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Developing and Using Benefit Measurements for Integrated Product Development (IPD)

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ABSTRACT

Integrated Product Development (IPD) focuses on the integration of people, process and technology to achieve best-in-class product development. Best-in-class means a development practice that provides the **optimum** values of cycle time, cost and quality for both the customer and the manufacturer.

Typical Integrated Product Development (IPD) projects measure benefits using two indicators: the reduction of Engineering Change Notices (ECNs) and the reduction of warranty costs. While these metrics are excellent long term indicators of IPD benefit attainment, in most of the organizations I have worked, feedback to management on IPD progress must be measured monthly or quarterly. Without an ongoing status of the IPD project's benefits, momentum and participation in the effort will wane over time, and become another "improvement plan of the year" at the manufacturer. This document focuses on the short term and ongoing collection and use of metrics at manufacturing firms undertaking change through IPD, and how IPD collaboration and technology can be used to translate these metrics into risk-reduction benefits.

INTRODUCTION

This paper will describe a pragmatic approach to identify and use metrics associated with the *value* of IPD to an organization. The approach is straightforward: if the value proposition of IPD is its ability to optimize cycle time, cost and quality throughout the development process, the lack of IPD practices will be reflected in additional risks in manufacturing effectiveness and customer satisfaction. These risks can be identified, quantified, and then used in the implementation of IPD as a collection of metrics to measure realized IPD benefits.

Two concepts must be understood by the provider's organization to realize how managing risk results in the achievement of IPD value: benefits gained through collaboration, and benefits gained through technology. Collaborative benefits are those generated through the avoidance of risk due to cross departmental interaction[1] and integration. For example, a cross departmental review which results in adjusting a design to meet assembly constraints. Technology plays an important role in the realization of IPD value as a vehicle to overcome the inherent logistical barriers to collaboration, that is, a delivery mechanism for timely and accurate product information to appropriate cross departmental units. An example is using 3D model information as the basis for detecting interference in an assembly or transferring 3D model information from a CAD system into a different system for analysis. Note that many collaborative benefits can be realized *without* the use of technology.

This document is written from the perspective of an IPD consultant sharing his experiences gained over several IPD related projects. The *change agent* referred to in this report is the resource who is responsible for creating or improving IPD practices at the manufacturer or provider. This change agent may be an employee of the manufacturer, or an outside consulting resource. The reader is assumed to have a basic understanding of IPD and concurrent engineering best practices.

This report reflects the guidelines I have used to surface and measure IPD metrics. Section I introduces the categories of risk and costs that can be reduced via IPD practices, and provides the reader with yet another acronym: DISDR, which stands for Design Iterations, Schedule Disruptions and Rework. Section II describes how information on costs and validation are collected and categorized to develop an historical baseline of missed IPD benefits. Section III illustrates how IPD Pilot Projects are used to both introduce the benefits of collaboration and technology, and link IPD pilot practices to benefits realized based on the manufacturer's historical baseline. The final Section focuses on the agreement and commitment required throughout all cross functional departments to adopt and institutionalize IPD practices.

I. BACKGROUND: THE ROLE OF DISDR

Most manufacturers intuitively feel good about IPD initiatives. They will readily admit that sharing information early in the development process makes sense. Studies have shown that extra time in deliberating a design with a fully staffed cross functional group saves significant dollars in downstream production and support areas. Yet, in spite of intuitive and "hard" facts that support an investment in IPD, providers have a hard time "justifying" the investment in an IPD effort. Why? Consider a manufacturer investigating the insourcing of a new transfer line. He knows what the present supplier is charging for the present part. He can get quotations from other suppliers to validate the "outside " costs. He can estimate the overall price of the installation of the new line, and calculate ongoing production and maintenance costs. He is under the belief that he is working with known costs (and risk), and "hard" benefit dollars.

The problem in justifying IPD expenditures is that, unlike a new transfer line, a much larger effort must be made, to surface and measure the *potential* benefits of IPD for the interested manufacturer. For example, a major barrier to IPD success is cultural in nature: moving people out of their comfort zone and asking them to work differently. Surfacing problems can lead to "finger pointing", with misguided emphasis placed on historical blame instead of corrective action. In the extreme, documented problems that can be resolved via IPD are denied. Clearly, the people issues of IPD are much more emotionally charged than fact finding for "best part price".

