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Computer Aided Design for Formula-Based Industries

Formulating Higher Value from R&D Investments

Executive Overview

Software applications have drastically improved the productivity of design engineers in many industries, allowing them to achieve designs that were previously not possible with manual, paper-based processes. Today's complex products were simply not within the reach of engineers prior to the advent of software tools that relieved them of the labor-intensive, time-consuming activities required to develop and validate their designs. Computer Aided Design (CAD) has played a large part in stretching the frontiers of modern products. When many people think of CAD they immediately think of Mechanical CAD (MCAD). Today's advanced computer chips, however, could not have been realized without Electrical CAD (ECAD) software that enables chip designers to focus on innovative designs instead of manually trudging through hundreds of time-consuming steps. The essence of CAD is to provide a "*digital design environment*" in which engineers can rapidly develop, iterate and improve designs while reducing the manual effort that creates a barrier to product innovation. Without the advantages of CAD tools implemented over the last decade, the current market leaders in the automotive, aerospace and electronics industries would find themselves at a severe competitive disadvantage in today's market.

The essence of CAD is to provide a "digital design environment" in which engineers can rapidly develop, iterate and improve designs while reducing the manual effort that creates a barrier to product innovation

If CAD tools have enabled such great achievements in mechanical and electrical design, why haven't formulators been relieved of their design burdens? There is certainly a lot of low value effort involved in developing a formula. Formulating chemists should maintain detailed documentation of their design and discovery process in order to protect intellectual property. They must review and take into account detailed information about target product characteristics, raw material specifications, ingredient interactions, ingredient ratios, premixes, wet and dry weights, usage restrictions and formula cost. More importantly, the formulator must be able to quickly iterate their designs in order to manage the trade-offs among cost, product performance, formula stability and regulatory requirements. To support this process, chemists are often forced to piece together spreadsheets and other "*homegrown*" tools to help solve their problems. Without relieving the R&D formulator of the burden of manual or suboptimal processes, innovation will continue to be hampered, products will be released at a slower pace, and companies will fail to deliver fully optimized product designs. If R&D staff can be relieved of their design overhead, they can develop more iterations in a shorter time—resulting in faster development cycles and significantly more valuable products.

The parallel CAD tools for formula-based product development are beginning to gain broader acceptance. Tools for formula-based R&D have matured to a level that provides the equivalent value to what CAD provides in other disciplines, allowing the designer to innovate without consuming significant time performing burdensome "*grunt work*." CAD, however, is not the only tool used in successful R&D environments. The value of CAD increases significantly when integrated with Product Lifecycle Management (PLM) applications. PLM extends product information and business processes beyond the individual designer, allowing them to both collaborate and to leverage product innovation for corporate profits. PLM tools can also provide an infrastructure for companies to seamlessly enable downstream processes that translate the designer's ingenuity into profitable products. The success of CAD and PLM solutions in discrete industries such as Automotive and Electronics points towards significant value for formula-based industries, including Consumer Packaged Goods, Cosmetics, Pharmaceuticals, Food & Beverage, Specialty Chemicals and Paints.

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This paper outlines the results achieved by Revlon, Shiseido / Zotos, Pfizer and other leading companies that have utilized CAD software for formula-based product development, and provides guidance for similar manufacturers to achieve their R&D goals. Specifically, we review the success that these innovators have achieved, and highlight—via real life examples—the business value that CAD and PLM solutions can offer to formula-based industries across several key functions:

- To the formulator, chemist or product developer, PLM-enabled CAD provides an automated, electronic lab notebook, a set of useful design tools, a tool to collaborate with others, and a powerful information-finding tool.
- To R&D management, PLM-enabled CAD is a productivity enhancer, a window to view overall R&D activities, and a way to make business rules visible so formulators consider them early in the design process.
- To corporate management, PLM-enabled CAD is a way to ensure compliance and better manage IP assets at the source of corporate value.

Based on these interviews and the benefits that these companies have achieved, we conclude that successfully implementing a CAD for Formulation strategy unlocks a tremendous amount of business value in an R&D organization—and provides a means for companies to more rapidly harness innovation for profits.

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Why Computer Aided Design?

Computer Aided Design (CAD) tools allow designers to spend their intellectual energy on innovation instead of focusing their attention on the mechanics of designing. As ideas are developed, designers must document and further develop them into fully marketable concepts. The more fluid the innovation process, the more readily innovative designs can be achieved. CAD tools have relieved the burden of documenting a design idea, and have gone further to provide automated calculations and analysis to allow the designer to focus their attention on their designs. The ideal design tool must embed significant industry knowledge and become a natural part of the innovation process, enabling product advancements that were previously unachievable. In essence, what would have taken a small army of assistants to retrieve information, perform calculations and analyze designs should now be automated at the designer's fingertips.

