Manufacturing *Breakthrough*

January/February 1993

Implementing Best Practise

Managing Product Development

Manufacturing *Breakthrough*

AIMS AND SCOPES

Manufacturing Breakthrough: Managing Product Development will provide executives and senior managers in industry with the information needed to create an effective product development process that will manage a viable concept into successful production in the shortest possible time.

Emphasis will be placed on organisational and management concepts, strategies and methods of implementation, which ensure competitive product development.

The majority of the magazine will provide case study features from companies in Japan, Europe and North America, and features/interviews from international authorities on the subject. The magazine will also include news and commentaries.

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Managing Product Development

Managing and measuring concurrency

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With the increasing competition, concurrent engineering can by the key to improving the new product development process. This article looks at numerous approaches and tools that leading-edge companies are successfully using to manage and measure their concurrent processes.

Concurrent/simultaneous engineering goals cannot be realised without the early involvement of all functions involved in new product development activities.

Today, many companies are forming multi-functional teams as a solution to rapid product development goals and improved product quality. Many of these teams receive 'team building' training, and then get 'turned loose' to show how well team approaches work. It is unrealistic to think that these teams will be significantly more successful than other organisational approaches, without building a process around them that is appropriate for this 'new type of organisation structure and product development process'.

The aim of this article is to discuss the major aspects and challenges of successful concurrent engineering programmes. Specifically, nine areas will be addressed. In each of these one or more tools – used by leading-edge companies – for managing and measuring concurrent product development processes in a practical and consistent manner within a company will be outlined. These areas are:

- Balanced product development resources.
- Dedicated core development teams.
- Concept and product filters.
- Phased management and funding processes.
- Milestone-driven development processes.
- Early and concurrent functional activities.
- Measurement of team and organisation concurrency.
- Robust product definition practises.
- Metrics and performance measurement.

BALANCED RESOURCES

How many people should we have in that function? How many people should be working on new product development (NPD)? How many people should be designing, and how many people should be checking the design? These are frequently asked questions that few managers have good answers for.

There are right answers. They depend on what industry one is in, and on how fast a product must get to market. While this author is generally not big on Far Eastern solutions for Western companies, this is one area of new product management that we are clearly being beaten at by the Japanese. The concept is simple and is analogous to manufacturing management. The product must go through several development phases, similar to production going through several work centres. Bottlenecks occur when the capacities between work centres are not balanced. If a company does not have the right balance of product planners, designers, engineers, buyers, production, etc., then bottlenecks will occur.

By definition, we are discussing resources that are involved or dedicated

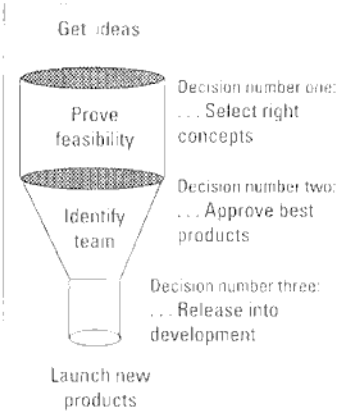


Fig. 1. Product filters.

to NPD. Take, for example, a company that makes automated test equipment (ATE). Key NPD functions include: marketing, design engineering, manufacturing engineering, software engineering, software quality assurance (SQA), and purchasing. Knowing the proper staffing ratios between these functions is key to long-term success. Notice that the word 'ratios' is introduced. Ratios allow this approach to be scaled to any size of organisation.

Begin by baselining your company. Count the percentages of each person who is 'dedicated to new product development'. Some people will be fully dedicated, some people will be only 10% dedicated in each functional group. Add up all the individual percentages in each department to get a total 'full-time equivalent' count, then calculate the ratios. The engineering and/or software functions should always be in the numerator.

Goldense Group (GGI) and our close affiliate Product Development Consulting (Cambridge, MA, US) have benchmarked numerous companies in the US and Japan. The ratios are surprising. In one best-in-class survey, as compared to industry average, consumer electronics companies had a 8:1 engineering:marketing ratio, and 4:1 engineering:manufacturing engineering ratio. Many companies that are striving to improve their process have 20-50:1 and 15-30:1 ratios respectively before they begin concurrent product development initiatives.

