took on the challenge of substituting nylon for silk in women's fashion hosiery without affecting the price. At the end of 1937, the first stockings were knit.

In January 1938, the Executive Committee authorized a pilot plant in Seaford, Delaware that subsequently expanded to its current million pounds a day capacity. Soon, other plants followed in Martinsville, Virginia (1941), Kingston, Ontario (1942), Chattanooga, Tennessee (1948), and Camden, South Carolina (1968).

Nylon was an instant market and financial success. In 1941, in only its second year of commercial production, profits were $7 million on sales of $25 million. Nylon stocking sales in the

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[1] Nylon 6 was commercialized in Europe by I.G. Farben shortly thereafter. Nylon 6 today is the major nylon fiber produced world-wide.

United States were over 60 million pairs, more than the number of women in the country at the time!

Nylon Emerges (1943-1959)

Other uses for nylon started emerging as soon as the totally man-made fiber was available. Before World War II, civilian uses of nylon included toothbrushes, fishing lines, ties, sewing thread, jewelry bead cord, football pants, and foundation garments. During World War II, almost all nylon production was earmarked for the war effort. The military used it in 3.8 million parachutes, a half a million airplane tires, and for an uncounted number of glider tow ropes, flak vests, and blood plasma filters.

After World War II, nylon expanded into dressware, blouses, skirts, linings, and shells. In the late 1940s, nylon carpets made their appearance. During the 1950s, advances in nylon texturing and carpet tufting facilitated the rapid development of the nylon carpet market. By the 1990s, carpets accounted for 35% of the world's nylon production. Also making its commercial debut in the 1940s was industrial nylon whose principle utility was strength and durability and was used in nylon cord (as tire reinforcements and ropes), bulletproofing, luggage, and sporting gear.

In 1951, sensing that demand for nylon was overwhelming, Du Pont licensed nylon to Chemstrand by building them a 50 million pounds per year plant for $110 million. No doubt, the prospect of Anti-Trust litigation figured in the decision as well.

Nylon Growth (1960-1980)

Overall, the worldwide nylon market enjoyed a 10.5% compounded annual growth throughout this 20-year period going from 1 billion pounds to 7.5 billion pounds annually. This sustained growth was made possible by an unrelenting progression of product extensions and process refinements. Fiber cross sections were manipulated to produce a variety of optical and tactile effects. Antistatic treatments were developed in the 1970s. In the factory, faster spinning of yarns reached a point where they could be spun at over 180 miles per hour (almost a football field's length per second).

Despite growth and progress, the 1970s were the first difficult times for nylon. The oil crises of 1973 and 1979 hit nylon hard. After many years of producing half of Du Pont's profits, nylon made no profit in 1975. Investment in nylon research and development was cut accordingly.

Nylon Maturity (1980-1994)

During the 1980s, the capital invested as a percentage of net assets in upgrading Du Pont's nylon plants was around 30% less than the amount invested by comparable companies such as 3M, Monsanto, Proctor and Gamble, and Kodak. One sign of the severity of the capital starvation was that in some of Du Pont's plants, power outages threatened production because their on-site power conversion units lacked the critical improvements to function properly.

In addition to capital, labor was cut back. Technical professionals were reduced by 50% during the 1980s and, during the 1990s, both technical professionals and factory personnel were cut back 25%. Only competitors who were *exiting* the nylon business experienced comparable cutbacks. Understandably, anxiety was high and morale was low. Meanwhile, some competitors were installing the latest technology in new plants and enjoying the improved economics that technological progress brings. By their own admission, Du Pont's nylon plant managers conceded that their yields were considerably lower (almost 10%) than those of their leading global competitor, Toray of Japan.

Another pressure on Du Pont's Nylon business was the growing market for "specific solutions." This led to a proliferation of product variations that could often be better handled by the newer plants of competitors. Du Pont's mass production factories were never designed for high flexibility and could not economically keep pace with the product proliferation. More pressure came from customers who were integrating backward. Some customers were no longer buying nylon fiber, but rather nylon polymer and doing their own melting, extruding, and spinning of nylon fiber and, of course, not paying firms like Du Pont the last 15-20% that these processes had customarily commanded.

