Title: Information Exchange in New Product Development

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Abstract: We take a critical look at current information exchange practices and tools in use today, and relate them to information exchange issues as found in two manufacturing organizations in Portland, Oregon. Recommendations for the two organizations are presented. It is suggested that information exchange within the New Product Development (NPD) team, as well as information exchange between NPD and external environment, is critical to a successful new product development.

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by

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for

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Abstract

The efficiency and timeliness with which New Product Development (NPD) teams bring new products to market constitutes a distinct competitive advantage in todays high-technology market place. It has been suggested that information exchange within the NPD team, as well as information exchange between the NPD team and elements in its external environment, is critical to successful NPD.

This paper takes a critical look at current information exchange practices and tools in use today, and relates them to information exchange issues as found in two Portland, OR, manufacturing organizations. Recommendations for the two organizations are presented.

1. Your project is highly descriptive.
2. Not many degrees of freedom in a sample of 2.
3. I do not feel you fully utilized your survey responses.
4. Some unfortunate lapses in "writing."
5. Many of your conclusions would have been obvious before your project.
6. General rec's weak.
7. Too much reliance on CADD systems!
8. otherwise, acceptable.

Information Exchange in New Product Development

EXECUTIVE SUMMARY

The objective of New Product Development (NPD) is marketable goods and services, delivered on time and within budget. Time-to-market considerations; however, have proven to be much more important than budgetary issues, when figuring the overall economic success of the new product's life cycle.

The efficiency and timeliness with which New Product Development (NPD) teams bring new products to market constitutes a distinct competitive advantage in todays high-technology market place. It has been suggested that information exchange within the NPD team, as well as information exchange between the NPD team and elements in its external environment, is critical to successful NPD.

The purpose of this paper was threefold:

1. To evaluate current information exchange practices and tools in use today, and identify information exchange channels that are most important to the NPD process.

2. To compare information exchange tools and procedures available, with those being used by two local manufacturing firms - a heavy equipment manufacturer, and a high-tech electronics manufacturer.

3. To recommend for these two companies, areas in which enhancements to communications systems might provide the most tangible benefits.

Surveys of the two companies, conducted in the form of both questionnaires and interviews, identified 79 separate channels through which NPD teams exchange information. We define a channel as a path between one functional specialty to another.

Of these 79 information exchange channels, only 9 were common to both organizations surveyed, and only the following 3 were found to be heavily used by both:

Engineering	to/from	Engineering
Vendor	to/from	Purchasing
Manufacturing	to/from	Product Planning

Both firms indicated a strong reliance on the Engineering Departments for information. Engineering information was found to be widely exchanged within the Engineering Departments, as well as provided to many other departments upon their request.

A good portion of the Engineering information was found to be in the form of drawings and/or graphical data. Although both firms had CADD systems in place, they were being used almost exclusively for automating drafting tasks. One of our recommendations includes suggestions to make much more extensive use of the CADD systems, and more fully utilize the information contained in what are currently thought to be only drawings.

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1.0 INTRODUCTION

1.1 Why This Topic Was Chosen

The objective of New Product Development (NPD) is marketable goods and/or services, delivered on time and within budget. Time-to-market considerations, however, have proven to be much more important than budgetary issues, when figuring the overall economic success of the new product's life cycle.

A McKinsey & Co. study indicated that "High-Tech products that come to market six months late but on budget will earn 33% less profit over five years. In contrast, coming out on time and 50% over budget cuts profits only 4%." [31]

OK

Of critical importance in reducing time-to-market in the product development cycle is the accurate and timely exchange of pertinent information between the various participants in the NPD process. We felt that an examination of information exchange in NPD would make a worthwhile project.

Specifically, this project initially sought to accomplish three things:

1. Identify information channels most important to the NPD process.
2. Compare information transfer methods found in the literature with those of two local companies, a heavy equipment manufacturer and a high-tech electronics manufacturer.
3. Recommend for these two companies, the areas in which communication enhancements might provide the most tangible benefits.

4. general rec's ?

In order to elude the activity trap, [2] and insure that we wind up with a report that contains significant results, we let the content of our survey data focus our report. These data suggested that we more thoroughly investigate electronic information exchange, rather than also include interpersonal communication and traditional written communication. We do recognize that some important issues span several of these media, and address them when important.

Advantages of electronic information exchange are many:

* It can provide instant access to large amounts of information
* It is reliable
* It is accurate
* The cost of computing power has dropped dramatically in

recent years allowing the use of previously unaffordable tools.