Most leading-edge companies have a three-step process. First, select the right concepts to develop. Many millions of pounds are largely wasted each year by working on efforts that are off-strategy and/or bad ideas. Secondly, approve only the best products for development. Work on the best ideas, and be successful at them. Don't try and do everything, mediocrity results.

Thirdly, carefully manage the timing of starting a project once it has been approved. Starting a project when key core team members are still juggling other projects causes slow starts and creates team frustration. Make the analogy to manufacturing, manage capacity carefully.

DEDICATED TEAMS

The implementation of teams stresses most functional or matrixed organisation structures. Managers are concerned about 'owning headcount'. Individuals are concerned about getting too far outside their organisation structure. Team-based approaches offer few simple answers, but a company can have it both ways if it plans properly.

Three structures are required for effective teams: physical, organisational, and review/reward, although I will only examine the physical structures.

Teams should be physically co-located. If this is not possible, then they should attempt to achieve virtual co-location. Physical co-location says that all dedicated/core team members should sit together in the same place. (Typically, the multi-functional core team consists of three to six members. All other team members are typically called 'supporting team members', i.e., their role is not dedicated.) Further, they should be surrounded by the facilities that they need to develop the product.

In the electronics industry, as in most industries in the 1990s, this would include immediate access to all engineering design and project information systems – a dedicated terminal on every team member's desk. A lab area to construct breadboards and tinker should be adjacent to the team offices. There should be a conference room for the sole use of the team. Resident in the project system should be every piece of documentation that the team produced, or uses as a reference. If teams are split by great geographic distances, then video-conferencing and office communications tools should be plentiful and travel budgets should be planned for.

The subject of the keynote address at the 1990 AT&T DEX conference was co-location. AT&T found that the: "Probability of communication decreases 80% when team members are more than 50 yards apart." This is not so surprising. Think for a minute where some of the most valuable knowledge that we all have comes from. We 'overhear' it from people within earshot as we go through our working days. If NPD team members are in close proximity, they will learn about all aspects of the product they are developing together.

CONCEPT AND PRODUCT FILTERS

Generating ideas, turning them into the right concepts, proving feasibility, and funding the best products from the right concepts are business critical issues. Every company hopes to have 40-70% of its revenue from products that were developed and launched within the past three years, and 20-50% of its revenue from products launched within the last year.

The whole company is geared to new product introductions. One of executive management's biggest sources of embarrassment and surprises is due to bombs of anticipated new products. Company and personal reputations are damaged, and the stock exchange shows the effects within a few days. Sales staff's goals and bonuses are set based on past products and new products. If the new products are late or unsuccessful, then bonuses are lost. At the very least, the sales staff must scramble to push the older products to customers. Customer satisfaction decreases as many of them are aware of just what is happening, and they are forced to buy the old version or switch to another supplier. Attitudes in manufacturing also suffer. Most people attribute quality and reliability problems to the production staff, when in reality the real cause is poor product definition and design. There is no end to the number of negative examples that can be cited due to poor development efforts and the surprises that result.

The rate and way in which companies process ideas through their 'idea factory' distinguishes them in the marketplace. It is not only necessary to develop approved products rapidly in the 1990s, companies must also get the right ideas into the pipeline at an ever increasing rate (Fig. 1).

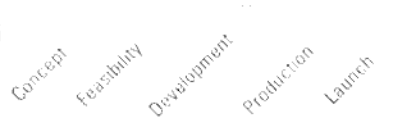
At each decision point, the 'holders of strategy and funding' meet face-to-face with the team that is presenting the concept or funding proposal. Dialogue is open between the senior executives and the team members. Proponents and dissenters on the executive team must voice their views and discuss them. A decision must be made at the conclusion of the presentation by the team. The reasons and rationale must be communicated in person, and a memo documenting the results must follow the meeting within a day. Not everything that the Japanese do is for us here in the West, but rapid decision-making is another lesson we should learn.

There are many ways to achieve rapid idea flow, but they must all provide for:

- The rapid transference of business strategy into the hands of the idea people and NPD functions.
- A face to face decision making process between the key company executives that set and/or fund R&D and new product strategies.
- Robust product definition and project planning efforts that give teams comfort that they can achieve the goals of their product and project plans.
- Active management of personnel and a sense of timing about when to release approved programmes into the product development phase.

