CASE STUDY: USER ADOPTION OF A PRODUCT CONFIGURATION MANAGEMENT SYSTEM AT A MODULAR PLAYGROUND EQUIPMENT PRODUCER

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Abstract
Product platform and product family strategies place tremendous demands on the efficient capture, storage, and retrieval of information in the form of product data. The user’s adoption of an information management system for product families and mass customization is critical for allowing the system to perform as it ought. The following is a case study at a major modular playground equipment producer undergoing the implementation of a new graphical-based configurator for managing its mass customized products. The case study examines the proliferation of software packages to perform configuration and the flow of information in the configuration process. Next, the new configurator is evaluated on its new features to capture, store, and reuse configurations and its visual appeal. Last, the paper addresses the personal behaviors and training methods used for increasing adoption and their success.

Keywords: mass customization, playgrounds, user adoption

INTRODUCTION

The successful configuration of engineered modules to create a customized product is typically addressed by computer configurators. Numerous configurators exist on the World Wide Web for validating the configuration of cabinetry, landscaping elements, clothing, paint colors, and more. Product configurators have the potential to be much more, however. As a design tool for engineers, product configurators can make the leap to being configuration management systems applicable to the leveraging product platform strategies. Shooter et al. [1] elaborate on this potential in their discussion of platforming, customization, and configuration agents in an information management infrastructure for product family planning and mass customization. As they describe, a configuration management system must interface with product information at the front-end and generate quotes/reports for branches in manufacturing at the back-end. It must also enable designers to capture, store, and reuse configurations with revisions. Ultimately, the ability to quickly and efficiently model modular assemblies will enable designers to create new product family-derived products and deliver them to market with alacrity.

The vision of a product configuration management system has not fully arrived yet on the commercial software market. While there exist product configurators and a large assortment of Enterprise Resource Planning (ERP), Product Development Management (PDM), and Product Lifecycle Management (PLM) software [2], no turn-key software package (at the time of this paper) has successfully integrated functions information capture, storage, and reuse across an enterprise with product configuration. An advanced configurator recently implemented at Playworld Systems, Inc. comes close to achieving this, but not without a number of human factors issues to address.

As research steps toward such a system, is it critical to take note of the high user rejection rates experienced with large-scale enterprise software implementation projects such as ERP, PDM, and PLM [3]. The goal of moving proactively toward eliminating features and structures that cause rejection and highlighting those that promote adoption should be placed top priority. Rejection caused by a mismatch between organization, its employees, and technology appears in many forms [4]; all-inclusive theories of adoption have come up short because they failed to address the high sensitivity to context inherent in issues of adoption. To better understand issues of information
management system adoption and implementation, and in particular that of an early configuration management system, the advanced product configurator at Playworld Systems was examined as a case study.

MODULARITY AND MASS CUSTOMIZATION

Playworld Systems®, Inc. is a major producer of modular playground equipment of about 300 employees located in Lewisburg, PA. Playworld’s products include modular playground equipment, climbing rocks, skateboarding parks, exercise trail stations, and site amenities (Figure 1). This case study focused on the Playworld™ brand of playground equipment for children ages 5-12.

At a quick glance, the product offerings include a variety of slides, upper body events, climbers, crawl tubes, railings, panel activities, swing sets, site amenities, stand alone stationary scenes and vehicles, rock walls, trail way exercise stations, and skateboarding ramps and rails (Figure 2). Components are designed to be mounted into the ground individually or mounted to an infrastructure of posts and decks (Figure 3). A few components are available in both versions. President Matt Miller told the US Business Review [5] in July 2005 that, “the regulations and guidelines are improving safety, but they're making it harder for companies to differentiate their products. As a result, we are developing our mass customization capabilities.”

Customers choose play components and their colors, the width of the components, and the overall height of the playstructure. Many preconfigured choices are already photographed in the catalog. Width of the components is specified at either 36” (‘Explorers’) or 48” (‘PlayMakers’), and total structure height can be 0-3 tiers. About 40% of customers opt to order a preconfigured playstructure with no modifications (except color). Choices of color are limited to standard paints denoted in the catalog. Another 40% of customers use a preconfigured playstructure as the recipe for making small modifications. The remaining 20% of customers specify a playstructure completely from scratch. The customer’s design is modeled by a member of the Technical Sales department to ensure safety and feasibility. In the process, Technical Sales initiates the entry of components into the production system.

