The Four Steps to Reducing Production Scrap and Rework

Defining all your product information digitally can put you on the right road to reducing scrap

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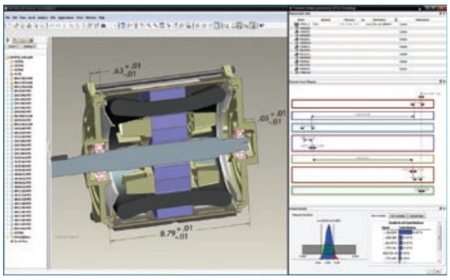
As a manufacturer, you know that production scrap can come from just about anywhere. It can be the parts you ordered from a sub-assembly supplier that don't fit into your finished assembly, or it can be a physical prototype you've used and discarded. Occasionally, scrap is a finished, delivered product that your customers simply don't like, or worst - case, it's a defective product that triggers a costly and embarrassing recall.



In each case, the scrap – and the required rework to fix the problem – costs you money or time, or both. And with raw materials and labor being the two largest cost centers for most manufacturers, all production scrap will cause a negative impact on both areas, according to industry analysts.

The Problem: Creating Production Scrap

Wrong materials, incorrect tolerances, faulty ergonomics–there are many ways to create production scrap. Here are some of the more serious ones:

- **Wasted prototypes** – Physical prototyping is a necessary part of product development, but the fewer prototypes required, the better. One maker of racing engines, a PTC customer, was able to cut weeks of development time by lowering the number of physical prototypes used for testing.
- **Parts that don't fit** – With product design teams now dispersed across the globe, those inevitable last-minute changes in design or manufacturing have become even riskier: one subcontractor may not receive the most recent file or latest email, and may end up producing parts that won't work.
- **Changes in materials** – When a subcontractor is unable to deliver the stock you requested, they'll often suggest an alternative. Too often, the new information gets lost somewhere between your company's procurement office and your manufacturing group.

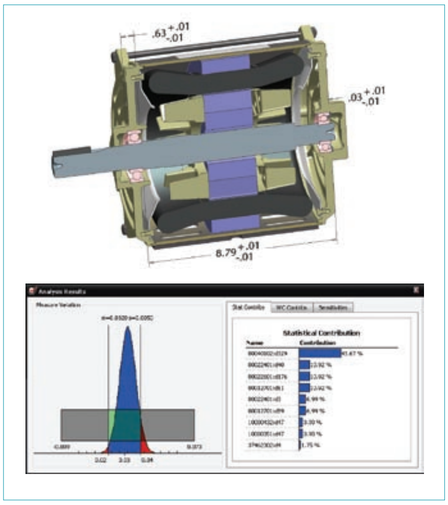
The impact of these errors, and countless others, can be devastating for a small or medium-size business. A look at the website of the U.S. Consumer Product Safety Commission gives you an idea of the extent of product recalls in the U.S. alone. One of the first recalls listed on Wikipedia, for 1959-60 Cadillacs, concerns a manufacturing defect. Wikipedia quotes the 1990 book, "The Struggle for Auto Safety" (Mashaw and Harfst), from page 150: "...steering linkage (pitman arm) failed on many cars while making a 90 degree turn at 10 to 15 mph (24 km/h)...the arms were made of metal somewhat softer than that usually employed to withstand the stresses of low-speed turns; and...General Motors had sold six times as many pitman arm replacement units during those years than during the preceding and succeeding years."

The Solution – in Four Steps

Because it touches on all facets of design and manufacturing, the effort to reduce scrap and rework must be defined and designed as a company-wide initiative.

It should begin with a commitment to full-digital product representation, and then evolve to encompass virtual prototyping and functional simulation; tolerance analysis and dimensional testing; and an information-dissemination workflow that runs throughout the business.

To a small or medium-size business(SMB), this goal may sound lofty – and expensive. But that doesn't have to be the case, thanks to advances in design and manufacturing integration, as well as today's out-of-the-box PLM (Product Lifecycle Management) systems for small and mid-size businesses. Here are the steps that many SMB's are using today to reduce scrap and rework in their organizations.



With PTC's Pro/ENGINEER Tolerance Analysis Extension, you can perform quick, up-front tolerance stack checking for critical dimensions.

Step 1: Full-digital product representation

Full-digital product representation means that all the digital data entered and/or generated over the product's lifecycle stays with the product throughout each stage of development – from initial concepts to final product retirement. That way, the same data used for the CAD model can be used for simulation and analysis, as well as for manufacturing, and for storage in the PLM vault.

Full-digital representation makes it possible to achieve end-to-end integration, so each step in the product development process is informed by the actions of other steps. For instance, in an all-digital environment, any and all changes in the CAD software automatically update the CAM file, and any change in a CAD or CAM application updates the data in the PLM data vault. With an intelligent PLM solution, this interaction doesn't cause undue stress to the PLM architecture because, although these functions give the appearance that multiple copies of each file exist, the reality is that just a single, central file is being created, updated, shared and stored at all times. The multiple views seen by different users are the result of repository pointers – or non-associative replications – and not by redundant data, and all changes and updates to the central file are managed by lockout and recovery mechanisms.

