STRATEGIC DESIGN

Report based on British Standards

and other relevant references

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April 2000

Summary

1 Introduction

Understanding the need of continuously revising and updating the design process throughout any manufacturing Company, the present report aims to provide a set of useful information that can help to incorporate new best practices regarding the Corporate Level, Project Management Level and Design Level of a Company. This report is addressed to the Board of Directors, responsible for running the Company and responsible for the overall Design Strategy.

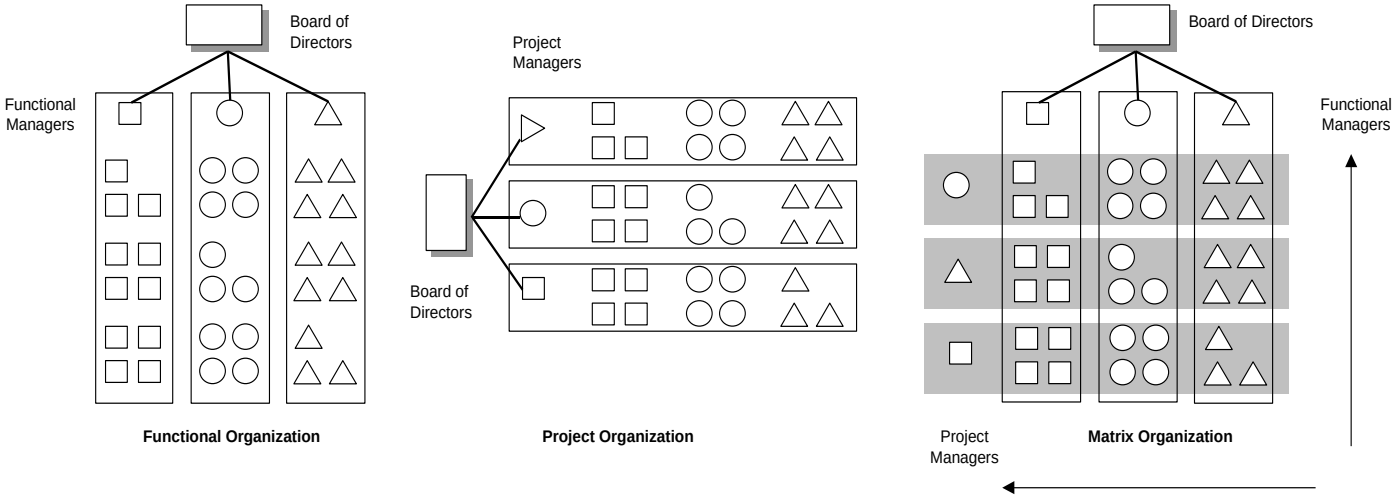
The recommendations here suggested were referenced mainly in the British Standards and in the legislation that are very relevant throughout the design/production process, and therefore shall be understood as generic best practice not being relevant the kind of product which is being manufactured. Please refer to the **References** section for full discrimination.

2 Organizational Structure

The first thing that seems to be reasonable to approach is the organizational structure, as faster decision making and higher profit levels rely on an efficient organization to carry out the necessary duties. When a Company shows interest in making changes to achieve better results, *organization study* ought to be highlighted as a prerequisite. It is said that the philosophy behind the concept of organization development is to implement changes as a continuous process, rather than a simply isolated activity. A **good structure** is the basis for implementing **effective design management**, reinforcing the strategic importance of design both in the **corporate level** as well as in the **project management level.** In order to suggest any sort of basic organization, it is extremely important not to loose the focus on what *design* really is, and how this strategic weapon has been changing along the past 30 years. Design is a hybrid and holistic activity, which involves art, science, mathematics, politics and time/resources management. It has been suffering addition to its scope since environmental issues are getting increasingly important, and as high quality production systems and final products show the way to conquer consumer's confidence, meeting his own expectations in all spheres.

The most appropriate choice of organizational structure depends on which performance factors are most critical to success. These factors can only be precisely identified if the activity of the Company is deeply understood. Nevertheless, generally speaking there can be *functional* or *project* organizations, or even a hybrid organization incorporating bits of both. Functional organizations tend to breed specialisation and deep expertise in the functional areas, while project ones tend to enable rapid and effective co-ordination among diverse functions. Although any of the two might be used in a Company, sometimes the market requirements, project constraints and other factors might need a quick adaptation and flexibility to meet these requirements in the most cost-effective way.