There is an old saying that: "A-teams can make B-products into A-products, but B and C-teams cannot make B-products into A products." GGI maintains that companies cannot have A-teams without the proactive and continuing support of senior management. Senior management must be involved to clear obstacles, provide resources, and to make the tough big-picture decisions that even the most empowered team cannot make in a vacuum.

Concurrent engineering is a team-based philosophy, but senior management must ultimately make the decisions on what products teams need to develop and then give them the resources to be successful.



Phase management

Never lose sight of the big picture during development. Manage the overall process to several simple and well understood phases that everyone in the company can relate to. Do not leap far ahead into the next phase until completing the tasks at hand.

Fig. 2. NPD phases.

PHASED MANAGEMENT PROCESSES

The filtering process is best operationalised through a high-level framework called 'phase management'. Phase management is also used throughout the entire development process. Many industry leaders, including IBM, Apple, Hewlett-Packard, and Abbott Laboratories, use this approach.

Notice that the filters discussed in the preceding section correspond to the first three phases in Fig. 2 and that the entire development process is depicted by five phases in total. Teams operate autonomously within the phase, and interact with management at the beginning and end of each phase. It is a simple and elegant structure in which to manage new product development.

New product concepts arise from numerous areas in companies, including senior management, marketing, engineering, manufacturing, and field service. Typically, there is no shortage of ideas. The problem is sorting them out in an independent and unbiased manner. Companies lose opportunities when they do not consider all ideas to be equal, and leave the ideas to be sorted out by the 'power brokers' in a company. What is needed is an independent process that sorts them out based on merit, not on who has the most clout. A process should be in place that allows all ideas to be heard and considered.

There is a danger in over structuring the generation of ideas and the management and selection of concepts. In some companies it makes sense to support the 'rubber room' approach for new ideas, but not to the exclusion of the rest of the members of the company. Smart managers will let the creative process bubble and boil day-in and day-out, but will start managing the process before significant funds are expended to investigate ideas and the 'back pocket treasure chests' are used to push the idea along until it cannot be refused.

A major challenge of phased management is moving to 'phased funding'. In phased funding, funds are approved to study the feasibility of good concepts. At the end of the feasibility phase, a go/no go decision is made. If the product is approved for development, the funds for the entire development cycle are approved at that time and budgeted into the R&D budget. However, only the funds for the next phase of development are released. Teams must achieve the milestones and goals of the current phase before funds for the next phase are released. Using this approach, the teams and management will come together several times during the process, and the alignment of values and objectives will be achieved.

The biggest obstacle to phased funding lies in the laps of the executive and financial managers. Most companies structure all major financial decisions on an annual periodic basis. Phased funding requires much more dynamic management of a company's new product R&D funds. Projects have their own natural cycles, which are not tied to any annual or periodic financial cycle. In order to seize new product opportunities as they occur, and release funding for next phases . . . or not, the financial function must become more sophisticated and flexible in its

Phases provide a robust structure for the overall management of NPD efforts, but they are not granular enough to manage month-to-month and day-to-day team activities. Develop a common and consistent milestone-driven framework that supports achieving the phase requirements.

Milestones' definitions should be consistent. They should be either 'initiating' or 'terminating'. Do not mix the two.

Fig. 3. NPD milestones.

budgeting and management of R&D capital and expense.

Time-to-market is a critical issue, good ideas cannot sit on the back burner for six to eight months until the annual funding cycle takes its course. For companies with fairly quick development times, this could represent a 30-50% loss in time-to-market.

MILESTONE-DRIVEN PROCESS

Opponents to concurrency are concerned about too much structure. It is often equated to the popular words 'standards' and 'control'. While contrarians do make some good points, most of them eventually concede that a structured and consistent process that delivers reliable products which meet the customer's needs in less time is worth the structure.

In order to understand the magic of structured processes, one must understand the importance of a common language at all levels in the company. Milestone-driven processes, typically eight to 20 steps in length, are easily remembered by everyone. Once the key milestones are determined, they become a framework in which to relate all other aspects of product development. They serve to place activities at a point or small range, in time. They serve as a focal point by which activities must be completed to avert risk and unexpected surprises downstream in the product development cycle. They most importantly serve as a common communications vehicle by which every person in the company can stay abreast of development activities in and across projects (Fig. 3). Design reviews, technical reviews, customer and internal specification documents, testing specifications, safety and environmental analyses, reliability plans, etc. become associated with each milestone.