Despite its weakening competitive position, Du Pont remained a major player on a global basis with over 10% of the $6 billion nylon textile market, over 35% of the $4.5 billion nylon carpet market, over 20% of the $2.5 billion industrial nylon market, over 20% of the $2.3 billion nylon polymer market and over 35% of the $500 million nylon intermediates petrochemical market in 1993. Moreover, nylon was still one of Du Pont's core businesses (contibuting roughly 10% of Du Pont's sales and 20% of its earnings).[2] Du Pont was resolved to remain in the business and improve its competitive posture. The firm's top management had recently engaged one of the leading consulting firms that specialized in process improvement and business transformation to help them better the performance of their various businesses and the corporation as a whole.

Step Change at Camden

Origins of Step Change

Far removed from these corporate actions, in June of 1990, Dr. Richard Hess, Manager of Du Pont Fibers Technical Planning was evaluating a smaller consulting engagement he had been managing.

The previous year, concerned with the lack of breakthroughs in technology, Hess had brought in a consultant specializing in the technology management area to overhaul the resource allocation process used by his group. On the basis of interviews with executives and operating managers, the consultant drew some alarming conclusions. There was widespread sentiment that the Technical Function could and had to perform better. Some voiced considerable dissatisfaction with the lack of technical breakthroughs, attributing it to an environment that discouraged experimentation. As one manager put it, "It's a long hard climb back from making a mistake around here." Interviewees recounted stories of more than one canceled project because of a quarterly downturn in its sponsoring business.

In presenting the findings of the resource allocation study, Jim Cook, the consultant, concluded that the competitive slippage and lackluster technical performance of the group could not be reversed by a new resource allocation process. Paraphrasing one of the managers he interviewed, Cook argued that "to truly change technical productivity, would require changing the culture as well as the managerial process." To support this conclusion, Cook pointed out that common to all the previous technical successes enjoyed by the group, was not just the resources

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[2] These data are obtained from various Investext reports.

allocated to the project, but rather the execution of the project. For the most part, Cook noted, successful projects were exceptional for their urgency, focus and local autonomy.

Cook recommended trying to systematize these conditions for success in an exemplar (i.e., model to be imitated). Then, the effective methods could be proven and subsequently diffused and institutionalized. He went on to suggest that focusing on the "hot problem" of First Pass Yield (the percentage of product that fulfills all quality standards without any rework) would be strategic to sustaining the competitiveness of Fibers.

Cook further asserted that the paradigm that had served the Fibers' Technical Function so well for the past 20 years had exhausted its wealth creating potential. He told Hess that Fibers needed a new paradigm that leveraged technological advances that had occurred *since* the current paradigm was established (see **Exhibit 2**). Advances in information technology were obvious candidates; less conspicuous, but equally important, were aerospace advances. Cook suggested the exploitation of all of these advances to dramatically improve First Pass Yield.

In his career as a developer, manager, entrepreneur, and consultant, Cook had been intrigued by radical differences in performance across groups. After reading a history of Beretta's manufacturing operations that showed that productivity jumped every time the company embraced a new production paradigm, Cook became convinced that paradigm shifts were key to dramatic performance improvements. On the basis of this experience, Cook proposed that what Fibers needed was what he called a "Step Change"—a systematic approach to introducing a paradigm shift (see **Exhibit 3** for a brief description of Cook's vision of Step Change).

Cook's ideas appealed to Hess just as he was about to "go public" in a meeting before the Technical Directors of all the Fibers' businesses on July 9, 1990. Hess knew that Cook's ideas would require seeking commitment in a potentially hostile environment. Hess enumerated several factors that made the environment difficult:

- Everyone was up to their eyeballs in work. Pressure was coming from everywhere to do more for less.
- The Technical Directors had the First Pass Yield problem in front of them for years. They were thus likely to be enormously skeptical that a new approach might uncover things that hadn't been previously considered. It was going to be very difficult to articulate a systematic approach to anything and make it sound different from the questions we had always asked about our processes. Moreover, there was so much activity already going on in manufacturing that touched on the Yield problem that the Directors were likely to question what a new inter-group effort would add.