This may tend to create the impression that the authors view computerized, electronic information transfer as a panacea for any communication need that may arise. This is not the case at all. It is quite likely that there are numerous avenues of communication which are best served by conventional means such as the telephone, interoffice mail, and personal contact. Inappropriate use of computerization would amount to technological overkill at least, and a reduction in efficiency at worst. However the literature generally indicates that computerized information exchange is finding more widespread uses. NPD managers would be well-advised to periodically review the communications needs of their organization, and to enhance the appropriate channels as technology and their businesses evolve.

1.2 Indicators of Communication Barriers

It is important for managers to be able to recognize when communication between NPD groups breaks down. As a general rule, when organization structure is out of alignment with organization needs, one or more of the following symptoms of structural deficiency appear:

1. Decision making is delayed or lacking in quality.
2. The organization does not respond innovatively to a changing environment.
3. Too much conflict is evident.
4. Little or no output (activity trap).
5. Unnecessary delays.

Consider the following examples:

* A midwest farm implement manufacturer required eight days to process an Engineering change order. After implementation of an automated form-handling system. This time has been reduced to three minutes. [10]

* In another organization, corporate policy dictated that all communications with vendors be routed through the Purchasing Department. As a result, response to a simple request for vendor information from the Test Division was delayed two weeks due to the vacation schedules of the designated correspondents in Purchasing and at the vendor. A vendor specification database, accessible by the Test division, could have alleviated this problem.

Same source?

1.3 New Product Development (NPD) Background

The very survival of many companies depends on their ability to satisfy the wants and needs of the modern global marketplace. [12] Competition is intense on both foreign and domestic fronts, requiring that companies constantly seek a competitive edge. New Product Development (NPD), the process by which the needs and wants of the marketplace are satisfied, is one of many areas explored in this quest. There is a disturbing statistic which states that approximately 90 percent of all new products fail in the marketplace. [6] This suggests that while NPD is vital to the success of most companies, there is much room for improvement in its execution.

It follows, therefore, that competitive advantage can be obtained through enhancement of the NPD process. This enhancement can be used to facilitate shortened project schedules, reduction in manufacturing costs, better value for the customer, and improved product attributes such as performance, durability, and attractiveness. In short, enhanced NPD can manifest itself in many different ways, all of which can contribute to a competitive advantage.

Modern corporate structures such as project and matrix

organizations, seek to enhance NPD by stressing the importance of teamwork and the involvement of many different groups of people, beginning with the earliest stages of product development. [1]

Additionally, and perhaps most important, there is a tendency toward parallel activities by different groups (simultaneous/concurrent engineering) as a method of shortening the product development cycle. This trend is expected to continue, as there is evidence that the opportunity cost of project slippage greatly exceeds the cost of NPD budget overruns.

2.0 INFORMATION

2.1 Sources and Uses

Managers spend 80% of their time actively exchanging information. [6] They need this information to hold the organization together. In addition, however, there are many other NPD participants who actively exchange information; the list in Figure 1 is not intended to be exhaustive, but it does serve to illustrate the point, and help focus our study.

A. Engineering	J. Manufacturing
B. Purchasing	K. Finance
C. Product Planning	L. Legal
D. Sales	M. Service
E. Human Resources	N. Executive
F. Data Processing	O. Marketing
G. Publications	P. Accounting
H. Vendors	Q. R & D
I. Library	R. Drafting

Figure 1 PARTICIPANTS IN NPD.

2.2 Organization of Information Linkages

If one can imagine all the different types of information that could be exchanged between NPD participants (Figure 1 lists eighteen), it becomes easy to see how vital this exchange is to the success of the NPD process. Some of the participants function only as information providers, while others function only as information receptors. Most, however, function as both, which results in a complex network in which no two channels of communication have exactly the same characteristics.

In the corporate communications network, vertical and horizontal information linkages are used to facilitate information exchange and provide relevant data for decision making and evaluation.

Vertical linkages are used to coordinate activities between the top and bottom of an organization. Organizations may use a variety of structural devices to achieve vertical linkage. These devices include hierarchical referral, rules and procedures, plans and schedules, positions or levels added to the hierarchy, and formal management information systems. Vertical structure has been the traditional concern of organization designers, but contemporary research has

discovered that horizontal dimensions of structure are also important. [6] Horizontal linkage mechanisms are often not drawn on the organization chart, but nevertheless are an important part of organization structure. Horizontal communication overcomes barriers between departments, and provides opportunities for coordination among employees to achieve unity of effort toward organizational objectives.