The truth is that a typical manufacturer is paying for their lack of IPD practices, but the price is not readily obvious. The price a manufacturer pays is manifested in three key reoccurring product development problems: **D**esign **I**terations[2] , **S**chedule **D**isruptions and **R**ework [**DISDR**]. While these are not the only manufacturing cost areas that are reduced through IPD, these have been selected as a basis of metrics for several reasons: (A) **Information** -manufacturers will normally have some records on design iterations, schedule disruptions and rework, or at least be able to reasonably approximate the costs associated with these areas with some degree of accuracy. Furthermore, design iterations, schedule disruptions and rework are non-ambiguous targets of investigation. Because of the manner in which most departments are measured, these DISDR problems are not easily overlooked or forgotten, (B) **Cause and Effect** - through IPD Pilot Projects, collaborative exercises in the early part of the design process and specific technology can be directly linked to the reduction of DISDR problems, and (3) **Agreement** -DISDR development problems can be *agreed to* (by the provider's cross functional departments) as both *symptomatic* of the lack of IPD practices, and *preventable* via collaboration and specific technology. All three ingredients must be documented and acted on to provide the preponderance of evidence needed to validate the measured benefits of IPD.

II. INFORMATION GATHERING

Information is collected in a three step process. In the first step, impacted areas of DISDR problems are identified with related costs. In the second step, product development costs that could have been avoided through IPD practices are further validated by an examination of the manufacturer's "fix" release process. The third step describes how to draw reasonable conclusions from the information gathered in steps #1 and #2 and build a historical baseline of potential IPD benefits for the manufacturer.

Step 1: Impact Categories & Costs

To develop the value-based metrics from DISDR problems the impact of these development obstacles on the manufacturer's business must be assessed. Table 1, Impacted Resources and DISDR Problems, illustrates the three problems, and their impact(s) on a manufacturer's resources.

For Product Development/Project type: Casting, Part 12376

	DISDR PROBLEMS		
IMPACT CATEGORIES	**Design Iterations**	**Schedule Disruptions**	**Rework**
Internal Cost in Hours			
Project Manager	12	17	28
Shop Floor- Direct Labor	0	10	32
Shop Floor-Overtime	0	26	26
Production Materials	0	15	20
Material Control	0	4	6
Design	53	43	56
Analysis	0	20	18
Test	0	35	25
Manufacturing Engineering	4	26	23
Purchasing	4	9	0
Scheduling	0	2	2
Shipping/Receiving	0	3	5
Inspection	0	0	2
Shop Floor Instructions	0	5	15
Order Processing	0	1	0
Sales	4	3	7
Internal Hours Total	77	219	265
TOTAL, Internal Costs	$3,003	$8,541	$10,335
External Costs			
Supplier overtime	$2,467	$3,860	$1,345
Tooling rework	0	0	$3,860
Premium Freight	0	$500	$1,297
TOTAL, External Costs	2,467	$4,360	$6,502
TOTAL COSTS	$5,470	$12,901	$16,837

Table 1: Impacted Resources and DISDR Problems

It is important for the change agent to document problem/impact areas for each type of product development category. Specific examples within each category are required to trace costs across multiple departments. Product development categories include, but are not limited to, castings, machined parts, forgings, vendor integrated parts, outsourcing efforts, insourcing efforts, and/or development projects related to product subsystems such as fuel, cooling, and electronic control. This approach will support the detection of problematic patterns specific to your manufacturer's development practices.

As part of the information gathering process, meet with the owner of the impact category (the manufacturers' resource) that supplies the staffing and is measured by performance goals adversely affected by the problem. Past experience has shown that information gathered by non owners, while provided with good intentions, needs to be at least verified to accomplish the level of acceptance required to show cause and effect benefits [risk reduction] related to IPD practices.

When agreement on an impact area is reached, the assignment of costs (in hours or dollars) to correct the development problem per impact area also is gathered. This task requires an understanding of manufacturing operations, patience and creativity since the owner of the impacted area may be tracking occurrences of problems, but not associated costs. For example, premium freight and shop floor overtime can be identified as an area impacted by a Plant Manager, but the cost-value of the related problem [schedule disruption] may need to be investigated through Transportation, specific Line Supervisors and/or the Accounting Department.