The challenge, Hess explained to Cook, was to describe their project's goals and methods in such compelling terms that by the end of the meeting at least one of the technical directors would say, "We cannot risk *not* trying this."

Selling Step Change

At the July 9, 1990, presentation to the Technical Directors, Cook opened by declaring that the goal of the project he was proposing was to pursue a Step Change in the rate of process improvement. Reminding the group that process deficiencies were costing Fibers almost $1 billion annually, Cook went on to say that only such a Step Change would break the spiral of diminishing profitability that would otherwise drive Du Pont out of the nylon business. The goal of Step

Change, he explained, was not a 20% or 30% improvement on some major problem, but rather a full 200-300% improvement within a specific time frame, such as one year.

Cook went on to suggest that such a Step Change would not occur: 1) by lecturing to the technical organization, 2) by relying solely on Du Pont people and practices, 3) by improving existing methodologies, 4) without proactive intervention, and 5) without an organizational predisposition to learn.

Furthermore, a Step Change would require: 1) a paradigm shift in approach and 2) a culture that allows mistakes and encourages experimentation.

The Technical Directors were then asked if there were any groups they knew of that might serve as pilot sites for a Step Change exemplar. Before the presentation was over, two Technical Directors had offered up candidates for a Step Change exemplar. In subsequent discussions, Dr. Ted Sandukas, Technical Director and Dr. Warren Easley, Research Manager of Flooring Systems, were the first to be "sold" on the idea of implementing a Step Change exemplar.

Easley organized a meeting at the potential pilot site, the Nylon factory in Camden, South Carolina for late August. Cook and Hess were invited to present their ideas at this meeting to seven Flooring Systems managers (three of who were technical managers from Camden, three from another Nylon factory, and one manufacturing manager from Camden). After the meeting in Camden, Easley said that though the meeting had gone well, they would have to persuade the actual technical team to embrace the proposal *or* go elsewhere. Hess and Cook felt they were already straining their goodwill back at Fibers' headquarters. As Hess put it, "To come up empty now would not look good."

Finally, on October 12, 1990, Easley assembled the prospective technical team for its presentation. To Hess, this meeting was the last chance to get the Step Change exemplar underway. At this presentation, Cook explained the exemplar would be as if it were a "skunk works" except that it would be done from within, not from outside, the factory. Just as in a "skunk works," the team would have autonomy and be mission driven. The autonomy would be assured by a managerial support team that would "pave the way" for the core technical team to set aside disabling policies and procedures, whenever required.

A champion emerged from this meeting. At the Camden factory, Richard Dommel, a Research Associate, felt that the Step Change initiative presented him with an opportunity to translate into reality his vision of a Nylon Spinning "dynamometer" (a highly instrumented test bed used on combustion motors). Cook felt that the dynamometer idea had great promise. However, he reiterated the necessities and consequences of a paradigm shift. Beyond the technical shift from off-line to on-line, analog to digital, and multi-second to millisecond technologies, he warned Dommel, there would be shifts in the work-place, work-ways and work-base for the technical people. With the instrumentation *on* the factory floor, researchers would have to actually work there. They would have to rely on and be relied upon by the factory workers. Also the vaunted tradition in research of "know before you try" would have to give way to "just try it and learn as a result."

In his 1991 budget, Easley included the Camden Step Change Exemplar as a Robust Fundamentals Nylon Spinning Test Cell. Before Dommel would formally commit to leading this effort, however, he insisted on getting a very special and talented person to tie together all of the computer hardware and software in the "experimenters' suite" he had envisioned. Maarten Meinders, Senior Research Engineer, came on board and Dommel's requirement was satisfied. By the end of 1990, the new budget item had been approved.

Step Change in Action

The original design of the Step Change effort foresaw a critical role for a Management Support Team that would meet on a regular basis to provide critical resources and remove bottlenecks for the core technical team (see **Exhibit 4**). In actuality, the management support team never convened. Instead, two of its members provided *ad hoc* managerial support for the core technical team.