Organizations should be designed to provide both the correct type and the correct amount of information to those that need it.

2.3 Types of Information

In the course of their work, NPD participants are routinely asked to lend their specialized expertise to team-type projects comprised of many such specialists. Coordination of the specialized knowledge into an efficient, results-oriented effort, requires a large amount of information exchange.

This information takes many different forms, including:

Drawings	Costs	Schedules
Ideas	Reports	Problems
Changes	Client Info	Vendor Info

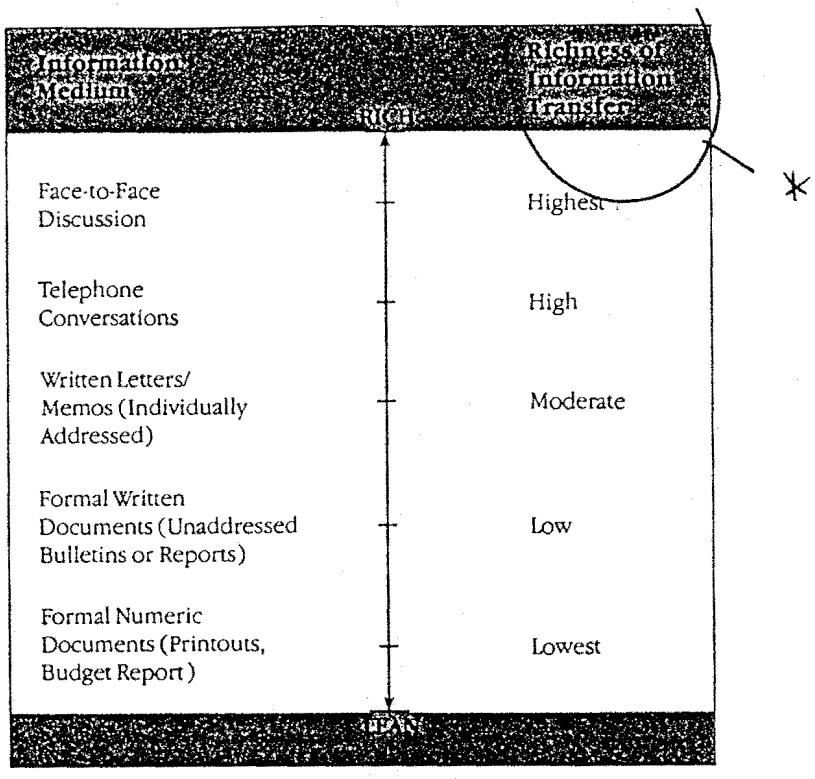
Competitor Info

Various type of information processing and exchange media can be used. A partial listing of tools used for these purposes includes:

CADD systems	Proj. Mgmt software
MRP systems	CIM systems
Integrated data bases	Quote/PO tracking systems
Inter-firm corresp.	E-mail systems
Bill of Mat'l systems	Telephone/FAX systems

The different forms of information above can be categorized as either "rich" or "lean" [6], and each has its place in the NPD environment.

Information richness pertains to the information-carrying capacity of data, and is related to the medium or channel through which the information is communicated. A scale of information media is shown below:



Source: Adapted from Richard L. Daft and Robert H. Lengel, "Information Richness: A New Approach to Managerial Behavior and Organization Design," in Barry Staw and Larry L. Cummings, eds., *Research in Organizational Behavior*, vol. 6 (Greenwich, CT: JAI Press, 1984), pp. 191–233.

When a problem is ambiguous and unanalyzable, and the factors surrounding it cannot be clearly understood, "richer" media such as group meetings, integrators, and direct personal contact are appropriate. These media provide multiple cues and feedback that enable people to define what is happening, and then respond correctly.

Isn't this obvious?

When the issues are more clearly defined, however, "leaner" media are preferable. For sending routine structured information such as cost figures and bills of material, written documents allow this information to be transmitted uncluttered by any other cues. Non-verbal cues in face-to-face meetings may complicate the routine data and cause confusion and misunderstanding in the receiver, although there is some disagreement in the literature about this. 8,11

For example, some believe that the non-verbal cues actually assist in the understanding of the true message being conveyed.