The major issues in the functional organizations seem to be how to integrate different functions to achieve a common goal. On the other hand, a project organization needs to manage a way to maintain functional specialisation over product generations, and also to share technical learning from one project to another. Formal and hierarchical organizations are satisfactory in stable conditions, but the organic (informal and less hierarchical) teams are more appropriate where flexibility and innovation are required.



Source: Ulrich and Eppinger, *Product Design and Development*: *Development Processes and Organizations*, Mc Graw Hill, United States, 1995

In a broad way, three big issues need to be noticed. First, the *staffing* must provide for the several key functions necessary to achieve technological innovation. Second, the organization must be structured to enhance the *flow of technical and market information* into research and development and to assure *strong links with marketing*, in order to guarantee that innovations effectively move forwards into commercial success. And last, but not the least, *strategic planning* methods must be adopted in order to improve integration between top management's technical plans and the other dimensions of overall corporate strategy.

The *British Standard* that provides an overview of this issue and suggest best practices regarding organizations is the **BS 3375: part 1: 1995 : Guide to Organizational Study**. According to the main reference for this report, **the BS 7000 : part 2: 1997: Guide to Managing the Design of Manufactured Products**, the awareness and understanding of organizational capabilities and limitations as well as relevant internal activities and innovations is one of the pre-requisites for effective design management. It is also stated that it is the **board's director collective responsibility** to ensure that the Company has an understanding and clear sense of direction with respect to design. A well-established organizational structure will enable design philosophy up in the **corporate level**. It will provide the mainframe for defining the boundaries of what it is acceptable to the enterprise regarding design activities and investments, and for formulating and quantifying design objectives and strategies.

Several different structures may be encountered in practice, whatever is the one adopted leadership and management will be required. Roy (1986) presents four different locations of the design activities in a Company, discussing pros and cons of each. You might have *design* under *production supervisor*, being then an effective part of production. Another possibility is to put *design* as an independent function, at the same level of *sales*, *production*, etc. A third choice is to build up a special committee, connected straight to the *chief executive board*. Another option is to have a design team built up only for launching a new product, because it is believed that in this last case it is easier to find help from the other departments, concentrating efforts in a more effective manner providing thus better results. The **BS 7000** reinforces that during the design process of a product "consideration should be given to forming, at the very beginning of the project, a small informal group of experts which may later become the nucleus of the project and design teams."

Once the importance of establishing a good organizational system is understood, now it seems necessary to have a good look upon the design process. Understanding the process, it will be possible to define which efforts are necessary for developing and launching a product, or revising a process. And once the efforts related to the process have been understood, it will not be difficult to identify job titles and job description of the personnel required, as well as listing the responsibilities for achieving the results outlined in the standards.

3 The design process

Generally speaking, the design activity can be seen as a union of *marketing* efforts*, problem solving* efforts and *manufacturing* efforts. These are the steps for understanding the process, based on the model provided in the BS 7000. The **design manager** is usually responsible for co-ordinating all these efforts and frequently reporting them to the Director's Board, although depth in technical expertising regarding his team will vary.

1. Identification of a need: perceiving a market opportunity and analysing possibilities. There are a relevant variety of possible opportunities, these are the basic ones: developing a market-pull product; developing a technology-push product; developing platform products; developing process-intensive products or developing customised products. A brief description of each seems necessary at the moment, as each Company ought to be sure about what its main activity really is.

A market-pull product is developed when an organization grabs an opportunity and finds the appropriate technology to meet customer needs. A technology-push product happens when scientists and researchers bring about a new discovery, and then a Company looks for an appropriate application, aiming at one specific market. Platform products are the ones who are built around the same technological sub-systems as existing ones. Usually these ones suffer continuous improvement process. The process-intensive product is the one, which is highly constrained by the production process (such as snack foods, for instance). Finally, the customised products are slight variations of existing configurations, and are typically developed in response to a specific order by a consumer.

2. Preliminary concept generation: a small team is formed in order to analyse the opportunity and the business concepts, against **corporate, business and operating plans**. Usually the output will be an approximate description of the technology, working principles and form of the product. These will provide the basis for a preliminary evaluation and subsequent approval (or not) of the project by the Director's Board.