Craig Corey, Production Manager at Camden, carried the cost of installing and maintaining the spinning test cell in his production budget. Corey was also generous enough to absorb the spinning machine down time (around $3,000 a day) caused by the spinning test cell. Beyond the money, Corey's support was also crucial because he was a seasoned manufacturing manager who enjoyed immense credibility throughout the plant. His support was key to getting the workers to collaborate with the technical team. Corey explained his support of the team as being ultimately motivated by self-interest. If the test cell worked, he reasoned, it would ultimately help him improve his cost performance numbers through increased yields.

In addition to Corey, Easley was the other management team member who provided crucial ad-hoc support. With the concurrence of Sandukas, for instance, he helped the team circumvent some cumbersome rules regarding vendor qualification as well as other "regular channels" and requirements of engineering and purchasing. Without this *ad hoc* management support, members of the team felt the tempo of the project would have been crippled and the whole idea, most likely, been abandoned.

By mid-1991, Dommel had a spinning test system with over 30 sensors and high speed (millisecond) sampling operating in the Camden factory. What the team had not anticipated was that the sheer number of sensors would require months of installation and that there would be pragmatic issues, such as how to install sensors in such a way so that they did not interfere with production. Much of the work on the project thus had to be done during times such as third shifts and weekends.

It took until the end of 1992 to get the Nylon Spinning Test Cell to perform useful experimentation. New techniques of testing, data collection, and processing had to be devised and implemented. This was twice the time predicted by the consultant, Cook. The major costs over the two year development cycle of the Step-Change exemplar were estimated at: $330,000 in direct technical labor (mostly the core team's time), $150,000 in consulting fees (mostly Cook's involvement), $150,000 for the installation of sensors in the factory, $80,000 in doppler laser velocimeters (for measuring speeds), an estimated $70,000 in sensors, $15,000 in computers, and $10,000 in software for a total of about $800,000, less than 1% of Nylon's R & D budget.

Step Change in Practice

The Nylon spinning test cell was an unobtrusive legion of (around a hundred) sensors located strategically on a standard spinning machine that feeds data into an adjacent "computer hut" for high speed data collection and manipulation. The spinning machine spun over half a dozen bobbin per hour of nylon carpet yarn. The sensors measured things like temperatures, air flow, power characteristics, thread line tension, broken filaments, yarn luster, and various thread line speeds. The "hut," about 11′ by 9′ by 9′ high, was easily accessible by manufacturing and technical personnel, and had a clear line of sight to the actual spinning. By 1994, the up-to-the-second processed data collected from the sensors had been made accessible by network to the technical area for continuous access to progress and "events." Curiously, the central control room of the factory didn't have direct access to the data.

Typically, engineers used the test cell to answer questions such as: "What operating conditions might improve our First Pass Yield on this product?" Most commonly, the engineers waited until the product was scheduled to run, and then went down to the "hut" to try some conditions that stressed the resulting product, by increasing tension and measuring the broken filaments, for example. The spinning machine operators were quite interested in this testing regime and often offered suggestions and comments. Frequently, they used the test cell to observe how the spinning machine was performing, even when engineers were not conducting tests. New product developers and product support specialists also used the system daily to explore the manufacturability of new products and to improve process parameters for existing products.

Prior to the spinning test cell, a test, called a "test series," was a major undertaking. It would tie up the spinning machine for up to one day, because detecting "events" was rare and the conditions of interest had to have sensors installed with customized brackets and, then, calibrated and recorded. Each test series was crafted to the occasion, and so each test had to be fully hypothecated and scripted ahead of time. To run a test series generally required a management "okay," since one series might cost over $10,000. This testing required coordination with manufacturing, but no other input was requested nor offered. Finally, the analysis was done in the din of the engineer's office over a period of weeks interrupted frequently by the technical demands of operations.

With the introduction of the spinning test cell, tests became a much simpler affair as they could be performed right "on-the-spot" by the turn of a knob, or more likely the press of keys. Because all the sensors remain permanently in place, there was no need anymore for "crafting," just "flying," so to speak. Unlike the earlier situation, manufacturing people were now active participants in the testing process. Data analysis could also be done "on-the-spot." Instead of the previous practice of engineers sifting through mountains of data after they had finished a test series, a report log, or better yet, just the data and analysis an engineer wanted was now made available in computer, printed, and report form. All told, a typical test series now took under two hours and required no management "okay."