The ATE company described earlier in this article might have a milestone process that emphasised the importance of managing the parallel development of hardware and software, with some key integration checkpoints along the way. A simple example is illustrated in Fig. 4.

CONCURRENT TEAM ACTIVITIES

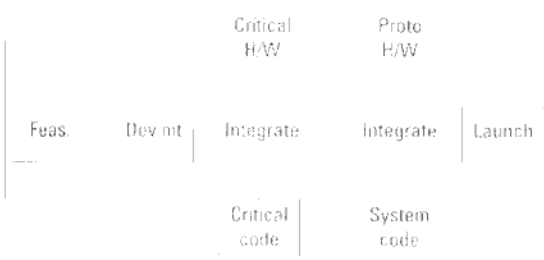
The early involvement of all critical functions that are required for any given product is essential. If one analyses the project staffing approaches of best in-class companies, one finds that they consistently have early involvement and fast 'ramp-up'. Poor product developers typically achieve full project staffing about 50-60% of the way through the development effort. The best approach is to achieve full staffing about 20-40% of the way through.

The common misperception is that multi-functional involvement is only needed at a few points during the development process. The companies that have gone through the exercise of sitting down and thinking through the process on a milestone-by-milestone basis for each function have seen the light. The conclusions are worth re-stating. Marketing, engineering, manufacturing, purchasing, and several other functions require a dedicated headcount to the project from the beginning of the development phase through market launch. There is no other effective approach.

The 'Function-Milestone Matrix (FMM[TM])' is a useful tool to determine project staffing. The FMM: "Lists the key activities that each function must perform in order to complete the requirements of the milestone." Once the activities have been identified and analysed to insure that each activity occurs as early in the process as possible, it is relatively easy to estimate the staffing requirements necessary to complete the tasks (Fig. 4).

The FMM typically consumes six or seven pieces of paper, and defines the minimum set of activities that must take place. It serves as a guide to concurrency and project staffing. It is also a tremendous tool to integrate new people into a project, and to rapidly bring brand-new employees up the learning curve as to what is expected of them.

The advanced concurrent engineering practitioner may have noticed that the word 'phase' has not appeared in this section so far. Phases occur over time, milestones occur at a point in time. Team



Milestone alignment

Insure that milestones of key functions and development activities have common integration points. Do not complete mechanical designs, and load the software on the shipping dock. Force early integration.

MKT				
H/W ENG				
S/W ENG				
MFG ENG				
PUR				

Functional alignment

The FMM is the final building block to structuring concurrent processes.

The major NPD functions should be listed in the left hand column. The matrix of activities and deliverables should then be completed for each functional milestone box. The FMM should be consistent across the company and be constructed at the same time that phases and milestones are determined.

However, tailoring by project will occur at this level of detail. Editing activities are best done during the planning phases of each project.

Fig. 1. Milestones and functional alignment.

activities should be focused on achieving specific goals, i.e., milestones.

MEASURING

Once team activities have been geared to 'milestones within phases' and 'tasks within milestones', it is now possible to begin to measure the process. The 'concurrency matrix' (CM) is a tool that may be used to measure the concurrency of NPD efforts (Fig. 5).

The CM can be applied early and proactively during any phase or stage of the project. The results will indicate which functions are lagging in their responsibility to the team at any point in time. It is typically best when the team does the exercise as a group, this way there is increased finger pointing from one individual to another.

The CM can also be applied to past projects and across the entire population of projects for the past few years. The results will indicate systematic weaknesses and lateness of the company business functions as a whole. It is a tremendous diagnostic tool to identify the most important areas in which to focus new product development process opportunities. Once these systematic deficiencies are identified, one then goes looking for the root causes. In some cases, functions will be determined to be understaffed. The staffing ratios tool discussed earlier can then be applied to re-balance the functions. In some cases, the functions are now aware of their requirements during milestones and phases. Priorities can then be established. The power of this tool to diagnose organisation and function strengths and weaknesses is immense.