3. Feasibility study: this will be the step when the project will continue or will be abandoned (or revised). Many requirements have to be met to make a successful enterprise. They would be performance requirements, cost requirements, time/resources requirements and many other considerations. Up to this moment of the project, not much money has been spent yet, but from now on these expenditures tend to rise steadily.

4. Specification: If the project was approved, a complete functional specification must be generated. This is the heart of the product design activity, defining all the requirements and constrains, as well as human-factors considerations. Then a work programme must be developed, identifying the expenditures in each stage. It works as a prediction. The **BS 7373:1998: Guide to the preparation**

of specification should be followed as a guideline. It carefully explains the necessary steps to build up an effective specification, providing the scope, terms and definitions. It also indicates the different types of specification, and explains the level of detail of each.

5. Analysis and Final Concept Generation: Since the targets were precisely defined in the specs, it is necessary to assemble the team who will effectively conduct the project until the production, selling and subsequent disposal. The final concept is precisely defined, and the Board of Directors can evaluate which skills will be necessary. This team will obviously be multidisciplinary and will operate in the design level, being co-ordinated by the manager. It is important at this stage to carefully consider the risks attached to investment in design. The **BS 6079: Guide to project management** is the perfect tool for the manager. The reason for taking it so seriously is the big amount of commitment and resources that will occur from now on. This standard provides techniques (such as CPM or Net Present Value) to evaluate whether the project is technically feasible and commercially acceptable. " It is seldom possible to achieve a clear cut transition from the development stage into production. Ordering materials/tooling, recruiting staff and so on involves risks that need to be quantified and assessed.

6. General Arrangement or Product Architecture: after the election of the final concept the team will define the overall architecture of the product, determining the type of components and their interfaces. A variety of possible different arrangements will occur, but at the end of this process a framework will define the parts of the product, that will be then tackled individually.

7. Detailed Design: The problems defined in the general arrangement will now be decomposed into smaller problems, which should be simpler to solve. The precise drawings defining the physical features of the product will be produced, and they shall be compliant with the **BS 308** and the **BS EN ISO 5455** and **5456**. All deal with technical drawings and representations for engineering. A manufacturer who owns an in-house design department might require the team to develop something according to the limitations of his own machinery, in order to keep costs as low as possible. Delivery timing and support strategy should also start to be discussed now.

8. Pre-manufacture – prototypes: Three-dimensional models and functional prototypes eventually have to be constructed to test specific requirements, such as capability, safety and reliability. The British Standards regarding this issue vary a lot and indeed there are very specific ones regarding the sort of product which is being manufactured (toys or electronic components). However, the right standards must be identified as they provide, through measurable units, subjective opinions of the customer. This can be very useful when it comes to product liability, in order to define what is reasonable to expect from certain products' performance.

9. Manufacture and distribution: the resources will be acquired and a whole manufacturing plan will be developed. This plan must include the project documentation and specification, personnel recruitment and training and the marketing strategy for the product launch. The distribution efforts must also be known and quoted, and the distribution scheme must be reliable in order to answer the geographical features. Consideration must be given to distribution periods, rush hours and parking restrictions by traffic laws.

10. Product launch: the generic marketing structure behind the technical features. The consumer must be warned about the product's benefits, and many times even being persuaded to think he needs something that he really does not! This is the promotion structure that ought to be established together with a feedback, called *customer support* or *customer services.* A full

psychology study is sometimes needed, as people behaviour and values regarding goods is valuable information for the one who will provide them with the materialisation of this desire.