The changes enabled by the test cell were best captured in the following remarks of one of the new product engineers: "Before the test cell I was called *knockdown* by the machine operators because of the frequency with which I would knock the machines down while I was experimenting to try and optimize the production process. With the test cell, we can avoid most of these knock-downs." With over ten times the experimental rate, the learning curve literature suggested that the spinning test cell had the potential to increase the learning rate for process improvements three-fold. In addition, the cycle time to develop a new product was reduced ten-fold and static yields of new products reached unprecedented levels.

The first products to be investigated using the new spinning test cell were the perennial "bad boys." These products seemed intractable to achieving high yields, often exhibiting over twice the threadline breaks of regular products. The results were immediate and the yields on these difficult products soon came up to regular performance standards. As a result, some higher valued-added products that were thought unproduceable became economical. Next some new products were tried. The engineers were able to achieve standard yields in about a sixth the time it used to take them previously. With the test cell, new products could be economically mass produced in one to two weeks, not the customary 3-6 months. Finally, high volume products that had been worked over substantially were investigated. In this situation too, the test cell allowed engineers to reduce spinning interruptions by over 50% helping raise process yields by as much as 15%, much to everyone's surprise (except the most ardent believers).

Despite these impressive results there were some who felt that the test cell was being "hyped beyond its real performance." As one process development engineer put it: "The yield improvements that we have seen are not all directly attributable to the test cell. Some of those gains may have been realized anyway." Despite this engineer's concern that the benefits to the system were being "oversold" he admitted that the test cell had given him the "confidence to push the boundaries" beyond what he would have felt comfortable doing with the older system. Proponents of the cell believed that what confused the allocation of credit to the new test cell was the alacrity with which new ideas could now be tested. It led to the mistaken belief that if the idea worked, it surely wasn't because of the cell. But if the cost to test an idea, proponents of the cell argued, was not so incredibly low because of the cell's performance, the idea may easily have languished in the past.

Whatever the real cause of the improvement, it was clear that a Step Change had occurred at Camden. By the end of 1993, Camden had the fastest rising yields and the lowest rejection rates, even while some of the most difficult products were gravitating there (see **Exhibit 5**). The duration between spinning breaks had tripled and the yield on nearly every product tried had risen five percentage points. Camden, consequently, became the best margin producer in the Nylon family of factories.

Camden's higher yields went well beyond saving "feed stock" (as the material consumed by production was called). Higher manufacturing yields had an impact not only on the cost of goods sold, but also improved scheduling and customer satisfaction. Reduction in breaks also enhanced workforce productivity. Dealing with breaks (cleaning up the spillage, resetting, and restarting the spinning machines) previously consumed as much as 15% of the total labor hours. At a more strategic level, higher yields enabled technical leadership in the marketplace, enhanced product and company image, and improved morale (see **Exhibit 6** for a summary of the benefits that could be derived from improved yields).

Leveraging Step Change Throughout Nylon

Notwithstanding its success at Camden, there were mixed reactions to the prospects of leveraging the technology throughout Du Pont. Some felt that since the test-cell had shown demonstrated results, its diffusion would meet with little resistance from the other plants, since they would all be able to see its value. Furthermore, they expected the resistance to be even lesser now that Roger Sharp, the VP of Manufacturing, was pushing its adoption.

Others felt that the adoption of the technology in the other plants would not be without significant difficulties. They pointed out that the plants were quite different in terms of the types of fibers they produced and the system would have to be adapted to take account of these contextual differences. Moreover, most plants already had their own technical initiatives underway to try to solve their unique problems and some people wondered how readily they would accept a solution that might make their own work less salient.