Step 2: Virtual prototyping and functional simulation

Today's products and assemblies, which are designed with many moving parts, demand strenuous testing for fit and movement. To ensure quality and performance, physical prototypes are essential, yet they can also be wasteful, since the prototype, once used, becomes scrap. Reducing – or eliminating – prototypes is every manufacturer's ultimate goal.

Full-digital product representation lets you replace some physical prototypes with virtual prototypes. Full-digital also means – depending on your 3D CAD software–you can "shrink wrap" your 3D model to a smaller, more manageable size, and email it to remote members of the design or manufacturing team, thus saving significant time and cost. Shrink wrapping cuts out non-essential data from the model, so you only share data that's pertinent to a specific role or function within the development enterprise. For instance, a manufacturer of automobile seats would want to use the body of your car as a virtual prototype, but might not care about the engine or drive-train components. With shrink wrapping, you send only the data they need (while also protecting your valuable intellectual property – i.e., the engine design – that you'd prefer not to share with the auto body manufacturer).

Step 3: Dimensional and tolerance analysis

Dimensional variation is always a key parameter in product design. Variation among parts can come from any number of circumstances. For instance, in Manufacturing, CNC drill bits may be sharper at eight in the morning than at noon, or the purity of cooling fluids may change from shift to shift. Also, in the end-user's environment, temperature extremes may trigger shrinking or expansion.

Setting tolerances is challenging because of the need to be cost-competitive. Tight tolerances may be good for the quality– or the "feel"– of the product. But too-tight tolerancing may prove too costly in terms of the time and the extra machining it requires. Ideal tolerancing is a matter of finding the best compromise between product quality and economics, and it's a critical consideration in terms of minimizing production scrap and rework. Accurate tolerance analysis is essential, and it's important that the tolerance values assigned to the model by the designer remain with that model as the product moves through the entire development process.

Step 4: End-to-end information dissemination

Engineering, Manufacturing, Procurement, Service, Sales, and Marketing – plus suppliers, customers, and design partners – should be able to share product-development information, where appropriate, and add their own value. Information-sharing is best accomplished with an information workflow that automates the movement of requests, queries, approvals, and other actions among the people who are most closely associated with your product-development process.

The workflow should contain alerts, alarms, and escalation levers to ensure that reviews or other requests do not go unnoticed. And the workflow should be tied-in with relevant product development processes, such as product validation and change management, that will contribute valuable information to the store of product-development knowledge.

Vendor Perspective: PTC's CAD and PLM Solutions

For thousands of small and medium-size businesses, PTC's Pro/ENGINEER® 3D CAD software is the starting point for full-digital product representation. Pro/ENGINEER supports industry standard 2D and 3D file formats, so it can serve as the heart of an end-to-end integrated digital architecture. Also, it supports numerous simulation and analysis modules natively, so you don't have to switch between different applications–and possibly lose track of key data – for testing.

PTC's Windchill® PLM architecture adds the information-dissemination workflow necessary to keep product-development data and manufacturing bill of materials (BOM) information current with all related business applications. And, PTC's an on-demand PLM capability lets smaller businesses take advantage of Windchill without making a significant up-front investment.

An example of a medium-size company that's using on-demand PLM to reduce rework is UK-based Eton SRF, a manufacturer of cooling systems for industrial, automotive, and agricultural applications. Previously, Eton's UK-based design teams used FTP links to exchange product design files with the company's manufacturing facility based in Turkey.

When Turkish manufacturing engineers made changes to the product designs, the changes weren't being recorded because no workflow existed to update the files of the UK designers. Consequently, the company had multiple versions of product and component designs in circulation, which caused frequent rework of designs and manufactured components. Eton, working with a PTC reseller, brought in Windchill® PDMLink® On Demand with change management for five users. Within one week, all important product data was controlled by the data vault; in the first month, rework was reduced by 75 percent, and travel costs between Turkey and the UK were reduced by 90 percent.

From Manual to Automatic

Not long ago, these issues – virtual prototypes, wide-ranging information dissemination, production scrap, and rework–were less than super-critical for businesses. Only a short decade ago, products were simpler, and product development processes were somewhat slower, such that workers had more time to iron out design flaws or manufacturing errors. Today, business is working within a tightly compressed, 24/7/365 world. In consumer and business-to-business markets, demand can change instantly, and new competition can emerge – with newer and more innovative products – overnight. Time-to-market is now measured in weeks rather than months or years, and any design flaws, manufacturing errors, or product-development inefficiencies are exposed quickly.

Production scrap and design rework are two such inefficiencies, and they can quickly put you at a competitive disadvantage if you're not working to continuously reduce them. Years ago, businesses could trust their product development information and processes to seasoned individuals – the designers who kept the drawings in the drawer, and the engineers who knew which ECOs applied to which parts. Yet for small and medium-size businesses to keep up with today's pace and competition, that trust must now be placed in the hands of digital product development – from "manual to automatic"– and the sooner, the better.