Computer Aided Design tools allow designers to spend their intellectual energy on innovation instead of focusing their attention on the mechanics of designing

In the Automotive and Electronics industries, among others, CAD has already added tremendous value by allowing designers develop more novel designs and then rapidly iterate these designs to optimize key attributes such as cost, performance and regulatory impact. By reducing the effort of design tasks, CAD reduces the barriers to trying "*one more*" idea—the idea that might lead to a breakthrough. With the enhanced speed and efficiency afforded by design automation tools, designers can impact more projects simultaneously and develop and optimize more product variations on a single project.

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CAD tools drastically improve the speed and efficiency of creating new designs, and can help in the collaboration and error-free communication of designs to others in the company and the supply chain. Companies can manage and share digitized product information much more readily than paper-based documents. This is critical for global product development organizations. In addition, CAD tools promote a standard approach to documenting product designs, which facilitates the flow of information—so designs and results are less subject to interpretation, as when a project is transferred to a new designer or handed off to product supply.

Enabling the Chemist / Formulator

CAD tools have provided tremendous productivity gains to product designers in other industries. The term "*Computer Aided Design*" clearly means different things depending on both the industry and the type of design that is developed. Designers in different industries have different issues and needs – and require very different design tools. Simply put, different tools are required to develop an automobile versus a computer chip. In the formula-based industries, there are ranges of product development staff that must work together to develop a new product – including chemists/formulators, process engineers, technologists, managers, microbiologists, analytical chemists, packaging engineers, toxicologists, regulatory affairs staff, perfumers, flavorists, sensory experts, bio-physical testing experts and numerous others. The key differentiation that these product developers share is that they are working with formulas and recipes as opposed to mechanical components or circuitry.

Product designers, technologists and support staff are the source of intellectual property and value for the formulation-based industries, and require tools developed with their specific needs in mind

These product designers, technologists and support staff are the source of intellectual property and value for the formulation-based industries, and require tools developed with their specific needs in mind. The tools commonly used in these environments have been manual and have not worked well together. They were developed to solve point problems as opposed to approaching the formulation/product development/product launch challenge as a whole. These "*solutions*" typically consist of diverse, poorly integrated, "*homegrown*" tools, spreadsheets, electronic documents and paper-based forms. Dominick Bartenope is Vice President of Process Development and Technical Support Services for Revlon Consumer Products Corporation. Mr. Bartenope described the prior situation at Revlon (which is similar to the way many other consumer goods companies still operate today). "*We were working with a lot of software that didn't work well together*," Bartenope explained, "*It didn't add a lot of value*." There is clearly room for process improvement in companies that are running disconnected—and often misaligned—tools for formula-based R&D. Revlon's Bartenope indicated that the value of an improvement comes in the form of enhanced innovation. "*Having the right tools at hand expands the formulator's creativity*," he stated.

"We were working with a lot of software that didn't work well together, it didn't add a lot of value"
- *Dominick Bartenope, Vice President of Process Development and Technical Support Services Revlon Consumer Products Corporation*

Pfizer operated in a similar manner before adopting a new, integrated design solution. Speaking at Documentum's Momentum 2003 conference in New Orleans, Rose-Emily Calo, Associate Director of Document Management Services for Pfizer Consumer Healthcare, explained that Pfizer had "*highly innovative scientists around the world creating breakthrough formulations*" on disconnected systems, with "*no processes for sharing knowledge locally and globally*." She explained that this situation resulted in increased time-to-market and problems with retention of scientist knowledge. Calo stated that their automated environment using **FWS** (Formulation WorkStation) and **Documentum** allowed Pfizer to synchronize their innovation, scientists, formulations and processes. Ms. Calo detailed the impact this system has had on global development, citing as an example a Pfizer product development scientist who found she could create 15 variations of a formula along with required reports and paperwork in 20 minutes. On the old system, she reported, it would have taken her two full days.

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Manipulating Formulas

One of the more important needs for enabling a formulator is easing the manipulation of the formulation itself, such as changing ingredients, levels, phasing, processing or other production details. Rushi Tasker is Vice President of R&D at professional beauty industry leader Zotos International, a subsidiary of Shiseido. "*Formulators need to consider percentage and quantities for different size batches, weight-weight conversions, weight-volume conversions, pre-mixes*." Mr. Tasker pointed out, "*There is a lot of calculation, and it is prone to error*." Mr. Tasker continued by explaining that Zotos tried in the past to work with spreadsheets and other documents, but the limitations of these tools led to errors and resulted in wrong percentages and incorrect materials in formulations. Zotos then implemented a software solution known as FWS from Connecticut-based IMS Inc.—the same solution implemented by Revlon and Pfizer—and Mr. Tasker reports, "*The number of mistakes has come down to almost zero*."