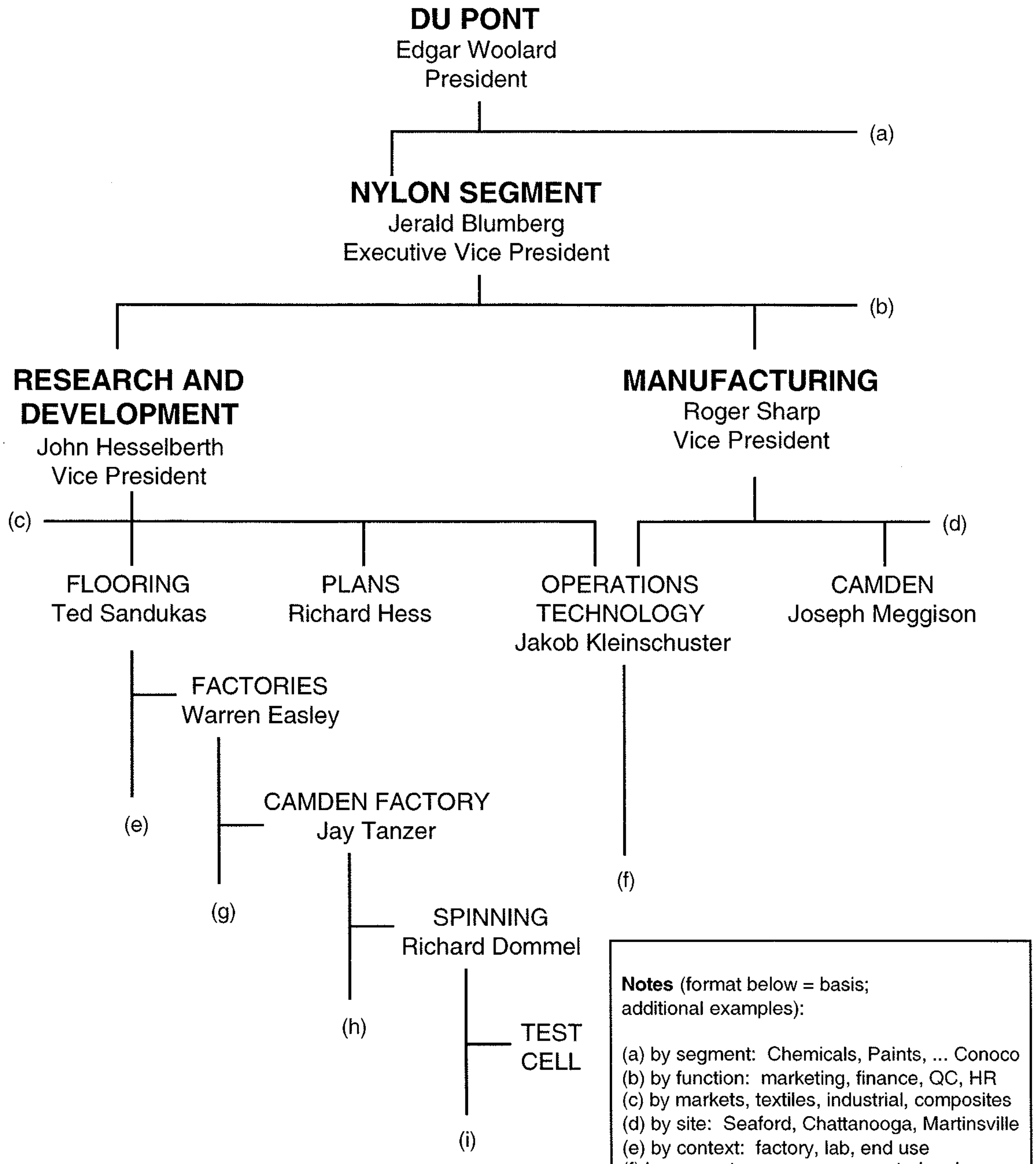
Beyond the familiar "not-invented-here" problem, some managers pointed out that as with any new tool, it would take time before engineers would feel comfortable changing their practiced ways and use the new tool. On the basis of these concerns, they wondered if other plants would have the stamina to stay with the change effort or if they would get disillusioned if they didn't see immediate results. The enthusiasts of the test cell countered that the learning curve for the new plants would be much steeper than it was for Camden since many of the thorny difficulties had already been addressed. They felt that it would probably take six months instead of two years for these plants to see tangible benefits.