Given that the playstructures are all customizable by height and component width, budgets and safety concerns should not be limiting factors in purchasing the “dream playground.” For instance, the same components are available for children at the lower end of the 5-12 year age range, suited for the Explorers 36”-width as at the upper limit of the age range, as in PlayMakers 48”-width. Also, because there is less material, Explorers can be a better choice for customers with limited budgets. But, the challenge in offering so many options is managing the number of degrees of freedom the customer is allowed to have. The decks that comprise the infrastructure are
manufactured for equidistant length on each side, therefore the customer cannot place a request for a playground that was 90% PlayMakers and 10% Explorers (as in Figure 4).

**IMPETUS FOR CHANGE**

The framework for designing, configuring, and manufacturing customized playstructures requires a considerable amount of expertise and information sharing between Playworld’s employees. In its fifty year history, necessary knowledge has been shared by close working relationships between individuals. However, as the company grows and the product catalog expands, Playworld is less able to continue working in this way. A variety of software packages have been implemented to assist employees with information capture and sharing. Many of these packages do not interface well with each other, leading to a complicated cycle of product information transfer that mixes paper documents with digital records and frequently requires intermediary software applications. This lack of interoperability is a common problem [6]. To further illustrate the issue, the severity of the problem is illustrated in Figure 5 as a Software Divergence Matrix (SDM).

The SDM shows the number of individuals who have hands-on time with one or more pieces of software in order to complete a task. The software applications are arranged chronologically by column; the tasks are arranged by row. The last column indicates information transfer that occurs on paper. A bolded, italicized value (appears in white lettering) denotes the number of individuals using the specified software application who work in different departments; otherwise the integers represent the number of individuals in the same department.

![Figure 5 - Current software divergence matrix, showing tasks in rows, methods information capture in columns, and number of affected individuals in cells](image-url)

![Figure 6 - Idealized Software Divergence Matrix](image-url)
using the application. The severity of an information flow problem is demonstrated by the physical distance between any two marks in a column and the value of the number.

Ideally, the matrix would only consist of one column, representing a case where everyone uses the same piece of software. At a microscopic level, it would be evident that the one software system actually consists of individual modules that deliver information through standard interfaces. Consequently, the new SDM at the micro level would show values on the diagonal only, as in Figure 6.

At Playworld Systems, no one system has been able to integrate all areas of the company starting with the abstract formation of ideas and following through to product development, order configuration, scheduling, and production. Despite the abundance of software applications, 13 of 24 (54%) tasks still require information to be documented on paper and imported to another application. Improvements are being made currently to eliminate this pattern, and among them, a new software application has been selected to assist in the configuration and ordering of playstructures.

INFORMATION FLOW IN TECHNICAL SALES

It has been observed that Technical Sales and Order Entry departments, in particular, report the highest number of paper transfers and the highest number of software applications. Technical Sales models configurations and generates a bill of materials (BOM) on paper, then transfers the BOM to the Order Entry department where three employees manually re-enter the order information into the enterprise system. Order Entry is also responsible for ensuring that a ship date is assigned to each order by the manufacturing group.

The flow of information, extended from the SDM, is illustrated in Figure 7. The primary conduit of communication was a batch of paper folders that are physically carried through the office building. Furthermore, the folder originated and returned to the Order Entry department (loops 1 and 3), though the majority of time in preparing the quote was spent in Technical Sales (loop 2a). Once the quote received a ship date from manufacturing on the ground floor, it came back to Order Entry to be routed to Technical Sales. The papers were read by a coordinator who logged the request for a quote into a database log book. The quote work was then distributed to individuals in the department (one quote per individual). Individuals interfaced with AutoCAD, a generic text editor, the company’s in-house management system, and the ERP system just to generate a 3D rendering of the playstructure and the BOM listing component colors. One individual always had the task of transferring all the 3D Pro/E solid component models to 2D AutoCAD wireframe models whenever a new project was launched.