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- Rushi Tasker, Vice President of R&D Zotos International

Small changes to a formulation can have far-reaching impacts that must be taken into account. A change to one ingredient may have significant cost, regulatory and performance impacts. Each change requires additional calculations to assess the impact on the net contents, labeling requirements and marketing claims such as "*mild*" or "*fragrance free*." An example of this is propagating a base formula of a cosmetic to create multiple color variations (i.e., shades). A simple "*find and replace*" approach to alter the pigment blends is not effective in this case, because the pigment changes will cause the balance of oil and water to change—resulting in unacceptable product performance or formula instability. Computer aided design tools that don't recognize the underlying chemistry and formulation science can't address this need, and result in a lengthy manual process to propagate the formula to new variations.

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Other complexities include multi-level and multi-phase formulations, where a change in a wet stage of production may alter the balance of ingredients or the total weight at a dry, post-processing stage, as is the case in a PocketPak™ film or a multi-layer tablet. An advanced application, such as the one used by Zotos and Pfizer can also automatically calculate formula changes from different perspectives, significantly reducing the time, effort and opportunity for error. For example, instead of being limited to changing the ingredient percentage in the wet stage of the tablet, the user can elect to alter the final (dry) composition of the tablet, allowing the software to calculate the required changes to the previous stages to derive the appropriate wet concentrations. These types of automated formulation capabilities allow the formulator to focus on results instead of fighting the design progress. Without design assistance, formulators often end up spending a significant amount of time in the lab making batches of non-viable prototypes—limiting their rate of innovation.

"We can duplicate formulas, propagate them, change the order of additions, change materials, adjust percentages—we just drag and drop"
- Cindy Moser, Group Leader of Haircare R&D Zotos International

Cindy Moser is the Group Leader of Haircare R&D at Shiseido / Zotos, and a user of the FWS software. "*We can duplicate formulas, propagate them, change the order of additions, change materials, adjust percentages—we just drag and drop*." Ms. Moser continued, "*Once the backbone formula is in, it is easy to manipulate and we can create a new formula in a minute*."

Comparing formulas and tweaking them is a major benefit to formulators that are considering multiple options. As they make changes, they can easily see the impact on product characteristics like labeling requirements and costs in real time—before they ever make the batch in the lab. As Revlon's Bartenope puts it, "*We can pull up what is in the formula, pull something out, add something in, and—bingo—we have a new formula*." Ms. Moser commented that Zotos has significantly reduced typos, miscalculations, product labeling issues and other errors. "*Before, we spent a lot of time 'fire fighting.' We would end up throwing things away, scramble at the last minute, and hold up production or change material listings*," Ms. Moser recalled.

Documenting Findings – Digitizing the Lab Notebook

Enabling the chemist can also come from removing paperwork and other obstacles to keep them "*on the bench*." Lab notebooks are intended to help protect intellectual property and document discoveries. In theory, the lab notebook would allow the formulator at any stage to review the iterations that led to the current formulation. They could pull up the previous iterations, sometimes five to ten or more, and very clearly understand each step along the path. Unfortunately, paper record keeping is far too time consuming and inefficient for most formulators to maintain every step along the way. Frequently, formulators will enter only the final, successful formulations in the notebook, resulting in lost history—assuming that formulators could effectively find the right information in their paper notebooks regardless of the number of iterations documented.

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Digitizing the lab notebook not only adds efficiency but also encourages the capture and reuse of more information. For Revlon, who also uses FWS, the documentation is created by the system automatically as the users create new products. It is as if each of their chemists has their own administrative assistant following them around capturing new intellectual property and keeping their notebooks perfectly up to date. "*The digital notebook allows the chemist to document the formulation from the very beginning, without doing additional work*," Mr. Bartenope explained, "*From the first time that a new ingredient is considered, we can track the history*."

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- Dominick Bartenope, Revlon

Digital lab notebooks also allow the inclusion of other documents, files and spreadsheets that are important to the development history. The electronic notebook can associate additional information with the formula, like stability reports, performance tests, fragrance briefs, final project cost estimates, packaging specs, product artwork, or even videos of commercials and other related information. "*By including additional attachments, we can store pilot batch results and batch sheets so there is never a question of what happened*," Zotos' Moser stated, "*It's not in a file drawer or floating around in a shared folder where we can't find it later, it is stored and linked to the formula forever*."

Having the Right Information at Hand

Capturing information during the design process is important, but enabling the formulator also requires providing access to a host of information beyond their own creation. Formulators constantly need to review ingredient information, regulatory impact and other information sources during their design process. If this information is readily available via live links to their digital workplace, they can continue with their innovation process unfettered. Otherwise, they must disrupt the creative process to stop and manually retrieve the necessary information.

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Many formulators have commented that even greater value comes from others in the organization being able to access up-to-minute formula design information directly from the central repository. This allows the formulator to focus on innovation and optimizing new product launches as opposed to dealing with the torrent of telephone and e-mail interruptions from coworkers that need access to product design information that reflects the latest changes.