As impacted areas are accepted, and cost-values are gathered, certain problem-impact patterns will emerge. For example, the problems on specific type of project will reflect a pattern of corresponding direct and indirect impacted areas: Assembly overtime, premium freight, supplier overtime, Design and Test [actually re-test], and tooling [Manufacturing Engineering]. These patterns will serve two purposes. For one, they will reflect, on a problem/risk-to-cost basis, the types of projects and products the manufacturer has particular difficulty in bringing to completion effectively. In addition, the pattern itself will help the change agent to begin to predict, with some accuracy, areas of impact per project or product type. This information can be used to show the manufacturer that their corrective solution set can also be grouped into categories of prevention by project type or product[3]. Over several families of project and product types, the surveyor will also detect "gaps" in impacted areas, and be able to justify revisiting select departments for additional cost information.

Finally, as each impact area is surveyed, and cost information is gathered, a simple set of questions are asked to begin the groundwork for Step #2:

Question #1: "How involved was your department in the early stages of this product development example?"

Question #2: "How well was development information[4] communicated to affected departments during the product development term?"

Since IPD benefits are based on collaboration and the effective and efficient use of information, the responses from these questions will further validate a direct link to IPD as a source of cost *avoidance*, an area further discussed in Step #2 below.

Step 2: Avoidable Fix Releases

All companies have at least two release processes, whether formal or informal, used to manage their product development projects. The main process is the "standard" release process. The second process is used either for continuous improvement, or to fix something that was in error in a previous release. In relating the cost information gathered in the first step to IPD benefits, the second, *avoidable* release process becomes the main area of focus[5].

In best case scenarios, the manufacturer you are working with -or for- has a designated resource to manage these secondary fix releases. In many cases, the fix process is informal, and must be documented to show its role in avoidable resource consumption. Planned releases will generally be those related to continuous improvement; *unplanned* releases are the prime targets of investigation. Further examination by the change agent will show that a fix release will usually be directly linked to assembly and supplier miscues, lack of design coordination and generally poor first pass yield of the original product release.

Once the *avoidable* releases are identified and categorized by product type, a total count of each type over the past year [minimum] is gathered. This count is a measure of missed IPD opportunities which are reflected in unnecessary releases [and resource consumption] that could have been avoided through the practices of IPD[6]. For every fix release identified, the change agent must ask two key questions:

Question #1: "Could this release have been *avoided* through better cross functional and/or departmental involvement?"

Question #2: "Could this release have been *avoided* through better communication of development information to affected departments [including outside suppliers] during the product development term?"

These questions serve two purposes. To identify which fix releases were caused by missing early collaboration, and which could have been avoided through better management of information *after* final design review.

Step #3: The Historical Baseline

At this point the change agent has costs related DISDR problems and has identified specific projects/product releases related to the avoidable fix process(es) of the manufacturer.

These figures and the answers to the two sets of questions will provide enough information to generate the historical baseline of missed IPD benefits. An example of a historical baseline for castings(designed internally) and castings (outsourced) is shown in the Table 2 below.

Product Development Area	Average Cost	Extension
Castings-internal [43 per year]		
Design Iterations	4,337	186,491
Schedule Disruptions	10,088	433,784
Rework	14,291	614,513
Total	28,716	1,234,788
Castings-external [31 per year]		
Design Iterations	2,086	64,666
Schedule Disruptions	10,673	330,863
Rework	11,923	369,613
Total	24,682	765,142

Table 2: Historical Baseline Example

This table is representative of the overall IPD benefits *potential* of IPD at the manufacturer. Average Cost is the average cost of all examples gathered during the impact categories and costs steps of the survey for the castings-internal and castings external categories. Occurrences per year [43 and 31] were gathered during Step #2, avoidable fix releases. Together these figures represent a small sampling of the total *missed* opportunities for IPD benefits of over $2 million in the last year at this manufacturer.