This year, Playworld has implemented a new software application nicknamed LUCI, short for Lucidity. The name indicates the high hopes that Playworld Systems has for cutting down some of the runaround. The revised information flow map is illustrated in Figure 8 (the gray shaded area indicates the portions of the software application that were operating at the time of publication.) One of the biggest improvements to the information flow with the new application is the integration of product color information which eliminates the need to route the BOM through a text editor. Additionally, LUCI accepts 3D solid models, eliminating the transfer of product information through AutoCAD. A screenshot of the system is provided in Figure 9. Lastly, all the information transfers are done digitally, curtailing many of the extra information transfer cycles once needed to capture and reuse information documented to paper. Improved digital archiving and transfer is particularly advantageous for finding archived preconfigured playstructures that have been slightly modified in the same way repeatedly over the years. This is explained in more detail in the section “LUCI’s Design Finder” on Page 7.

Despite these improvements, however, it is still necessary to examine the human factors criteria for adoption of the new application (i.e., new features, task compatibility and personal behaviors). These criteria are evaluated in the next section.

TASK COMPATIBILITY

LUCI’s new features

By virtue of being a single system, LUCI is able to unobtrusively manage data and information more closely than the old process of passing information through five formats (paper being one). Whereas the old system had limited traceability of documents, LUCI’s digital formats record, for example, designer name, project status, and the date the file was created/modified/reused. Additionally, LUCI is able to monitor the sales behavior of regional representatives including the packages they quote, the percent deviation from the suggested retail price, and with what frequency these variations occur. The coordinator has immediate access to this data on a dashboard. The same fields appear in the designer’s view, but the values are locked down and not accessible for editing. There are improvements to LUCI that eliminate the need for the designer to have an extensive knowledge of the products and the industry. In effect, LUCI eliminates the need to have a large amassed expertise. This is evidenced by the fact that a new hire with no computer design or playground experience, but some other computer skills, was able to learn the program on the job within a few weeks. Playworld’s pride is its adherence to safety standards and several designers maintain certification with the playground safety board. With LUCI, however, the fall zones around components which minimize the danger of collision with a second child or component are automatically drawn into the configured system. Intersections between the fall zones can be easily spotted and corrected. Secondly, the components are imported with all the support hardware including the safety hardware. Other standards can be checked as well. In a special
Figure 7 - Information Flow at Playworld Systems before LUCI implementation
Figure 8 - Information Flow at Playworld Systems following LUCI Implementation

Figure 9 - Screenshot of the LUCI configurator
field, the designer can click on the standard in question and all the components will temporarily change color to indicate components that pass, those in question, or those that fail.

**Visual Appeal**

The visual effect of the configured playground with LUCI makes revision less difficult. The color palette is customized for each component, eliminating the chance for a fully configured system to appear in the graphic environment with an inappropriate color scheme. Soon, a redline tool will be functional, too. It has been seen that the quick 3D rendering makes it easier to spot configuration and color problems that are difficult to catch in 2D sketch skeleton view (AutoCAD). Now this tool will allow supervisors to further verify the design on screen without requiring hardcopy. Even after the colors and safety features have been settled, though, the playground still needs aesthetic customer approval. With the old AutoCAD procedure, the 2D playground model had to be rendered in 3D, printed, distributed to representative and customer (countless quantities of scans, prints, and mark-ups), and returned to the designer to make changes before production. Now the files are stored online with immediate global access to all the representatives. The long process has been cut to just one day for customer revisions.

The renderings can be more visually attractive to customers. The GUI enables cameras and lights to be arranged around the playground using drop and drag techniques. These tools will be of particular interest to the marketing and publications department since they can highlight special areas that might otherwise be overlooked. The renderings are easily saved to standard image formats and uploaded into presentations and web content. The image quality is satisfactory up to about 44x34 inches.

**LUCI’s Design Finder**

There are links to reports and to the quote package. Of particular interest is the link to the Design Finder, a database of previously configured systems. Until the introduction of LUCI, the process was done completely manually by scrolling through a file of digital pdf’s listing part numbers. The only allowable modification was changing the customer’s name, thus the pre-existing configuration had to be a 100% match with the desired system. Otherwise, the partial compatibility between configurations would be unusable, up to 99%. Design Finder enables designers to retrieve pre-existing designs in their native 3D format and make modifications on-the-go. The Design Finder will require time before it is operational, however, since all the designs already stored as pdf’s need to be added to LUCI’s database of “predesigns.” One individual was given the job of doing this and found it difficult since some components necessary for the design were missing from the digital catalog (like Slither Slide).