Being able to quickly retrieve information significantly helps with productivity. Searching for a material by functionality, common name, description, trade name or other identifiers allows the formulator to find the information they need to make decisions quickly and with greater confidence. Whether they are looking for specifications, approval status, cost, regulatory data, formula attachments or even which formulas include a particular raw material, a centralized repository for R&D information—with the ability to store *both* structured data and unstructured documents—puts information readily in hand. Simple product structures, such as a bill of material, allow basic where-used inquiries; however formulators need advanced tools that consider overall formula concentrations, both "*as added*" and "*after processing*," including a complete breakdown of ingredients delivered within other ingredients and premixes.

Mr. Bartenope explains that they often need information about a third-party formula from a contract manufacturer, so Revlon has the vendors break these down into their associated raw material components and makes that information available to Revlon formulators. This empowers the formulators by providing the right information at the point of need, avoiding disruptions to the design process. Zotos' Moser describes the value of focus. "*With this type of system, I don't have to ask questions like 'Where do I find this information*?' or '*Who would know about this other data*?'—I can ask more important design questions instead of tracking down seven people that may or may not know the answer to my question."

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Enabling the R&D Team

Beyond enabling a single formulator, a computer aided design approach allows R&D teams to work more effectively together. Being able to retrieve information quickly is important, but only if the information is complete. R&D teams can't create as much value if they work independently and keep information to themselves. While there may be reasons to limit access to certain information, an enterprise CAD system should allow authorized users to quickly find and access current information that will impact their part of the project.

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Sharing Information

A computer-based approach to formulation makes information sharing practical. Paper-based processes don't allow the free flow of information among formulators. Building formulations on the computer in a global repository can help with this. At the Documentum conference, Ms. Calo explained that Pfizer previously had scientists creating formulations on floppy disks, and most of their product development documentation resided on paper. She explained that this fragmented their knowledge base at the local and global levels and made the access, review and approval processes problematic. In 2002, Pfizer rolled out FWS with Documentum as part of their "*TechDocs 2.0*" project. Hundreds of scientists globally use that system to access thousands of shared formulations, she presented.

Spreadsheets and other document-based approaches are not enough. Computer aided design for formulators requires a structured approach that provides a standard way of documenting formulations so they can be shared and analyzed. Zotos' Moser described how a central repository containing all formulations has helped to determine which formulas in production and under development are impacted by new regulations. She described how Zotos could now find every formula that contains ingredients containing a specific substance like *nonoxynol*, which can no longer be used in Europe, and to see which formulas may need additional information on the packaging. "*That kind of request used to take a four day search, it was bad*," Ms. Moser explained, "*That information is now at our fingertips*."

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In addition to the current formulation, all previous iterations of the formulation are also immediately available. A computer aided formulation approach can automatically capture the history of the formula for later retrieval. The first formulation is typically not the best, but neither, necessarily, is the last. Each step along the path to developing a formula provides new information and has value. Storing the final formulation provides some benefit, but capturing the process and the steps along the path can provide tremendous value to other product development groups or projects. While the plant and many other parts of the business only care about the final, released formulation, R&D can benefit from comparing different variations of the formula quickly and tracing the history of the formula. Getting to market more quickly requires avoiding the dead-end approaches that have already been explored—the problems that derailed previous formulations. Revlon's Bartenope explains that with a digital product history, when a processing problem occurs they can readily compare the formulation to another one to see what is different. "*We get a lot of insights by comparing formulas*," Mr. Bartenope explained.

Getting to market more quickly requires avoiding the dead-end approaches that have already been explored— "We get a lot of insights by comparing formulas"
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Managing the R&D Process

Computer aided approaches have removed the barriers to innovation for individual contributors. Beyond the individual, however, companies that have successfully adopted CAD have extended design automation beyond the realm of the individual to the team, and beyond the team to a corporate or even supply chain level. After all, to turn an innovative new formulation design into a profitable product, multiple contributors must work together.

As VP of Process Development and Technical Support Services for Revlon, Dominick Bartenope is responsible for managing the team—and the process—that creates ideas and turns them into products. Revlon's goal was to put in place what they called a "*platform*" to deal with work activities in R&D. By linking the people and activities together, they could work more effectively as a team and manage the product development process more effectively. "*We want to make sure there is no non-value-added work by the chemists*," Bartenope explained, "*so we keep the chemists on the bench, keep the engineers in the pilot plant, keep the analytical people working on the right raw materials and formulations—keep everybody focused on delivering maximum value*."