With all product development groupings of the manufacturer, the change agent is now armed with an historical baseline of costs directly linked to IPD benefit areas. Linking these benefit metrics to specific IPD project activity is the next challenge faced by both the change agent and manufacturer. The activity is IPD Pilot Projects where the collaborative and technical practices of IPD will further support the immediate value of IPD practices by using the manufacturer's own historical problems in contrast to improved IPD practices.

III. IPD PILOT PROJECTS

IPD Pilot Projects are used to demonstrate how specific IPD best practices provide a cost benefit to the manufacturer. The pilots introduce IPD corrective activity which is linked to the historical cost baseline of DISDR problems.

An IPD Pilot Project is a product development effort selected from the pool of potential projects at the manufacturer that can be completed in a reasonable time span, requires a cross functional team to participate in for optimal results, and falls into a product group with historical DISDR problems. Members of the IPD Pilot Project are totally empowered to immediately deploy any or all best-in-class IPD practices on the project.

In an IPD pilot, the old "silo" methods of performing the work of product development are replaced by the best practices of IPD. These best practices of IPD include FMEA and other quality practices, and well as improved cross functional communication between team members. While quality practices are a significant contributor to IPD benefits, this report will focus on the value of early collaboration and specific technology.

COLLABORATIVE EXERCISES

The value of strong cross functional collaboration is at the root of linking the benefit metrics to IPD activity. Cross functional collaboration is a learned skill that without practice will deteriorate. The ideal forum to practice this skill is through an IPD pilot project.

The collaboration exercises require an understanding of the Pilot Project's goals and of the manufacturer's historical baseline of IPD benefits. The steps in the exercises are outlined below.

1. Preparation: Meet with the Project Manager

It is imperative that you meet with the project manager before the pilot project launch. As a change agent you will be introducing new discipline into his normal product launch effort. Your role is to describe why this project was selected, and show using the historical baseline, what IPD benefits are possible through collaboration and technology use. Your activities would include, but not be limited to working with the Project Manager in the following areas:

-Insuring that the goals of the Pilot project are clear [documented]

-Explain how the Pilot Project goals can be reached through early collaboration and use of IPD technology

-Insuring that the Pilot Project team is cross functional, as required to reduce risk based on the manufacturer's historical baseline

-Structuring the launch meeting agenda and facilitating collaboration exercises for the Pilot team, as detailed below.

2. Collaboration at the Launch Meeting

The stage for collaboration has been set based on the preparation above. When the pilot team has assembled, begin the collaborative exercise by having the team members introduce themselves[7]. Note which members feel at ease with their introduction, and which appear anxious or shy. Immediately review the project 's goals with the team. Begin the collaboration exercise by focusing on team dynamics, most notably how the success of the project is tied to the *team's* overall ability to work together effectively. Review the manufacturer's historical baseline to show how early cross functional involvement and effective management product development information have generated unnecessary risk and costs on projects[8].

<u>Leonardo Exercise</u>

Leonardo Da Vinci can be used to emphasize the importance of team collaboration. Leonardo was an great inventor, scientist, and artist. Yet, despite Leonardo Da Vinci's genius, retooled for the 20th century, he could not execute a Pilot Project alone. Moreover, although team members have special skills and talents, no one on the team is a Leonardo Da Vinci! Does it make any sense that any one team member could or should bear the responsibility of the entire project's success? Discuss the merit of team ownership with the team members. Point out that in a fully empowered IPD Pilot, everything about the project can be challenged. This includes the ROI based on the original order requirements, due date forecasts, insourcing verses outsourcing assumptions, design approaches, and supplier selection. If some reason surfaces to break from tradition, alter significantly or even stop the project, it is the team's viewpoint, which can be elevated to management for further action and direction. This "Leonardo" verses team perspective leads to another important aspect of team collaboration: roles and responsibilities.

Roles and Responsibilities Exercise

Often roles of participating members in a project are ambiguous. Review the *expected* contribution of each cross functional department with the team. In particular, focus on the roles of the Project Manager and the Designer. All too often the Project Manager becomes the "dumping ground" for the project. He can not be expected to take on all aspects of the project. He is the quarterback- the organizer of the cumulative talents of team members. Second to the Project Manager, the Designer's role is most distorted. He may also have some related subject matter expertise, but his contribution is a recent as his last similar project. Resource constraints, manufacturing processes, and lessons learned are always changing. He cannot be expected to capture the design intent without the latest input from the Product Engineer, Suppliers, Manufacturing Engineering and other team participants.