The Planning function operates in the middle between rich and lean. Planning initially involves face-to-face, "rich" discussions in order to formulate the plan. The plan, in turn, becomes a rigid, written document for monitoring activities conducted in accordance with the plan. Thus, each NPD participant in the network has different information requirements, and information from opposite ends of the rich-lean continuum cannot substitute for each other.

2.4 Amount of Information

The amount of information required is a direct function of the degree of uncertainty under which the organization operates. Factors influencing the amount of uncertainty include non-routine technology, organization size, environmental change, and interdependence between departments. All of these factors are quite prevalent in the NPD process.

When tasks are non-routine and interdependent, the amount of information processed is greater to help people understand and solve frequent problems. Organization size influences information transfer because a larger number of people and departments have to be coordinated. Frequent changes in the environment induce uncertainty, which requires more information gathering. Changes that require information sharing occur when a client cancels an order, when another department changes its production schedule, when a supplier delays delivery by nine weeks, or when R&D cannot modify a product within cost estimates. These events create uncertainty for managers who then have to process information to coordinate work activities.

2.5 Barriers to Effective Information Exchange

Even in the areas where it is desperately needed, implementation of an improved information exchange system (for the focus of this report, primarily through electronic means) is likely to encounter significant resistance.

2.5.1 Cost

Probably the most notable barrier is the reluctance of management to provide the funding required to put such a

system in place, and to train personnel in its correct operation. It is important, therefore, to initially enhance only the communication paths that can most benefit from the improvement. Implementation in stages can spread the expenditures over an extended period of time, so that capital budgets are not stretched beyond their limits.

2.5.2 Logistics

The logistical problems of electronically linking all the entities listed in Figure 1 would be formidable at best. Response to this problem depends upon the evolutionary point at which the organization exists. The typical scenario is for a company to first "automate", then "integrate". Initial efforts toward automation usually result in individual "islands" of information transfer, such as an Engineering Department local area network. Integration is the process of linking these islands. This "island" concept is usually associated with Computer Integrated Manufacturing (CIM), although it is valid for total integration as well. (Actually, CIM can be considered a subset of total integration, which includes additions such as information exchange with customers and vendors.)

Companies in the early stages of automation would probably find it logistically and financially prohibitive to buy the

hardware and software necessary for total integration. Instead, effort should be placed on the establishment of additional islands as capital budgets permit, which in themselves can reduce costs. [30] These companies actually might have an advantage over more established firms in that they have the opportunity to choose "island" hardware and software which will provide easy connectivity in the future.

Purchasing stand-alone automation sub-systems, without planning for future integration, invites problems in the areas of data sharing, peripheral incompatibilities, and excessive expenditures for integration hardware and software.

2.5.3 Psychology of Information Exchange

The enhancement of information exchange involves change, and wherever change takes place there are likely to be some behavioral problems among the people affected by the change. With regard to integration, there arises a question about the "ownership" of information. People tend to feel threatened when faced with the notion of allowing their files of information to be examined by others. It appears that a significant source of difficulty in this area is middle-managers who somehow believe that their authority is being usurped by the free exchange of information. These people

will go so far as to sabotage projects in order to protect their sacred domains. [23,3]

Another problem arises due to the inability of some people to distinguish between "data" and "information". Information has been defined as that which alters or reinforces understanding. It is not tangible or measurable. Data, on the other hand, is the input and output of a communication channel. Data are tangible and can be counted (memos, drawings, telephone calls, etc.). Data do not become information unless people use them to improve their understanding. In an effort to appear productive within the integrated system, people can succumb to the temptation to misuse the computer to generate mountains of data, which are meaningless to the recipient but nevertheless impressive in terms of volume and tonnage. This is a classic example of the Activity Trap, and as such it is a management problem. A better approach might be to institute a communication system which is receptor-driven; i.e., the person requiring the information is the one who determines the amount and type of information to be transferred.

The decision of what data is necessary to convert into information is best made by the group that needs to actually use the information. What may be only data to one group, may have the potential to be converted into very useful

information by another. For these reasons, access to data must be facilitated to a wide variety of groups. How do you know that "they don't need that data" and then restrict access to it, if you don't know exactly what their information needs are? Security issues are a very real concern in this area also. (DEVELOP SECURITY ISSUES?) ?

If properly used by the receptor, the computer can be a powerful tool for gleaning useful information from large amounts of raw data. In fact, this is one of the computer's primary advantages over more traditional means of information transfer.