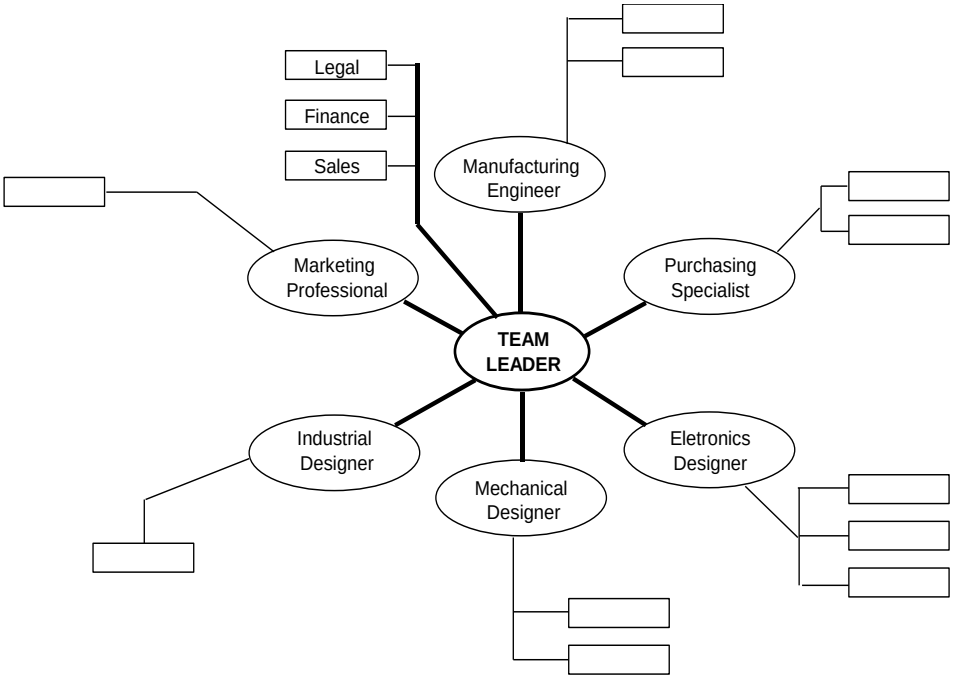
11. Product selling and use: It is considered to be the longest stage of the life cycle of manufactured products. It is extremely important for the manufacturer to make this period as long as possible, as this is the step where profit will be achieved. Meanwhile, research through customer new needs that may arise from long usage of the product need to occur. There exists a trend of selling for longer period's products, which are quality certified and environmentally friends. The British Standards series **BS ISO 9000** and **BS ISO 14000** should be known and considered throughout the **whole design process**.

12. Feedback and evaluation: It is the continuous monitoring of the customer's needs that will provide insights for the Company to generate new ideas for new products, or improvements for the same one. Then, the heads of each department involved in the project should meet with the Board of Directors to evaluate new business opportunities.

13. Decommissioning and Disposal: the right amount of concerns must be given here, as some decommissioning processes might last years. Spare parts and maintenance ought to be considered. This seems to be the consequence of the policy " keeping the customer satisfied". Nevertheless, when the customer is not satisfied with a good anymore he will start a disposal process. Beyond the severe ecological implications that might surround some parts of products, the manufacturer ought to be aware that contractual and legal liabilities will continue for products still in use. It is extremely important to highlight here that all the many aspects that arise from the liability chain are mandatory, and can be found in the **Consumer Protection Act of 1987** (UK) and in the **Council Directive of 25/07/85** concerning **liability for defective products.** Regarding the disposal process, the series **BS ISO 14000** provides guidance and requirements for defining Environmental Management Systems in an effective way. It is stated that the success depends on commitment from **all levels and functions**, especially from **top management.** Basically, the key areas should be: defining the legislative and regulatory requirements, identifying significant environmental aspects, examining existing environmental management practices and procedures and finally keep evaluating the feedback from previous severe ecological incidents.

4 Defining the team and assigning responsibilities

Now that the design process was fully explained, we can understand what kind of effort is necessary in each of the steps. The number of professionals may vary a lot, depending on the complexity of the business and on the size of the production shop. The Company must have available the following set of professionals, at least. A fully operational **marketing department**, a **marketing manager**, a **design team** (comprehending industrial designer, mechanical designer, manufacturing engineer, product designer, CAD technician), a **design manager**, a **production unit** (CAM technician, manufacturing engineer, quality control team, machine operators, stock management), **external consultants** (environmental engineers, electronic engineers), **support team** (sales, legal aspects, human resources, transportation and distribution, implantation, suppliers, subcontractors). The following graph provides an example of one case:



Source: Ulrich and Eppinger, *Product Design and Development*: *Introduction* , Mc Graw Hill, United States, 1995

It is easy to understand how big and intricate a product development team can be. The important thing here is to identify the **level of responsibility** of each phase. Basically, an enterprise will have **Managers**, responsible for each field (marketing, production, etc); an overall **Board of Senior Executives** which are responsible for these department managers; and on the other extreme there will be professionals which are part of a big team, like **Designers** and Engineers, and they will have their own amount of specialisation.