In the launch meeting, make sure that every one on the team has an opportunity to describe what they feel their role is, and how they intend to deliver their department's value to the project. The change agent must pay particular attention to assist team mates not prone to discussion, and balance their "time on the floor" with the more dominant team members[9]. This team exercise is guaranteed to surface some surprises. In many cases a department's view of their contribution will not be in line with other team member's view . This learning experience will not only help project participants to recognize and understand inter project roles better, but will surface areas of attention that may *not* have clear ownership. As a change agent, you must review these inconsistencies impartially with the team and reconcile them with the pilot project's goals. Although this discussion will take some time on initial IPD Pilot Projects, the investment is well worth it.

Dependency Exercise

By asking each member the simple question, "What do you need from other team members to do you best job on this project?" another critical dimension of team dynamics is initiated: inter role dependencies Information from the historical baseline will illustrate how a dependency may have been overlooked on previous, similar project types. The change agent must focus on using history as a lessons learned vehicle to avoid a nonproductive history-blame discussion. As each participant reviews his dependencies with the team, relate the dependency to specific action items needed to improve the project success. *Every* action item requires an owner, brief statement of the action, and completion date, and must be documented on a Action/DISDR log immediately [Table 3 below].

Action/complete date	Owner(s)	DI	SD	R	V	R P
Add bracket to pump 9/95	M.K.					
Run new pressure test on seal 9/95	G.M ,S.R.					
Reconstruct assembly instructions 11/95	D.L.					
Contact supplier on change to assembly steps 10/95	D.L., N.V.					

Table 3: The Action/DISTR Log

Like the discussion of project roles this activity will consume some time, but the benefits of early collaboration will *always* be in proportion to the reduction of project risks and the avoidance of unnecessary costs.

3. Collaboration and DISDR Avoidance

The next step in the collaboration process is for the change agent to link the information shared between team members and DISDR problem avoidance.

The project's goals are revisited by the Project Manager. Begin another collaborative discussion by asking, "in light of understanding your team member's contribution areas and dependencies, and *because* of the way this launch meeting was conducted [using collaboration], which action items have been surfaced that will cause you to avoid a design iteration, a schedule disruption or rework?" To facilitate this discussion, the change agent can review previously recorded action items from the action/DISDR log. Again experience has shown that a spirited discussion will begin. As each action item is reviewed, the change agent must probe for yet additional action items, and identify them as avoiding a design iteration, schedule disruption and/or rework. In addition, the change agent *must* verify with the team, that if it were not for the cross functional collaboration exercises, the action item *would not* have been surfaced.[10]

The results of the collaborative exercises will surface clear cut links to specific collaborative practices that already have a value associated with them. Based on experience, a significant amount of action items will have been surfaced by the collaboration, and will link to the avoidance of one or more DISDR problems, as recorded in Table 4 below.

Action/complete date	Owner(s)	DI	SD	R	V	R P
Add bracket to pump 9/95	M.K.	√			√	
Run new pressure test on seal 9/95	G.M ,S.R.		√	√	√	
Reconstruct assembly instructions 11/95	D.L.	√			√	
Contact supplier on change to assembly steps 10/95	D.L., N.V.	√	√		√	

Table 4: Beginning the Action/DISDR Log

It is important to note that the IPD Pilot Project team has identified and verified the cause and effect of the collaboration with DISDR problems. In a complex project requiring several new components, the original launch meetings will generate separate "break out" sessions, which in turn, can also be optimized through additional collaborative sessions. The change agent must work with the Project Manager to function as information distributors to insure that action items are completed and all project information is distributed to appropriate team members. Over several IPD Pilot Projects, team members will commingle into other projects, enriching the collaborative discussions and beginning the transition of IPD collaborative practices into the mainstream of the manufacturer.[11]

THE ROLE OF TECHNOLOGY

Out of the many benefits of technology use in IPD initiatives two will be examined: Product Data Management and Rapid Prototyping.