In the case of the data generators, as well as the middle-management saboteurs, it is the responsibility of management at the appropriate level to create an environment, and corporate culture, conducive to the free exchange of meaningful information. Ideally, prior to implementing a receptor-driven system in which people have access to the information "belonging" to others, a corporate culture based on universal trust and teamwork should be established. A spirit of loyalty and personal involvement where all participants feel that they have a stake in the success of the organization are essential. In areas where sensitive information really does need to be protected, the custodians of that information need to be reassured that proper security

How?

steps have been taken. For many companies, adapting to the age of large-scale electronic information transfer represents a significant departure from their established mode of operation.

3.0 AUTOMATION AND INTEGRATION IN INDUSTRY TODAY

We decided to examine the literature in an attempt to assess some of the current trends in industry today in the areas of Automation and Integration. This was not intended to be an exhaustive study, but the results clearly show a steady movement toward electronic information exchange in the functionally diverse areas constituting NPD.

Today, total integration is becoming increasingly popular among companies with established islands, which have the resources and commitment to overcome the cost, logistical, and psychological problems. [10] Companies faced with the prospect of total integration usually become involved with complex hardware and software designed to make connectivity between islands possible. The literature abounds with examples of CAD drawing translators, [29] networking products, [20] and many other tools.

Total Integration is sometimes referred to as Electronic Data Interchange (EDI). Ford Motor Company has implemented a form of EDI called Common Manufacturing Management Systems (CMMS) [3] which links existing information islands into a system which will allow precise tracking of component parts, from the supplier all the way through the production process

to the customer. Similarly, Fischer and Porter, a manufacturer of controls and instruments, is in the process of linking its operations in the U.S, Canada, France, and Germany together in a common database. The system encompasses design, manufacturing, inventory control, and accounting functions. [17]

Industry analysts estimate that there will be almost 10,000 U.S. firms using some type of EDI by the end of 1990, with this number increasing to over 22,000 by 1994. [3]
Less comprehensive "automation" types of communications improvements are also being implemented throughout industry which enhance the ability of many different groups of NPD participants.

* CUSTOMERS

At Peterbilt trucks, a "Red Oval" used truck network is accessible through selected dealers. [35] The purpose of this network is ostensibly to assist customers in finding just the right truck for their needs by accessing a large database of used trucks throughout North America. In addition, though, this system has the potential of "closing the loop" by providing Peterbilt with information about customer needs and buying habits.

* VENDORS

General Electric and DuPont provide on-line databases for their plastics customers to assist them in the correct selection of the myriad of engineering plastics available from these two vendors. [7] These companies also offer interactive expert systems which assist customers in troubleshooting their plastics manufacturing problems.

* CONSULTANTS

Wilhelm Engineering Co., Progressive Tool & Industries Co., and Reko Tool & Mould are three examples of engineering/supply firms who have established electronic information exchange with their clients. Typical information supplied by these firms includes CAD drawings and tool path design. [28]

* MANUFACTURING PROCESSES

At Texas Instruments, the loop with some of the process machines on the factory floor has been closed. Manufacturing computers control the process, and even provide an expert system to advise the machine operator how to proceed if a malfunction occurs. [10]

* ORGANIZATION

One of the most critical NPD interfaces is the one

between Design Engineers and Manufacturing Engineers. At Hewlett-Packard, all distinctions between these two groups have been eliminated. [24] The idea here is ensure during the design phase that the product can be efficiently built. This philosophy is called "Design for Manufacturability", (DFM), and has found proponents in other firms, including Ford Motor Company and IBM. [27] Both of these firms use software packages to aid in DFM.

4.0 SURVEY METHODOLOGY

Survey data were obtained from two relatively large firms in the Portland area, both actively engaged in NPD. One is a heavy equipment manufacturer, and the other is a high-tech electronics manufacturer.

The two firms were chosen to be at opposite ends of the engineering spectrum, both for reasons of convenience to team members, and to allow the possibility of comparing and contrasting information transfer issues of the radically different firms.

4.1 Heavy Equipment Manufacturer

The questionnaire distributed at the heavy equipment manufacturer was designed as a tool to analyze the flow of information in the corporate environment. A copy of the two page questionnaire is included in Appendix 1. A mix of respondents was selected to get feedback from as many departments as possible. As the summary in Appendix 2 shows, we obtained responses from just over fifty percent of the departments in the company.