5 Set of Recommendations for each level of responsibility

5.1 Recommendations for Board of Senior Executives: Corporate Level

- Ensure that the organization has a full understanding and a clear sense of direction with respect to design, aiming at design excellence.
- State job descriptions and responsibilities of all involved in the overall process.
- Develop a Corporate Business Plan, stating the business mission and formulating objectives in a precise and quantifiable manner.
- Take into consideration the physical, operational and human features and values which make the organization something singular.
- Establish and promote a Corporate Culture.

- Define and document design practices and implications.

- Define how the market demands and technological innovation will be brought together.

- Highlight specific niches, markets and industries that should have special attention.

- Frequently assess current products and services in their life-cycle and thus future turnovers and profits. This analysis may reveal potential gaps in the overall performance.

- Establish a Corporate Design Program, and make sure that it is understood, followed and respected. This should break down the work into stages, specifying the respective outputs. Must be a formal and easy to access document.

- Establish communication in all directions in an effective manner, using formal and informal channels. Stimulating and easily comprehensible visual imagery must be used to achieve these goals.

- Understand the key issues for design management systems, providing this infrastructure for the managers.

- Identify and establish the right links with other disciplines (for example when new technologies and other manufacturing processes are to be adopted).

- Make sure that its management personnel is aware and compliant with the relevant standards and legislation

- Promote a Visual Identity policy to its products and shop layout, as the commercial benefits are huge (take as an example The Coca-Cola Company, Mac Donald's fast food chain or Marlboro Cigarette brand). This will be noticed in colours, materials, textures, shapes, packaging, stationary applications, selling points, etc.

- Adopt an environmentally conscious overall philosophy, considering energy balances, waste reduction and impacts elimination or reduction, and introducing recycling policies whenever it is possible. Refer to the **BS EN ISO 14000** series and to the **Environmental Protection Act of 1990** for deeper discussion.

- Be aware of the legal dimension of design, considering litigation and intellectual property rights. Consider the relevant patents and assure that the Company owns the relevant standards and that the Law Department, Staff or Consultant deeply understands the **Consumer Protection Act 1987, Part 1: Product Liability**, as well as the **Council Directive 85/374 of the European Economic Community,** specially the **articles 4, 6** and **7.**

- Guarantee the appropriate resources to undertake research, design and development work

- Write down the financial plans, (i.e. profits, paybacks, return on investments) and keep them under a strong control, ensuring that funds will be available when needed. The budgeting system must be easy to operate and comprehend.

- Define strategies to seek for external help and financing.

- Offer customers and suppliers the possibility of joining in-house training programs, to provide an overall common language and minimise communication mistakes and timing.

- Keep evaluating the design strategy with regular audits, covering; similar products, facilities, equipment, procedures of suppliers, customers and competitors, skills, knowledge and experience of the team. Conformity with the present standards must be checked. Guarantee the staff participation and circulate widely the outcomes within the organization.

- Identify areas of improvement after the audits through a deep evaluation. The lessons should be learnt , documented and disseminated. The performance of executives with responsibilities for design should be evaluated.

5.2 Recommendations for Design Managers: Project Management Level

- Develop a detailed design model, which suits their particular products and circumstances, being aware that the process should be capable of receiving feedback at any stage.

- Guarantee a proper design brief and a proper set of specifications, according to the item 4 of section 3 of this report. Aspects of quality and environment must be bare in mind. Again, the British Standards series **BS ISO 9000** and **BS ISO 14000** should be known and considered, specially the **BS EN ISO 9004-1:1994**, which provides guidance for quality management and models for quality assurance. Careful consideration must be given to benefits, costs and risks (section **0.4** of the **Introduction**) for both the organization and the consumer. Regarding risks to consumer and machine operators, another document must be well known - the **Health and Safety at Work Act 1974,** specially the section **6** : **General duties of manufacturers etc. as regards articles and substances for use at work**.

- Give special attention to the sections **4 Management Responsibility**, **10 Quality of processes**, **18 Personnel** and **19 Product Safety** of the **BS EN ISO 9004-1:1994.**

- Give special attention to the **BS EN ISO 10007 : 1997 : Guidance on Configuration Management**, as it provides visibility and control of the functional and physical characteristics of a product. It should be used as a reference to define project specific procedures and the depth of application of each.

