From the Freezer to the Autoclave and Beyond for Aerospace and Automotive composite manufacturing

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Introduction

Composite component or part manufacturers use a variety of software to support their key manufacturing processes. This is usually an evolutionary result of software purchased over many years of developing and improving specific processes. Individually, each software package may perform well according to its designated purpose. However, seldom do they perform well together, requiring expensive integration or manual intervention to transfer relevant data from one to the other.

Focusing on the areas of the composite component or part manufacturing processes, we discussed this situation with dozens of manufacturers worldwide. Management seems to be increasingly worried about these "blind spots" or "painful gaps" during the production process which tend to cause issues such as material and asset loss, increased WIP, and a lower level of Quality Assurance.

These gaps in process control are common in the areas of optimally selecting raw material from stock, monitoring the condition and tracking the position of raw material, monitoring the conversion of raw material into WIP kits, and tracking position of kits through the process. In addition, tracking of expensive tooling is an issue.

Gaps in process control are often bridged with extensive human intervention, further reducing the level of shop floor visibility, process control, quality

This whitepaper briefly discusses some of these challenges, and presents an alternative, holistic decision framework, that allows for increased visibility and process control as a basis for dramatic improvements of production efficiencies: from the freezer to the autoclave, and beyond.

The Gaps

Challenge #1: Tracking location and shelf-life of Raw Material and WIP Kits

A fundamental challenge presented to manufacturers is the **Lack of Real-Time visibility of Raw Material & Kit Inventory,** as rolls, spools and kits move in and out of the freezer given production requirements. Shelf life is also affected and needs monitoring.

*Whether roll-level inventory is managed within or outside the ERP, **there is rarely real-time data about rolls in use** and which kits are being cut from any given roll.*

This challenge is further complicated by the fact that many **ERP Inventory modules** are oriented by overall level of stock, and **do not track inventory at the roll or kit level**. In such cases, the inventory system lacks roll- or kit-specific properties such as length, width, shelf-life or expiration date. To enable roll- or kit-level management where missing, we have found numerous manufacturers utilizing ad-hoc methods based on Office applications such as **MS-Access, MS-Excel** or even paper-cards. These systems are detached from the real-time production environment and are error prone given the amount of human labor required to maintain them.
Beyond that, once rolls are cut into kits, tracking the kits' location and shelf-life is commonly managed through yet another system, often paper-based. This further denies manufactures the ability to relate kits to their 'parent' roll or rolls, track kits in real time, and act effectively should shelf life be in jeopardy.

Challenge #2: Optimally selecting raw material from inventory

Even with real-time inventory visibility (let-alone without it), **how does one know which roll, or rolls of raw material will optimally fulfill a given order or set of orders?**

In many cases, the nest required for a given kit is prepared in advance and pulled from a library of such 'static' nests every time the kit is scheduled for cutting. This nest was created via 'Nesting' software regardless **of the production realities such as actual order volume and inventory status.** As such, it considerably limits the flexibility of the manufacturer to optimally use its raw material, for example:

- if a given nest requires 8 meters of material, any rolls shorter than that will not be used, and neither would the order be split over two remnant rolls should they suffice to meet the demand;
- if two (or more) such kits are required that day, they will not be combined into a single nest, nor will the operator be able to pick a roll more suitable for two kits;
- and above all, there is no easy way for consolidating the above considerations with the ticking clocks of shelf-life and material expiration.

Challenge #3: Locating rolls, spools & kits in a large freezer

There is the practical difficulty in locating kits and rolls in a large freezer. Even with the ultimate visibility of overall stock levels and a better optimization framework, shop floor operators lack accurate information about the exact bin-location of a specific kit or roll and naturally lean towards the **"take the nearest one"** selection method. At freezer temperatures well below -20C (-4F) degrees, it is hard to blame them.

Challenge #4: Managing shelf-life and thawing processes of rolls & spools

And then, there is the challenge of managing material receiving and thawing processes while accurately monitoring in and out of freezer times. In many cases shipments of hundreds of rolls and ATL machine spools are brought to the receiving areas while operators start with a manual receiving process that includes applying barcode stickers before taking all items to the freezer. Thawing process is manual as well, the required material is taken out of the freezer and put on shelves. Many organization lose precious time and delay production due to lack of traceability and as a precocious measure they wait for 24 hours for the material to thaw.

Bridging the Gaps

Solving these truly complex problems requires suitable optimization software tools and processes that are based on three key principles:

1. **An Integrated or Holistic Approach:** integrating multiple data sources to maintain a comprehensive picture of inventory and production statuses. This picture is drawn based on robust interfaces with currently used systems such as ERP, MES and CAD, but also on internal modules where these systems fall short. For example, a fully-integrated RF/IR-based inventory tracking system that maintains constant visibility of roll, spool and kit inventory: their shelf life, specific bin-location inside the freezer and location on the production floor.
2. **Dynamic, on-demand optimization**: leveraging complete information in **real time**, optimal solutions are automatically presented to the various production dilemmas: as the production picture evolves, so does the solution.
3. **Automatic and quality-compliant:** Optimally 'crunching' this endless stream of broad-based information requires a robust set of software algorithms that can resolve these complex challenges in real time. Moreover, automating these decisions also saves tremendous amounts of labor and ensures optimal decisions are made every time.

Summary

Traditional software applications currently used to support manufacturing operations have several inherent deficiencies that limit the manufacturer's ability to truly optimize key parts of their production processes: CAD/CAM applications are typically used at the product/kit library level, as opposed to the business or manufacturing order level; ERP/MES software deal with work orders and their scheduling, but completely lack any information on the product design or the geometric shape of their parts; finally, inventory software rarely include or consider either geometric-part or customer-order information. **Thus, as existing software solutions do not integrate geometry, time and inventory considerations into one holistic decision framework, their ability to optimize production decisions in real time is greatly hindered.**

Addressing these challenges methodically and efficiently requires a dynamic and integrated optimization approach, based on close collaboration between the various teams involved (namely Engineering and Manufacturing), while bridging the gaps between the systems they use (ERP, CAD, PLM, MES etc.)