The primary roles of technology from an IPD perspective are to (1) remove logistical barriers to collaboration and (2) reduce risk by enabling rapid prototyping. Logistical barriers to productive collaboration are time and distance. Time is required to hold collaborative sessions, but in a typical manufacturer, even IPD zealots are busy with several projects at once and find it difficult to meet together again for post-launch discussions and follow-up meetings. As the project progresses, new information must be recorded and distributed to other team members, including distant suppliers. Downstream participants -both internal and external to the manufacturer- must have a vehicle to check the status of projects as they move toward test, production and assembly. Mismanagement of information can lead to additional DISDR problems, even after a successful collaborative launch. The manufacturer is faced with two alternatives: use expediters [or consultants] or enabling technology to manage project information, that is, give all stakeholders of a project the ability to contribute to and access project information according to predefined release controls. Enter Product Data Management (PDM) [12], a technology enabler well suited to the task of managing project information. Moreover, PDM systems will typically provide for several "types" of release workflows adjusted for control to match the inherent project risk.

Our DISDR approach to measuring IPD benefits also link to PDM. The degree that your manufacturer is penalized by information mismanagement is reflected in the answers to the questions asked in the impact and avoidable fix release surveys. If the effected department *was* involved in early cross functional collaboration [question #1], but development information *was not* communicated faithfully during the product development term of the project [question #2], you have a likely project/product candidate to identify DISDR problem removal through PDM. When the change agent and Project Manager assume the role of the information distributor during an IPD Pilot Project *they became* the PDM for the Pilot. Just as with collaborative benefits, the historical baseline for missed IPD technology benefits can be constructed.

The benefits of Rapid Prototyping as an IPD best practice are straightforward. With the best of collaboration, the complexities of some designs make it difficult to predict the product's usability when placed in a customer's application. Rapid prototyping allows the manufacturer to use their 3D technology to create a real world replica of the product, before permanent castings, tooling and other long term investments are in place. The DISDR calculations are straightforward: *any* fit, form or function irregularity surfaced through a rapid prototype has avoided a design iteration, schedule disruption and possible rework. Post rapid prototype collaborative sessions with the project team will more than substantiate this; additional support will enthusiastically come from the manufacturer's customers. At this stage the Action/DISDR Log looks like Table 5:

Action/complete date	Owner(s)	DI	SD	R	V	R P
Add bracket to pump 9/95	M.K.	√			√	
Run new pressure test on seal 9/95	G.M S.R.		√	√	√	
Reconstruct assembly instructions 11/95	D.L.	√			√	
Contact supplier on change to assembly steps 10/95	D.L., N.V.	√	√		√	
Widen opening for bracket mounts clearance 11/95	P.P., T.H.	√	√		√	√
Add boss to left side of bracket [ref machine note AA] 11/95	M.K.	√	√	√	√	√
TOTALS:		5	4	2		

Table 5: Completing the Action/DISDR Log

Once the Action/DISDR Log has been completed, the calculations for costs avoided through the collaborative and technical (rapid prototyping) IPD activities are computed. Using the historical baseline example for Castings, internal design, and Table 5 above the following calculations are generated:

Design Iterations	5 x 4,337	=	21,685
Schedule Disruptions	4 x 10,088	=	40,352
Rework	2 x 14,291	=	28,582
Cost Avoidance Total		=	90,619

IV. AGREEMENT and CONCLUSION

A successful benefits measurement activity for an IPD initiative is based on agreement.. Your manufacturing sponsor must agree that *some* unnecessary design iterations, schedule disruptions and rework are symptomatic of missing IPD practices, and are preventable via the collaborative and technology benefits of IPD. It is up to the change agent to validate and quantify the agreement by gathering the preponderance of evidence required to support the historical baseline of missing IPD benefits, and then apply that history to IPD Pilot Projects to reflect the cost avoidance benefits of IPD-specific activity.

Each step of the validation and quantifying process must be accompanied by acceptance of the customer: the resources contacted, the questions asked, the cost values assigned, the historical baseline defined, the portions of the baseline which links to IPD collaborative activity or technical enablers and finally the selection and execution of IPD Pilot Projects to demonstrate specific benefit examples.