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Ensuring coordination and focus across the R&D team allows the innovations of individual contributors to reach their full potential by more rapidly and effectively developing them into launch-ready products. By focusing on the development process and making it more visible to the team, individuals can see the activity on their project and be notified when they are required to contribute. Coordination and visibility cannot be achieved without a common system, particularly in a large or distributed organization. Coordination provides value in the form of faster product development, and can eliminate rework and delays from poor communication. "*People are now aware of problems much earlier in the process*," Zotos' Moser describes, "*Hopefully we can catch it even before a batch is made in the lab, and we can avoid wasting time, effort, and resources*."

"The whole process is taking less time. We have accelerated the process of formula creation and formula approval all the way to releasing formulas from within R&D to the factory"
- Rushi Tasker, Zotos

Process automation also allows for process improvement. Zotos' Rushi Tasker described that by using FWS his organization was able to significantly streamline their development process. With the system, they removed two steps in the process through automation. "*The whole process is taking less time*," Mr. Tasker stated, "*We have accelerated the process of formula creation and formula approval all the way to releasing formulas from within R&D to the factory*."

Product Lifecycle Management – Profit from Innovation

Computer aided product design approaches have provided great efficiencies to both individual designers and R&D teams across many industries. Early adopters of CAD tools have also added another layer of value onto their early benefits. Product Lifecycle Management (PLM) extends the advantages of design automation beyond product design to achieve higher levels of corporate benefit.

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PLM leads to corporate value by extending design information and processes across multiple organizations and implementing consistent corporate processes and control. The value that PLM provides comes in many forms. PLM enables collaboration that allows people to work together more effectively to increase innovation and leverage it appropriately. PLM can also enable corporate initiatives such as strategic sourcing, eliminating undesirable raw materials for regulatory or "*green*" purposes, or reducing proliferation of raw materials that lead to increased inventory and overhead costs. In short, PLM has proven value in helping companies harness innovation for profits.

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PLM also provides value as the corporate "*repository*" for product information. The on-going success of a company is strongly linked to how effectively it can capture and leverage its intellectual property and product-related knowledge. Product knowledge is an asset that can only be effectively leveraged if it is shared with the right people, when they need it, and in a format that they can easily use.

Experience has shown that the format, level of detail and amount of product information needed varies by role. For example, R&D values access to all design iterations, including false starts, so they can be avoided in the future. They may also view a formula differently, such as on a percentage basis. Manufacturing, on the other hand, would prefer to see the recipe by batch quantity and potentially organized in a way that better reflects the production environment as opposed to the lab. This could include formulas broken into multiple phases or sequences, specifics about premixes, process instructions or safety data sheets. Although the view may be different, everybody is working on the same information for consistency.

Whether the intellectual property is being used to develop a new product—or manufacture and market an existing one—better creating, capturing, standardizing and sharing product information helps corporations leverage product knowledge for profit.

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Collaborating Outside of R&D

Another key benefit of PLM is collaboration. Tools to enhance collaboration are critical to improving the product development and product launch processes. Many consumer goods companies, for example, have global R&D organizations. Collaboration can involve direct collaboration, such as taking advantage of design skills in different geographical locations. For any given challenge, the right resource may not be in the same country—or even the same time zone—as the primary formulator.

PLM allows design sharing that lets companies leverage the right skills without regard to geographic boundaries. Not all boundaries are geographic, of course. PLM also allows R&D teams to selectively share design information and specifications with suppliers or customers that might be able to make critical contributions to a formulation. Without digitized, standardized specifications, the ability to collaborate is limited at best. Rushi Tasker of Zotos put it simply; "*All of our formulations in Word were useless, and raw material specs were the same way*."

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Collaboration can also add value by sharing information and linking processes with downstream functions. Consumer goods companies must translate formulation information into many different forms, including region-specific product labeling and regulatory documents that need to be generated. Mr. Tasker explained that product information packages for the European Union were a particular challenge. Zotos had to collect all of the required information about a formulation. "*The information existed, but it was all over the place*," Tasker said. "*Some data was with the chemist, some was in files, and some was elsewhere. Regulatory people had to run around to pull it all together—we wasted too much time tracking down the right information*." A properly designed PLM approach based on FWS 7i and Documentum provided Zotos a solution to this challenge.

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- Rushi Tasker, Zotos

Protecting (and Leveraging) Intellectual Property

Digitizing formulation processes and having information readily available enable the individual formulator and provide clear value to the R&D team. When viewed from a PLM perspective, digital design information also provides corporate level value by aggregating, documenting and protecting intellectual property (IP). Researching innovative new products takes a significant corporate investment of time and money. Unfortunately, the returns from these investments are not being fully realized in many cases because the sole focus is on getting the new products launched—and there are no systems to facilitate the aggregation and reuse of IP. As a result, IP is an asset that is not well managed in many R&D organizations.

Researching innovative new products takes a significant corporate investment of time and money. Unfortunately, the returns from these investments are not being fully realized in many cases because the sole focus is on getting the new products launched

There is a tremendous amount of knowledge in an R&D organization, but it is often stored only in the memories of a few key individuals and not readily accessible to others. This people-dependent approach results in companies reinventing solutions to problems that have already been solved elsewhere in the business.

