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BMW: The 7-Series Project (B)

On June 12, 1991, following the project meeting, Carl-Peter Forster, Hans Rathgeber, and others involved in the interior design of the 7-series agreed to implement the proposed approach to prototyping. However, instead of applying the new method just to the cockpit section of the prototypes, they decided to go even one step further: the proposed method of prototyping would be applied to fabrication and assembly of *all* the interior parts of the vehicle. Following this new model, all interior components for the third and final prototype generation would be fabricated by outside vendors using pre-production grade tooling. The cost to design and make this new tooling was estimated to be DM 17 million. Prototype vehicles would be assembled on a pilot assembly line by pilot and commercial production assembly workers.

Shortly after the project meeting, senior managers at BMW gave the interior design team their final approval to proceed with the new approach. However, even at that time, much uncertainty remained about how successfully the proposed changes would actually be carried out and how effective they would be. Dr. Rathgeber, head of the cockpit design team, recalled:

With this new way, we didn't know if we could come through and if it would improve anything. Management accepted the proposal very quickly, even though we had no figures. The only thing we had was a good feeling.

The Third Generation Prototype Cycle

Between September and November 1992, 25 prototype vehicles were produced on the assembly line of the Munich pilot production facility. Two-thirds of the workers involved in pilot assembly had come from the Dingolfing plant where the car would be produced commercially.

According to Carl-Peter Forster, the benefits of the new approach became apparent almost immediately:

We began to find problems that in the past would have surfaced during pilot production and commercial production ramp-up. (See **Exhibit 1.**) For example, the assembly workers discovered that one section of the cockpit, composed of four wooden parts, did not fit together well as designed. They sent these four parts back to the designers. The parts were subsequently modified for a better fit. Another example was the instrument panel. Assembly workers found it difficult to slide the instrument panel into the dashboard. The panel had to

Research Associate Sharon Rossi prepared this case under the supervision of Professor Gary Pisano. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

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connect perfectly with the heating and ventilation ducts in the dashboard. Any slight misplacement would corrupt the working of the system. Assembly workers suggested to designers that this interface was too exacting to be highly replicable in commercial production. The interface was redesigned for a more robust fitting.

Ramp Up and Launch at Dingolfing

In February 1993, one year prior to the scheduled start of commercial production, the Dingolfing plant (located about 1 hour east of Munich) began its initial pilot production runs of the new 7-series.¹ In the past, factory pilot runs typically began three months prior to launch. One engineer in the plant commented, "The early start of pilot production in the factory had some real advantages. We had more time to identify and solve problems than on past projects." In February 1994, commercial production started. In contrast to past launches, which used a gradual phase-out of the old model and a phase-in of the new one (a "mixed-model" approach), the new 7-series ramp-up was done with a sudden changeover. In February, production of the existing 7-series ceased and production of the new 7 series commenced (production of the 5-series and the 8-series, also performed at Dingolfing, was unaffected). By April, the plant was producing 90 cars per day and planned to reach 260 per day by July. Although the rate of ramp-up was slightly slower than previous launches (6 months to full production volume versus 4.5 months), managers at the plant were very pleased with initial quality results. Dr. Gunter Walsch, director of assembly operations noted, "We did not have any serious problems with any of the interior parts. All of the major problems had been solved before going into the plant." This was a significant change from the past, where typically 70% to 80% of the problems were related to the interior.

Initial quality audits on production models were also highly encouraging. According to Forster, "The internal quality audit index for the first car of the new 7-series is better than the last car of the old 7-series." Rathgeber said that this has never happened before in the industry. He further commented, "This is truly surprising because the new car is much more complex and incorporates totally new processes."

Another indication of improved quality was the reduction in rework. With the new 7-series, about 5% of total assembly time was spent on rework and this time was expected to drop to 2% to 3% within the next few months. This compared with 15% rework time required when the old 7-series was first launched, and the 10% required after the car had been in production for several years.

Walsch noted that one of the big differences between this project and prior ones was the earlier involvement of manufacturing in development:

In the past, equipment design and procurement were all taken care of by the central planning department in Munich. Our production engineers and plant workers only got involved about nine months prior to launch, when we started in-plant pilot production. On the new 7-series, our engineers got involved three years before production and production workers were involved in the last batch of prototype production. This gave us a chance to have some input into the design. For example, at our request, the hood was designed with greater stiffness in order to make it easier to manufacture. There was a new willingness to listen on this project.

Despite this "new willingness to listen," however, it was also noted that designers would not compromise on anything affecting styling or performance of the car. Walsch added,

¹ The vehicles produced from factory pilot production runs were not sold to the public.

Everyone within BMW, from the designers through the people in the plant, understands that BMW has been successful because we've been highly innovative. We can't lose sight of that, even if it means that designs are difficult to produce.

"Soft Effects" of Soft Tooling

One completely unanticipated benefit of the new prototyping process was its broader impact on the designers. Because the new prototyping process involved producing prototype parts with tools, designers had to submit more complete and carefully specified designs than they had in the past. Designers could no longer rely on prototype specialists to make adjustments and assumptions about design requirements; instead, designers had to determine and document the exact size of parts, their exact placement, and the exact materials to be used. In short, under the new approach, prototype designs had to be better quality than before. On this change, Forster commented:

The new approach to prototyping forces a certain amount of discipline on the designers. Now, if you want to produce a prototype from pre-production tools and assemble it on a small assembly line, you need every part fully specified and a full bill of materials. The designers are under pressure to come up with complete designs and to worry about details.