- Make sure that the design process discussed in **section 3** of **this report** is fully understood, and assign the right amount of responsibility and tasks to each individual involved in the process, as well as the necessary standards for successfully finishing each of the steps.

- Establish key dates for specific objectives, set targets and measure and document progress. Planning, programming, controlling and delivering the design content is essential at this moment. Agree priorities, and cry for external help identifying when external specialists are needed. Make use of the **BS 6079: Guide to project management**, discussed at the number 5 of section 3 of this report.

5.3 Recommendations for Designers: Detailed Project Level

- Follow the principles and tasks defined by the manager
- Communicate formally and informally during team meetings and design reviews
- Generate new ideas for products, making use of intensive creative thought. Use tools such as analogy, combination, lateral thinking, inversion and Delphi.
- Be aware of the potential of the team, and help to evaluate the most suitable concepts.
- Generate product characteristics being compliant with the standards mentioned in **number 7 section 3** of **this report.**
- Show the type of interfaces as well as the appearance of the product.
- Describe the assemblies that make up the total product, including materials, processes and assembly techniques.
- Meet the requirements for product performance, product life and environment.
- Highlight the disposal needs, feeding this back to the manager
- Develop the product packaging, approaching it as another project that will have its own requirements. Consider storage needs and lifting machinery
- Follow the CAD and manual draughting practices defined as an internal standard or procedure by the manager, giving special importance to safe storage and back up copies.

6 Summary of Relevant Standards

Target level	Standard	Level of importance		
		low	medium	high
corporate	BS 7000			
	BS ISO 9000			
	BS EN ISO 9004-1			
	BS EN ISO 14001			
	BS EN ISO 10007			
	BS 3375			
project management	BS 7000			
	BS ISO 9000			
	BS EN ISO 9004-1			
	BS EN ISO 10007			
	BS 6079			
	BS 7373			
	BS 5760			
design	BS 308			
	BS EN ISO 5455			
	BS EN ISO 9004-1			
	BS 7373			
	BS 5760			
	BS 7000			
	BS 6548			

obs. Depending on the company business, the Standards relevant to Design are many more, and vary a lot.

The standards here related are usefull in a General way.

7 References

7.1 British Standards

- BS 7000: part 2 : 1997-03-15: Design management systems part 2: Guide to managing the design of manufactured products
- BS 3375: part 1: 1995-00-00 : Management services part 1: Guide to Organization Studies
- BS 7373:1998-08-15: 1998 Guide to the preparation of specifications (G)
- BS 6079: 1996-04-15: 1996 Amd1: Guide to project management AMD 10146: February 15:1999
- BS ISO 9000-:1997:-08-15: 1997 Quality Management and Quality Assurance Standards – part 2: Generic Guidelines for the Application of ISO 9001, ISO 9002 and ISO 9003
- BS 308: part 1: 1993 Engineering Drawing Practice Part 1: General Principles
- BS EN ISO 5455: 1995-00-00: 1995 Technical Drawings
- BS EN ISO 9004-1: 1994:00:00:Quality Management and Quality System Elements Part 1: Guidelines
- BS EN ISO 14001:1996-09-15: 1996 Environmental Management Systems : Specification with Guidance for Use (G)
- BS EN ISO 10007 : 1997-00-00 : 1997 Quality Management: Guidelines for Configuration Management
- BS 5760: Part 0: 1996-00-00: 1986 Reliability of Constructed or Manufactured Products, Systems, Equipment and Components: part 0 : Introductory Guide to Reliability
- BS 6548: Part1: 1984-00-00: 1984 Maintainability of Equipment part 1: Guide to Specifying and Contracting for Maintainability

7.2 Others

- Consumer Protection Act 1987
- Environmental Protection Act of 1990
- Health and Safety at Work Act 1974
- Council Directive 85/374 of the European Economic Community

7.3 Text Books

- Ulrich, Karl T. and Eppinger Steven D.: *Product design and development*. - New York; London: McGraw-Hill, 1995. - 0070658110

- Keynes, Milton: *Product design and technological innovation*: *a reader* / edited by Roy, Robin: Open University Press, 1986. - 0335151108