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Leveraging IP can offer accelerated product development and save significant cost. On the other hand, the inability to find and utilize information costs organizations both time and money. For example, a product idea that was discarded based on a characteristic that was not ideal for one application may end up being perfect for another project. The previous project may have progressed through multiple stages of discovery and testing that can simply be reused and applied elsewhere.

Unfortunately, it is often so hard to find out if there is any relevant IP that can be reused—let alone be able to retrieve it—that companies start from scratch and squander good opportunities to leverage existing development work. In theory, paper lab notebooks protect IP and make it available to the corporation. In practice, this is simply not the case. "*Paper notebooks are useless things, in my opinion," Zotos' Tasker explains*, "*They are black holes that you put in information that nobody can retrieve. We have had notebooks going back to the 1920's, and nobody has looked at them, because finding the information you need is too difficult*."

"Paper notebooks are useless things, in my opinion, they are black holes that you put in information that nobody can retrieve"
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There are two key challenges with saving research ideas and then utilizing them in the future. The first challenge is being able to find the information, which paper processes or even digital documents stored in shared folders will not help. The other is providing the right information. When researchers are working with paper documents, they will typically capture the end results of their work. The final formulation may be clearly documented, but what is lost is the history and context. Capturing knowledge means not just capturing the final results, but also capturing each step in the often difficult path that was taken to achieve them, including the dead-ends and pitfalls which represent an important portion of the product knowledge.

If documenting findings is seen as additional work by the formulator, researchers will not document decision-making processes, but just the final decisions. Worse yet, they may just document the results of the decision. With a digital approach, each step of the journey can be stored automatically—without burdening or delaying the formulator—and stored in a common way so that it can be readily retrieved for future projects.

"*With our digital solution, product design information from the past can readily be accessed and utilized to avoid retracing old ground, repeating the same mistakes, and reinventing the wheel*," states Revlon's Bartenope, "*It provides a memory bank to hold everything*." "*We now understand the history of the project, how we got from point A to point B*," Zotos' Moser adds, "*We are now able to leverage what would have been lost knowledge, it was a big issue*."

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- Dominick Bartenope, Revlon

Compliance

Another major issue for large organizations is promoting compliance with governmental, international and corporate regulatory guidelines. Non-compliance can have major impacts on a business, ranging from publicly visible fines and damaging product recalls to more mundane—but potentially costly—problems like throwaway costs from incorrectly labeled packaging. While some regulatory issues are "*events*," many opportunities go by without much noticeable attention; a common example is the inability to expand a formula to a new geography because it includes an objectionable ingredient for that region. This non-compliance could easily have been avoided during the original formulation process. Compliance requires a centralized approach, and responsibility can't be placed solely on individual formulators. "*We can now automatically flag restricted materials so we can take them out, or at least ask questions*," Zotos' Moser commented, "*In the past, we weren't catching all of them*." That can be a costly mistake. "*We were using ingredients and formulas without proper review and approval*," Revlon's Bartenope said, "*It would get to the factory, and we had to throw it out*."

Compliance requires a centralized approach, and responsibility can't be placed solely on individual formulators

Regulatory compliance is important beyond the initial product launch and must be monitored throughout the lifecycle of a product. Materials are being reviewed and de-listed from geographies on a weekly basis. Enhanced public attention regarding animal testing and potential allergens in raw materials has brought about newer legislation such as the European Union's 7th Amendment which, among other requirements, forces companies to identify potential allergens in their products, even where the allergen may be a trace component of the product fragrance. This requires a precise knowledge of the overall formulation and the composition of each ingredient within the formulation—or formulas within formulas.

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- Cindy Moser, Zotos

Revlon described that they previously calculated the master list of ingredients (MLI) for their products manually. Revlon has now automated this process via FWS, and the MLI now has the precise breakdowns of materials—including full breakdowns of purchased multi-component ingredients. This insures that the ingredient statements are completely accurate—that they are created identically regardless of the operator, and that the nomenclature is kept up-to-date based on a centralized raw materials database.

"Now, we don't add a material that is being phased out, or on regulatory hold, because rules in FWS warn the formulators and prevent them from making mistakes"
- Dominick Bartenope, Revlon

It is important to remember that not all compliance issues are regulatory. Corporate requirements, like the desire to consolidate the number of raw materials procured—or at least manage proliferation—must also be addressed. A digital approach can help by incorporating regulatory requirements from multiple legislative bodies with corporate guidance. "*Now, we don't add a material that is being phased out, or on regulatory hold, because rules in FWS warn the formulators and prevent them from making mistakes*," Revlon's Bartenope says, "*Formulations now comply with the business rules—not just anybody's rules—the rules commonly agreed to throughout Revlon*."