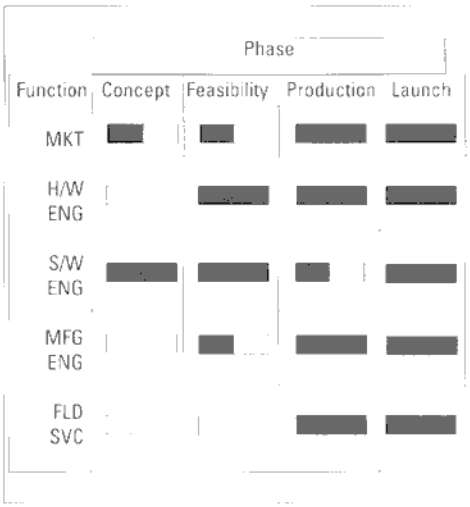
ROBUST PRODUCT DEFINITION

Product definition is a topic that continuously escapes the focus of even the best product development companies. The body of knowledge that exists at the present time is filled with holes, and lacks a 'continuous thread' that ties all the different definition activities together.

Typically, definition occurs three times during a project. The marketing function does a definition, design engineering does one, and so does process engineering. Product definitions are usually completed independently, and too little effort is invested to reconcile the differences, conflicts, and trade-offs until the product is well into development. A *California Management Review* article published in the winter of 1990 indicated that 71% of problems with new products can be traced to poor product definition. This is such a huge figure that it cannot be ignored.

From a more limited time-to-market view, one cannot possibly predict an accurate completion date until the definition is largely complete and the feasibility of the definition has been proven. The relationship between product definition and process or schedule prediction accuracy is immense.

It does not matter if one takes a 'product quality' and customer satisfaction' or a 'process quality and



The concurrency matrix is a great tool for measuring concurrency. For each matrix box, determine if full involvement (black) or partial involvement (half black), or inadequate involvement (white) represent the true contribution.

Assign two points to black, one to half black, and zero points to white. In this matrix, there are 40 possible points. The team achieved 28 points.

The team was 70% concurrent.

Fig. 5. Concurrency matrix.

time-to-market' view, the importance of product definition cannot be under estimated.

GGI predicts that product definition will be a 'field of study unto itself' by the mid-1990s. Right now, companies are ranting and raving to learn QFD methodologies, believed to be in widespread use in Japan, to fill their current gaps in product definition. GGI has four concerns about QFD. Most Western companies do not have the culture to support such a detailed approach that analyses each piece of data 'five ways from Sunday'. We may never have the culture to do this. At the very least it will take years to do so, and it is not clear that we can wait that long. Secondly, for companies with relatively short development cycles, QFD may actually increase time-to-market if it is not managed to the '80-20' rule.

Thirdly, for companies with very long development cycles, normal management and staff turnover reduces some of the benefit of the knowledge gained from the early stages of QFD. Fourthly, QFD is fairly comprehensive, but it must be supported by numerous other activities in order to complete the matrices. One must still gather requirements, analyse competitive capabilities, determine trade-offs, and perform the other tasks to complete the QFD matrices.

As such, it does not provide a high level framework for managing the overall definition process. Its strength is in determining the specific features and functions that will go into a product, and then how the product will be developed and manufactured.

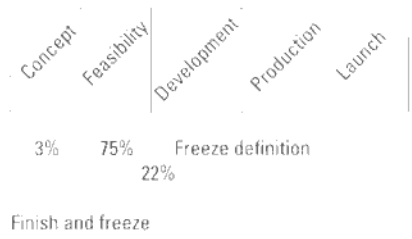
Product Development Consulting recently completed a second benchmarking study in Japan. The study focused on four 'household name' electronics companies. None of these companies used QFD, only two had heard of it. Based on this and on the feedback of several companies that have tried QFD, it is a useful tool to consider and try out, but the conclusion is to manage the QFD processes and tools and not be managed by them.

GGI recommends an approach that focuses on the 'process of product definition.' The approach is analogous to, and a subset of, the 'process of product development'. Industry should move to a logical and rational process that specifies the activities that must occur and the timing of those activities in relation to the overall development process.

The approach is simple and straightforward and utilises tools which are familiar to anyone who has been involved with new product development. The GGI's product definition toolbox actually contains 15 drawers which represent 15 specific phases that successful product definition efforts must go through. The product definition activity is managed as a major subset of the overall product development effort. Each drawer in the toolbox contains several tools that facilitate definition activities at each phase in the process. A series of specifications capture the approved/frozen results. Static and dynamic metrics monitor the process.