Another key issue raised by those concerned about the ease with which this innovation could be leveraged across Du Pont was the importance of a few key individuals to the success of the effort at Camden and the difficulty of finding such people in the other plants. For instance it was pointed out that the success at Camden was in large measure due to the championing role played by Dommel and the excellent support that was provided to the project by Craig Corey and Warren Easley. Another person singled out for attention was Maarten Meinders. Many wondered where the other plants would find people of Meinders unique computing talents.

As Jim Cook, the consultant who had been a key part of the entire Step Change effort at Camden pointed out,

> Finally, there are the things—equipment, software, and techniques. These are the tools of Step Change. But without replicating the Crisis, Support, External Intervention, Clear Purpose, Unifying Strategy, Buy-In, New Approach, Mastery, Spirit, and Champion that had made the exemplar at Camden work, there can at best be gradual change, not Step Change.

Exhibit 1 Du Pont's Organizational Structure



Notes (format below = basis; additional examples):

(a) by segment: Chemicals, Paints, ... Conoco
(b) by function: marketing, finance, QC, HR
(c) by markets, textiles, industrial, composites
(d) by site: Seaford, Chattanooga, Martinsville
(e) by context: factory, lab, end use
(f) by competency: process control, polymer
(g) by site: Waynesboro, Seaford
(h) by application: finishing, anti-stat
(i) by project: quench profiling, bulking upgrade

Exhibit 2 The Proposed Paradigm Shift

TECHNICAL SHIFTS

Old Paradigm		New Paradigm
Off-Line, Static	-------------->	On-line,Dynamic
Multi-second Sampling	-------------->	Milli-second Sampling
Low Dimensionality	-------------->	High Dimensionality
Analog Processing	-------------->	Digital Processing
Hardware Intensive	-------------->	Software-Intensive

MANAGERIAL SHIFTS

Old Paradigm		New Paradigm
Internal Technology	-------------->	External (and Internal) Technology
"Know Then Try"	-------------->	"Try Then Know"
Ignore Manufacturing	-------------->	Include Manufacturing

Exhibit 3 Jim Cook's Description of Step Change

If you find yourself in the following situation you are ready for Step Change:

For several years you've had disappointing progress; everyone's discouraged; and at a distance people don't seem to work as hard. It's vital to your business; you've been the leader, and now the gap's narrowing. You've allocated generous resources; put your "best" talent on it; and the results make you feel cheated.

The once fertile approach that served you so well has been substantially exploited and is now exhausted. Now that this "mother lode" is gone, you must move on. You must find a new "mine"—a new paradigm—which will yield a renewing "Step Change" in performance.

"Step Change" in performance comes from a paradigm shift in the prevailing strategy (or organizing principle of your approach). This new paradigm typically involves exploiting unexploited advances in technology to achieve contemporary goals or objectives. Once the strategy has been articulated, excitement has been created, and constancy of support is assured, then appropriate new structures, methods and behavior are required.

Some old structures, be they policies, organization, relationships and/or dependencies will actually work against the new strategy and, therefore, must be circumvented or replaced. Some new structures will need to be designed and some will "self-organize."

Methods, that is, the new equipment and the procedures to get results, are the most obvious issues to consider in a Step Change project and are seldom overlooked. Often, though, Step Change fails because methods are the only issues which are treated thoughtfully and thoroughly. What is most often neglected is the necessary change in behavior. Also neglected is the effect of the Step Change on the prevailing power relationships and personal know-how investments. It is important to remember that Step Change brings in not just new information, but new beliefs, with all the havoc that that can create.

The lessons we learned from this and other Step Change projects are:

1. Top management must pledge constancy of support.
2. Pick a small exemplar first that can be leveraged and focus on a specific, self-contained, measurable problem.
3. Let the champion "self-select" as the one who leads the local buy-in process and is possessed by the success of the new approach.
4. Cultivate buy-in and bond with all those affected: invite, inform, include, listen, collaborate, educate, and share (and opposition will dissolve).
5. Middle managers must facilitate circumvention of crippling procedures on a rapid response, on-going, and as-needed basis.
6. Provide intellectual intervention through access to outsiders, at least one of whom has the ear of top management, as well.
7. Demand mastery of the new technology through education, team composition, and external contacts.