This type of reuse happens frequently. Up to 80% of the Explorer’s family, from the PlayDesigns® brand, is predesigns selected from the catalog with no modifications. 14% are predesigns with modifications and only 6% are entirely new designs. In the Playworld™ brand, those numbers drop to 40% preconfigurations with no modifications, 20% preconfigurations with modifications, and 40% from scratch. The most likely explanation for this tendency is that the PlayDesigns® systems are smaller in size and serve a market that is smaller in number. It is less likely for a young childcare center that serves 100 children to invest the time in custom design that a major elementary school with an enrollment of 1,000 students. What’s more, the larger playground will encounter more competition for space and thus see a greater desire for a custom design that maximizes what space has been won. Indeed, the recently updated Playworld Systems webpage encourages customers that, “I live in a wonderfully diverse world. Different play areas have different needs. Each playground has its own requirements, and “cookie-cutter” playground designs simply can not address these individual needs. Playworld’s products are designed to meet the unique needs of virtually every play area in the world.”

**Success of Implementation - Software**

In the first full week, two quotations successfully passed through the LUCI information cycle out of a total 10-20 estimated quotations. The slow start was caused by the complexity of Playworld’s most popular and unique product, the Slither Slide (Figure 10). The slide is formed by configuring left bends, straight passages, and right bends into a customized slide that can fit 48", 60", 72", 84", 96", and 108" decks. Each segment has its own part number. When LUCI went to launch, bugs still existed in the rule schema for configuring this product. One of the improvements that LUCI makes over the AutoCAD configuration process is its ability to directly output a digital list of part numbers. Thus, with this function inoperational for the Slither Slide, it was impossible to complete many of the orders in a week. A chain of straight segments was operational but a chain of bends and straights caused problems.

The IT department at Playworld and View22 were sharing the burden of fixing the bugs in the program. The individuals using LUCI forward the requests for fixes to the Technical Sales Coordinator who communicates with IT or View22 to fix the problem. One individual reported that as time goes on, View22 and IT are getting faster at fixing the bugs. An Order Entry and Configuration Kaizen event was tentatively scheduled to address issues in the departments, following Playworld’s commitment to total “continuous improvement.”

A week after launch, the IT department had begun working on digital connectivity between LUCI and the ERP system that manages materials and production. This task couldn’t begin until View22 had released the software since changes to the way the components interface with each other in LUCI would cause a ripple effect in the way LUCI interfaces with the ERP.
This digital transfer between LUCI and ERP exemplifies a situation where ERP has perhaps not anticipated the needs of an engineering design and production company. Despite multiple partnerships between ERP, CAD, and PDM, these conglomerates have not yet tapped the issue of component configuration which will be critical to product platform design.

ADOPTING THE CHANGES

The implementation of LUCI incited a change in the way individuals had been accustomed to working and thinking about configuration of the products. The old process had become esoteric and skilled, requiring fluency with several complex software packages as well as an in-depth knowledge of the products and the way they interacted to meet the customer’s critical needs and desires. Thus the change to a new information system had the potential to bring up a lot of interpersonal issues surrounding the ownership of skills and knowledge.

Personnel Training

Everybody in the Technical Sales department had a part in testing the software through the summer. Small assignments were made to designers to test a piece occasionally. Two weeks before the launch all the employees in the department were given an intense training that required an afternoon to complete. The regional distributors were trained for about 2 months before the launch using weekly scheduled WebX webinars. These representatives were notified that they could submit work through LUCI (via access to the company’s secure online server) two weeks after launch.

An interesting comparative case arises around an individual (Employee A) who was hired to work entirely with LUCI. Employee A, who had no prior experience, spent 3 weeks experimenting with the system on the 2nd shift and declared that it had been “easy to learn.” (All new Playworld employees are required to spend 2 weeks on the 2nd shift with a supervisor learning procedures.) When Employee A felt confident with the software, this individual was given projects with which to populate LUCI, including the pre-designs. Because of software bugs, the supervisors later decided that this was not the best use of the individual’s time and so this individual learned AutoCAD as well.