CAD or PLM for Formulators?

Properly implemented digital design processes help enable designers to enhance innovation, while concurrently channeling innovation for corporate growth and profit. But which is more important for corporate value—a PLM-enabled product development environment (Formula CAD) or a corporate PLM backbone? Both are important, and which area needs greater focus depends on the business being discussed.

It is critical to select a PLM tool that doesn't burden the innovator—or you will end up with less innovation to leverage

To be effective, implementing automated design and development processes requires a balancing act. A PLM-enabled product development environment can help improve the design process and therefore create more innovation value. A corporate PLM backbone can leverage that innovation to provide greater profits to the business. However, it is critical to select a PLM tool that doesn't burden the innovator—or you will end up with less innovation to leverage. Some early PLM initiatives were developed with the expectation that designers would spend *additional* time entering information into the corporate PLM backbone or "*feeding the system*." Not surprisingly, those approaches did not work because of poor adoption rates.

On the other end of the spectrum, a CAD or formulation authoring tool that is not PLM-enabled does not offer the ability to share information and work better across R&D and the supply chain. Non-PLM-enabled CAD may help with authoring a formulation, but the resulting design information is not available to others and often doesn't make it off of the designer's hard drive.

While many PLM initiatives start with enabling the designer and the R&D team, the initiative should also be designed up front to support corporate PLM needs. Ms. Moser explained that at Shiseido / Zotos, discussions started around implementing product development software and electronic notebooks, and interpretations about what that meant. Ultimately, she explained, that led to an integrated package—FWS—that provided both formula-based CAD and R&D-centric PLM capabilities.

Computer aided formulation is valuable by itself but it has to understand the bigger context of product development or it will not provide full value

CAD, or in this case computer aided formulation, is valuable by itself but it has to understand the bigger context of product development or it will not provide full value. PLM-enabled CAD for formulation solves the product designer's problem of discovering the best possible formulation. It provides value from many perspectives. To the chemist, it's an automated, electronic lab notebook, a set of useful design tools, a tool to collaborate with others, and a powerful information-finding tool. To R&D management, it is a productivity enhancer, a window to view overall R&D activities, and a way to make business rules visible so formulators consider them early in the design process. To corporate management, it is a way to ensure compliance and better manage IP assets at the source of corporate value.

A corporate PLM backbone also provides significant value. It extends the resulting IP across organizational and supply chain boundaries to make a profit for the business. PLM promotes information sharing and coordination of product-related processes and information across all of the players in the value chain. It can help manage multi-functional views of development projects and new product introductions, as well as provide a centralized repository of product information to ensure consistency, compliance and better IP management.

PLM without the CAD for Formulation inside, however, does little to increase innovation at the bench level—where the IP comes from in the first place

PLM without the CAD for Formulation inside, however, does little to increase innovation at the bench level—where the IP comes from in the first place. One critical point that bears restating, PLM must not impose heavy constraints on the innovators or it will not be adopted.

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- Dominick Bartenope, Revlon

"*At first, our chemists didn't want a system, they were focused on opacity, drag on the skin, and other product performance characteristics*," Revlon's Bartenope explained, "*But we have won them over by giving them the tool that they wanted to help them innovate, and develop better formulas with less effort*." Business rules should take a respectful view of the formulator, by providing reasonable constraints where they need to be followed, but not forcing strict compliance during the very early design phase, where creativity reigns. After all, a new material might be just what is needed to perfect a product, but it should not be added without consideration to the impact. "*You have to give the chemist some artistic leeway to achieve innovative products*," Zotos' Moser explained, "*That will always be necessary*."

CAD and PLM for Formula-Based Industries

Both CAD and PLM tools provide value for developing and launching successful formulations. For formulation-based industries, it is sometimes hard to draw the line between what is "*CAD*" and what is "*PLM*." Each business needs to review their R&D needs and current infrastructure to determine what will provide the most value. Some companies have already invested in a corporate PLM backbone that helps spread information to the supply chain, but doesn't meet the formulation-specific needs of R&D. In those cases, strong computer aided formulation tools to enable innovation at the formulator's bench can add significant value to the overall product development process. For this to be effective, however, the CAD system must be designed to work in an overall PLM context and not simply be a tool designed for a chemist to work in a vacuum. The inability to work in a broader context is one of the fundamental issue with using spreadsheets. For companies that don't have a PLM infrastructure in place, a PLM-enabled Formula CAD system to document and manage R&D information may be the best approach. The important thing is to make sure that the right processes are covered in order to generate new IP and leverage it appropriately for the business.

Both CAD and PLM tools provide value for developing and launching successful formulations

Fortunately, both PLM-enabled CAD and PLM tools are available for formulation-based businesses. Early formulation tools were purely focused on the formulation, but didn't understand the full context of the formulation decisions being made and didn't provide the ability to collaborate or share information. Early PLM tools often did not have an understanding of the chemistry involved in a formulation-based product, and therefore didn't support the formulator—in fact they added additional work—and were not able to promote compliance and proper IP management. What was lacking in early generations of CAD and PLM for formulators was the combined understanding of chemistry, new product development and downstream corporate needs.