8. Step Change sometimes takes longer than expected, but the payoff is usually larger than expected.

9. The exemplar can diffuse throughout the organization without a comprehensive program.

10. Step Change resulting in 200%, not just 20%, increase in performance is programmatically repeatable!

Exhibit 4 The Team for the Step Change Exemplar at Camden

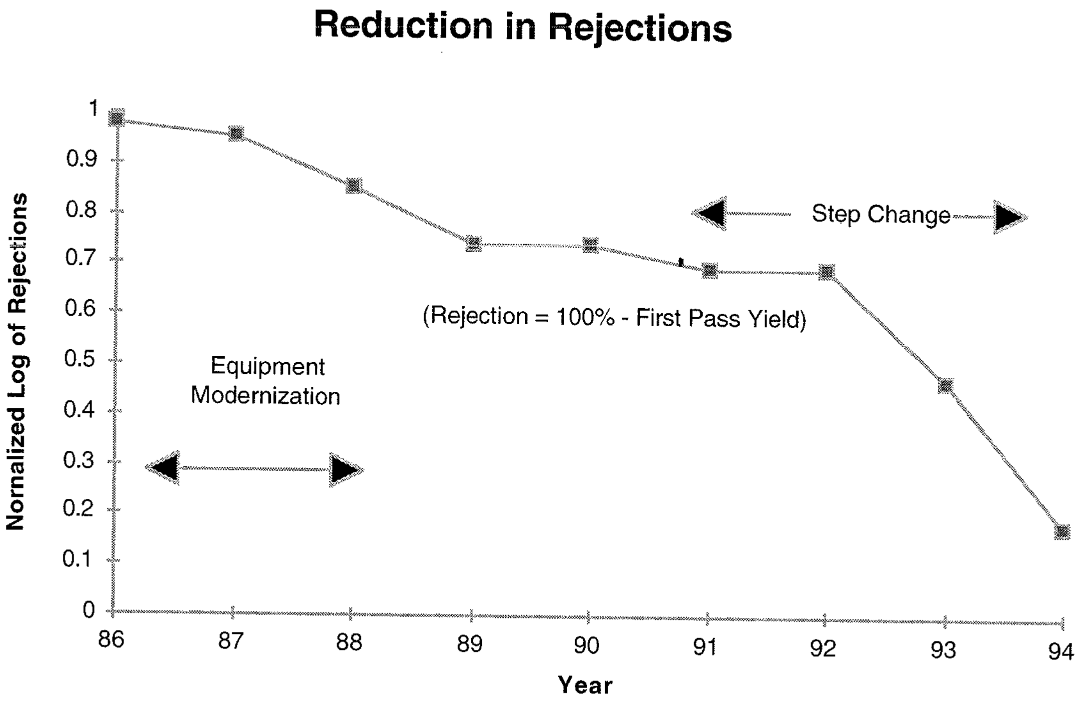
CORE TEAM

Dick Dommel	Champion	Research Associate	60%
Maarten Meinders	Computerziation Guru	Research Engineer	90%
Tim Cahill	Instrumentation Implementor	Engineer	70%
Cecil Truesdale	Equipment Support	Assistant	50%
Don Carter	CAD Designer	Contract Employee	50%
Lide McGovern	Apprentice	Undergraduate Co-op Student	90%

ENABLING TEAM

Warren Easley	Chairman	BCF Technical Manager
Don Pullum	Polymer	Group Manager (Camden)
Jay Tanzer	Spinning thru use	Group Manager (Camden)
Craig Corey	BCF Manufacturing	Manufacturing Manager
Gary Milosovich	Textile Technical	Group Manager (Camden)
Dick Hess	Headquarters liaison	Manager of Technical Plans
Bill Slack	Seaford liaison	Technical Manager (Seaford)
Mark Robnett	Waynesboro liaison	Group Manager (Waynesboro)

Exhibit 5 Reduction in Rejections as a Result of the Step Change



Note: Relative "Slopes of Progress" tell story.