The foundation of agreement for IPD benefits measurement are grounded in reasonableness. Is it reasonable to use the survey information from the manufacturer's own resources who support the link between Design Iterations, Schedule Disruptions and Rework to specific failures in using IPD collaborative methodology and technology? If the historical baseline shows that projects related to cooling systems reflect $4 Million dollars costs avoidable through IPD collaboration and technology is it reasonable to target half that amount for a on going yearly goal? Is it reasonable to use the manufacturer's own projects and resources to corroborate the cause and effect of improved product development and IPD activity? In all cases: yes.

The single most important agreement that the manufacturer must keep is a *commitment* to IPD. It takes 12-18 months to generate the baseline and begin IPD Pilot Projects. It will only take 2 months for the counter IPD revolution to begin. It is extremely rare to have the entire organization fully supportive of changes as drastic as those required in IPD. If you do not sustain energy on the IPD initiative, the nay seers will quickly erode the support you have and easily justify the status quo. Management commitment must be in hand to assist in overcoming IPD barriers, not just in funding of the project, but with *visible evidence* of support-participation in IPD steering committee activity and in as many Pilot Projects as possible. Finally, management must be directly involved in corrective discussions with IPD detractors.

The identification and use of metrics discussed in this report is not rocket science. This simple approach has worked to provide a better than reasonable barometer of IPD value to a manufacturer. It takes into account the overall product development history of the manufacturer, and links specific instances of development problems to a measurable and repeatable cure: Integrated Product Development.

ABOUT THE AUTHOR

G. W. (Jerry) Czernel is a Program/Project Manager at EDS Unigraphics. Mr. Czernel has over 20 years experience in Manufacturing Resource Planning [MRP], Computer Integrated Manufacturing [CIM] and Integrated Product Development [IPD]. He is CPIM certified and has developed and implemented multiple manufacturing systems in the automotive, transportation and DoD communities. His business management background includes cost analysis, process assessments and process reengineering, with emphasis on direct deployment of best IPD practices.

[1] Cross departmental interaction includes the manufacturer's internal departments, customers and suppliers involved in the product development effort.

[2] Note that not all design iterations are a development problem. A design iteration may be a result of continuous improvement. In the context of this paper, only design iterations that are generated to correct a preventable design error are part of DISDR.

[3] This pattern of information will greatly assist the manufacturer in prioritizing IPD efforts based on frequency and impact. In short, these patterns can direct a consulting change agent and his client toward expending resources for the biggest "bang for the buck".

[4] Development information: weight maximums, implementation envelopes, environment considerations, manufacturing limitations, schedule limitations, field support requirements, etc.

[5] In cases of severe denial, the manufacturer will not recognize this phantom process. Rest assured, it does exist, even if hidden and informal.

[6] There is a separate, additional metric associated with the effort required just to process a fix release. Since the entire release could have been avoided, *any* resource consumption is a cost avoidance metric for IPD benefits.

[7] If cross functional representation is not present, make a reasonable attempt to bring in the missing departmental resources. If this fails to produce a true cross functional representation of the required skills/experience as determined by the historical baseline, suggest that the meeting be rescheduled. Use the time between the rescheduled meeting to meet with all team members to stress the importance of attendance. After several pilots have been completed, attendance will increase.

[8] There are ample illustrations of the benefits of early team collaboration on product development projects available form concurrent engineering research.

[9] Before facilitating a collaborative session, it is useful for the change agent to become familiar with interpersonal behavior patterns. Each team member will have his or her own style of communication and reaching decisions. Failure to recognize dominant, amiable, analytical or expressive styles in team members will result in less than optimum facilitation.

[10] Questions to establish this verification include: "Would you have had a chance to surface this action item in another forum?" "Can you say that collaboration has allowed you to rethink the way you must contribute to the success of this project? What are you going to do differently?".

[11] There are other collaborative exercises that can be executed to assist the team in ISO9000 and QS9000 practices, validation of the IPD Pilot Project's reasonableness [ROI, due date, etc.], and early supplier involvement.

[12] Product Data Management (PDM)is a useful technology that enables the control and distribution of product development information to cross functional project members. PDM technology can include a workflow status and release, project "vaulting", and product structure mechanisms. In addition, PDM enablers can also support a manufacturer's internal project accounting administration: key characteristics, planning schedules, costs, test results, supplier information, tooling, etc. Because of the scope of PDM, the subject is not discussed in this report in any great detail.