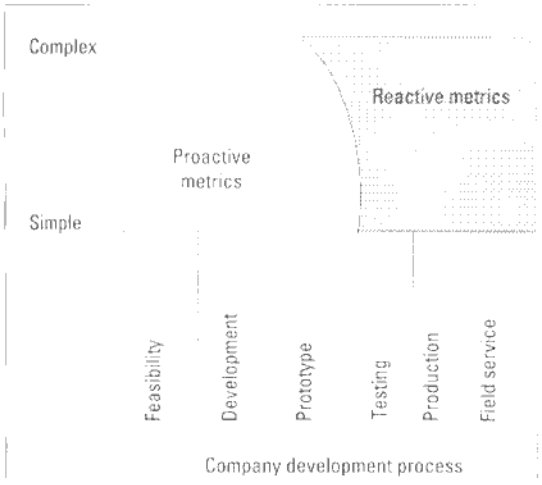
For example, in the drawer named 'collecting', tools exist for identifying ways to collect customer requirements. Focus groups, surveys, and on-site visits are all tools that we know how to use. Having flushed out the population of needs, one moves onto consolidating them into groups and then onto analysing their merits. Ultimately, one must select the final features and obtain funding for feasibility or development.

This overall product definition approach provides for a rational structured process that is easy to communicate and understand. It fits within overall product development milestones and frameworks, and does not mix apples and oranges. It is broad enough to satisfy the needs of top management, as well as individual team members. It is flexible enough to change over time as collective industry knowledge grows and new tools are developed for specific purposes. It fits within the values and cultural



Projects get scheduled with committed launch dates before feasibility is proven and the uncertainties brought under control. Use the feasibility phase to reduce the risk to a +/- 15% schedule forecast accuracy. Then, complete the product specs and freeze them.

Fig. 6. Product definition.



Leading-edge companies have numerous metrics that are best described as 'simple and proactive'. The idea is to measure areas and events that give a 'view to the future'. There will always be a place for 'after-the-fact reactive metrics', but these types will only result in the improvement of future projects and programmes.

Industry must shift to measures that provide for action on projects-in-progress today, not the next time around.

Fig. 7. Metrics.

approaches that will be hard to change in the short run.

METRICS AND PERFORMANCE MEASUREMENT

One of the biggest changes occurring in industry today, especially US industry, is the measurement of performance. Until the late 1980s, it was not popular to perform a detailed measurement of people, products or processes. Most measures were geared to 'look back and see how we did', if they really existed at all. Engineering change orders were tracked, but it was only so important to minimise them in total or on any given project. DPU or PPM quality data was tracked, but 'trees did not shake' and 'heads did not roll' if improvements were not incremental. Many companies were content with measuring MBTF or MBTSC, which is a virtually unactionable metric.

Right now there is a huge change taking place in performance measurement. It is driven from numerous sources. The quality movement is contributing. Global competition is contributing. Most importantly, the pride of America's top executives has returned and they are directing improvements. Bottom-up quality will only get you so far, direction must come from the front office. No longer will our leaders settle for the status quo, they want to be the best . . . again. This is very exciting.

New measurement systems and metrics are now required. Fundamental changes must be made. We must move towards predictive metrics and away from reactive metrics. We must not only measure the product, we must measure the process (Fig. 7). Everyone in the company must be tied to performance. Performance must be tied to collective achievement, not to individual achievement. Hand-slapping and back-slapping must be doled out in equal portions. Disincentives and incentives must exist. Feedback must be immediate and fair, not late and modified due to abstraction of information.

These changes will have profound impacts on what, when, and how much is measured. Investment in performance measurement systems will increase and grow in importance. Before these new trends get out of control by themselves, managers should step in and set strategies and directions for measurements. One risk is that it will be a bottom-up or middle-up evolution.

One strategy for metrics might be described as having: "Numerous simple and proactive metrics while maintaining meaningful reactive metrics." We want measures that can be frequently applied, at low cost, that are easy to understand, and that measure something we can act on. There will always be a need for complex and reactive metrics, but the future is in increasing the number of simple and proactive metrics. ⌟

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GGI has performed assessments of new product development capabilities, conducted the product definition, specification, and design review processes, assisted clients in planning and implementing concurrent products and project methodologies, facilitated project and programme planning and control, and in getting problem projects back online. GGI also offers a series of public seminars and customised in-house workshops for its clients.

GGI clients include companies that design and manufacture diagnostic instruments, medical devices, automated test equipment, aircraft, lift equipment, machined parts, fasteners, computer hardware and software, and textiles.

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