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Revlon, Shiseido / Zotos, Pfizer and many other leading formulation-based companies have found value in PLM-enabled CAD solutions such as FWS that are chemistry and formulation aware. Revlon chose to work with their solution provider because "*IMS understands the science behind the formulation—and also the business*." "*FWS allows our new formula development process to work very effectively*," Revlon's Bartenope commented, "*We now work in an environment of order as opposed to chaos and innuendo*."

"Things that took 20 to 30 minutes are taking 5, things that I do routinely that used to be labor intensive, like releasing a product, I can now make a change and reissue in 5 minutes
It is comfortable, it works, and I love it—you can quote me on that"
- Cindy Moser, Zotos

Others using the FWS solution provided positive feedback as well. "*From the personal side, things that took 20 to 30 minutes are taking 5. Things that I do routinely that used to be labor intensive, like releasing a product, I can now make a change and reissue in 5 minutes*," Zotos' Moser explained. "*It is comfortable, it works, and I love it—you can quote me on that*," she concluded. Zotos' Tasker provided the management perspective, "*We will get to market faster by a month*," he stated confidently.

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Summary

As one Revlon executive explained, "*These tools are catalysts to better things. Better formulas. Better management of formulas. Better management of your whole business*." Many industries have benefited from enabling designers to do more by giving them the tools that allow them to focus on their product design as opposed to the mechanics of the design process itself. By removing burden from the designer, they have allowed for more innovative and effective product designs. They have gone further to expand this value across their organizations and their supply chains—to leverage new product designs to improve their profitability.

"This is a must-have if you are going to continue to progress in this industry, if you want to maintain status quo, you don't need it. Remain slow, have errors, put out the fires, do the re-work"
- Rushi Tasker, Zotos

These tools are now available and proven for formula-based industries. Companies that fail to empower their formulators will continue to suffer from intellectual property value leakage and mediocre, lower value product designs for their investment—and those that fail to aggregate and leverage that IP will face lackluster business performance and risk missing breakthrough opportunities. "*This is a must-have if you are going to continue to progress in this industry*," says Zotos' Tasker, "*If you want to maintain status quo, you don't need it. Remain slow, have errors, put out the fires, do the re-work*."

Recommendations

- All companies must find more effective ways to harness product development and intellectual property for corporate value.
- Formulation-based industries must enable R&D and formulators with strong PLM-enabled design tools that provide them the information to make the right decisions and automate and accelerate formula design.
- PLM initiatives must work within the R&D environment by automatically capturing information as a part of the natural innovation process to avoid burdening the innovators.
- Spreadsheets and shared folders are no longer enough to fuel the speed and throughput requirements to remain competitive in formulation-based industries.
- New regulatory demands like the European 7th Amendment demand new software capabilities to achieve compliance—and dictate that formula CAD tools provide better control and visibility to design constraints early in the process.
- Packaged, proven digital design solutions—PLM-enabled CAD—are available for formulation-based industries; Few companies, if any, should consider attempting to build and maintain their own system.
- Understand the needs and opportunities for your business, and then select the appropriate PLM-enabled Computer-Aided Design Environment, Product Lifecycle Management backbone or combination of solutions to provide the most value to your business.
- As a first step, strongly consider the use of a PLM-enabled CAD tool as an R&D-centric PLM system that allows your company to enhance innovation, collaboration and compliance—and significantly reduce time-to-market.
- Select a system based on open standards such as XML (eXtensible Markup Language) that can integrate easily into a corporate-wide PLM backbone as needed.
- Take action! Digital design processes have proven to be a disruptive technology in other industries. Begin exploring these tools, and develop a "*PLM Program*" that addresses the broad CAD and PLM needs of your business, but achieves that value through incremental projects that individually provide a return on investment—and also fit into a larger, highly strategic PLM vision.

About the Author

Jim Brown has over 15 years of experience in management consulting and application software focused on the manufacturing industries. Jim is a recognized expert in software solutions for manufacturers and has broad experience in applying enterprise applications such as Product Lifecycle Management, Supply Chain Management, ERP, and Customer Relationship Management to improve business performance. Jim began his professional experience at General Electric before joining Andersen Consulting (Accenture), and subsequently served as an executive for software companies specializing in PLM and Process Manufacturing solutions.

Jim is the president of Tech-Clarity, a research and consulting firm dedicated to making the value of technology clear to business, where he is a frequent author and speaker on applying software technology to achieve tangible business benefits. Jim also serves as the PLM Analyst for Technology Evaluation Centers and The PLM Evaluation Center.

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