Although some BMW designers had initially objected to the new prototyping approach and the "design discipline" that it imposed, positive results with the 7-series were changing their minds. Rathgeber noted, "In the beginning, there was resistance from the designers. But now they see opportunities."

Forster made a point to implement the new prototyping approach in a positive way. He did this by posing it as a challenge to designers. "I told them, 'Wouldn't it be great if you could design a perfect prototype?' If I had said, 'You guys must be more disciplined,' they would have said to me, 'Okay, Mr. Forster, thank you. You may go home now.'"

Forster and Rathgeber also made it clear to designers that numerous changes would have costly consequences. Dr. Rathgeber explained, "Every one of my people knew these were expensive tools, so they worked very hard to get the design right as much as they could. In former times, they always knew they could change it." Designers now understood that the objective was to "get it right the first time," as much as possible. Forster also noted:

Our mindset has changed. We are now handling prototypes like pilot or pre-series production in terms of QA and logistics. We do a full QA check on prototypes, including everything from checking parts availability and assembly operations to training. By being more disciplined in our prototyping process, we have managed to shrink the time it takes to assemble a batch of prototypes from more than 120 days to 75 days or less.

Unlike the old approach, which could accommodate inaccurate or incomplete designs, the new approach was characterized as "fault intolerant." If mistakes were made or details were overlooked in the design, the problem would be readily apparent in the finished prototype. The objective of the prototype, under the new approach, was to surface problems, rather than to represent the designer's intentions. In Forster's opinion, "The prototype is now a QC check on the design."

In addition to improving the quality of the design, the new approach had the benefit of improving communication. Dr. Rathgeber explained, "The process of designing the soft tooling requires stronger communication between design and production people. One of the soft effects of the new tooling is that it forced people to communicate." Better communication contributed to better quality.

Rathgeber said, "Many problems never arose because people were talking. We anticipated problems and avoided them."

Even with the emphasis on prototype quality and the more disciplined approach, however, important design changes would continue to be allowed at BMW, especially for reasons of styling or performance. Forster commented, "Whenever we think a design change is necessary, we still do it, regardless of cost."

The Introduction to the Market

By 1994, the competitive environment in the luxury car market and BMW's position within that market had changed significantly since 1991. With the introduction of the completely re-designed 3-series in 1992, a car that was widely hailed for its innovative styling and performance, BMW saw its market share and volume grow dramatically. While Japanese luxury carmakers found their sales growth leveling off or even declining in the United States, BMW's sales in the U.S. increased 23% in 1992. By 1994, BMW's U.S. market share reached a record of 7.3% of the luxury-performance segment.² It was in this atmosphere of renewed competitive momentum that BMW introduced the new 7-series to the market in late May 1994. The car received nearly unanimous praise from automobile reviewers for its performance, styling, and technical enhancements. In terms of styling, the car was viewed as an evolution from the old 7-series rather than as a radical departure. Vic Doolan, president of BMW of North America responded, "BMW considered a more radical shape, but decided against it because of the conservative nature of the 7-series buyer."³

To redesign the 7-series, BMW invested an estimated DM 2 billion, including DM 550 million for pre-production and production tooling. The company expected that sales of this new model would reach 60,000 units per year, exceeding the company's 1988 production peak of 58,178. First year's output (1994) would be 25,000 to 35,000 vehicles. With this new series, the company expected to attract a 20% share of the luxury car market.

The 5-Series Project

In January 1993, Carl-Peter Forster was appointed to direct development of the new 5-series sedan. Given the success of the 7-series project, he planned to implement the new prototyping approach on this project as well. However, based on what had been learned, he advocated a slightly modified approach.

What we learned is that we don't need the same approach for all parts. There are some parts that are so simple from a production point of view that they will never present problems, such as the A-pillar⁴ or the speaker covers. The time and money that we invest in these for prototype tooling is wasted because we don't learn anything new. If the design is locked in quite early, we can go directly to hard production tools for the prototype parts. The opposite case is a part like the door panels. It is an extremely complex part. It is actually cheaper to produce it with a tool. The dashboard is a third type of example. Like the door panel, it is a very complex part. It is also a very integrated part that must fit perfectly into the body. But,

² "BMW's Comeback," *Business Week*, February 14, 1994, p. 42.

³ *Automotive News*, May 23, 1994, p. 6.

⁴ The A-pillar is the support beam running along side the front windshield, connecting the front of the roof to the front quarter-panel of the car.

unlike the door panel, the design of the dashboard can change quite a bit during development. Because of this, it's much less risky to use a pre-production tool, instead of a full production tool.

Another aspect of the 5-series development was to use pre-production and production tools (where appropriate) as early as the second prototyping cycle, rather than just for the third cycle (as was done for the new 7-series). This would involve an extra investment of approximately DM 35 million in pre-production and production grade tools. Forster commented, "This new approach is a next important step to further improve our launch quality. For the future I foresee an early use of production tools for as many parts as possible with a low change probability."

Exhibit 1 Graph of Cost of Engineering Change Orders