User adoption and resistance

Encouraging users to adopt the upcoming information system went through three distinct periods coincidental with the seasons. In the spring, the potential users were very resistant. By summer they were saying, “let’s wait and see how it goes before we judge it.” In fall, immediately before and during the launch, the leading opinion was that, “it’s not as bad as we thought it would be.” The initial move from spring to summer was in part the result of intentional actions by management. The employees were treated to “Lunch and Learn” sessions at a nearby restaurant that gave individuals a chance to voice their concerns outside the structured environment of the office. Helpful insights were gained during these sessions, including the fear that switching to LUCI would destroy an individual’s marketability as an AutoCAD expert. Many had gone to technical school to train specifically for AutoCAD. A few individuals left the company because of their concern for this topic. The company also started a “Who Moved My Cheese?” campaign to generate constructive dialogue about the nature of change. Both of these initiatives were good because the individuals had not been as honest with the coordinators in one-on-one interviews.

Reflecting on the skills of coworkers, Employee A didn’t think much training would be needed on LUCI for the current employees. The wording is not the same as in AutoCAD and the menu is a bit different, but the systems are analogous to each other on the whole. Informational reference cards were printed up for all the employees, but Employee A remarked that few had been seen using them. Employee A, who had not yet been hired for the “Who Moved My Cheese?” and “Lunch and Learn” campaigns, also mentioned that the experienced employees perceived LUCI as being almost “too easy to use.” Another anxiety, the employee hypothesized, might arise from an unwillingness to freely experiment without accomplishing anything tangible.

REFLECTIONS

There is much to be gained from following the story of Playworld’s LUCI adoption. The growing size of the company and the product catalog had placed additional strains on employees. The success of mass customization relies on the ability of the seller to efficiently produce safe, appealing, customized products. So, in the absence of an information system that can oversee the safety and aesthetic qualities of both products and the systems they comprise, mass customization would fail to accomplish its purposes. Reusing prior configurations also enables mass customization to move faster.

With the old process of doing business, the transfer of information through various software programs and paper documents would soon become too difficult to use. Preconfigured designs were unusable unless there was a 100% match to the new order. Furthermore, the propagation of
engineering change throughout the entire product line would become impossible to affect quickly because of the disjunctive nature of the information transfer. LUCI has already made it easier to propagate changes, reuse existing information, and to oversee the interactions between products in a family or system. All these features fit the process needs of mass customization business plan, and so, in effect, help to ensure the continuation of mass customization at Playworld.

Task compatibility being only one half of what is required for a successful information system, LUCI is also proving to be appealing and easy to learn. This is evidenced by the story of Employee A, who was able to learn the information in three weeks without any prior experience with playgrounds or configuration software. The employees with such expertise were able to learn the basics in an afternoon. To address the psychosocial issues of software adoption, Playworld deployed two programs that gave its employees safe space to air tensions. Though there were early bugs in the systems, this is expected from any software program. Playworld did not disable the old system when it made the transition, allowing the company to continue taking orders in the interim. The operation of both systems simultaneously witnesses to the compatibility of the inputs and outputs of the Technical Sales/Order Entry loop and compatibility is a leading concern for encouraging adoption of an innovation of any sort.

**FUTURE WORK**

It was alluded to in earlier sections that observations of Playworld’s changes to its product configuration process are only snapshots of what the transition would look like for the entire product development cycle. Moving to a larger scale will undoubtedly introduce more challenges. Moreover, the case study has examined a particular portion of the cycle that may not appear in all industries. Playworld specializes in mass customization, whereas in the case of product platforms, the engineers are responsible for configuring modules into new products before production (i.e., a family of disposable cameras are not completely customizable, but there are twenty of more models on the market.)

Future case studies could examine the entire process. Playworld has introduced changes to its information management schema for the other sectors of its business, but it could take years before the changes are implemented. The whole picture would certainly yield more observations to which the current case study could be compared.

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**REFERENCES**


