An Online Learning Tool for Product Platform Planning

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Abstract

Product Platform Planning is an emerging philosophy that calls for the planned development and deployment of families of related products. It is markedly different from the traditional product development process, which focuses on optimized designs for individual products. This is a relatively new development in engineering design, which is not typically a part of an engineer's education. Furthermore, it is different from traditional engineering topics in that it requires an integration of principles from both management and engineering design. All this makes for a new and different topic for which educational material needs to be developed. This paper presents and describes an online learning tool that includes a tutorial, cases, and a glossary in a multimedia format hosted on the Internet. The tutorial presents the basic concepts as well as current research on planning and architecting families of products. The case study section has three cases based on a family of popular power tools. The cases, of increasing complexity, present information in the form of function diagrams, assembly diagrams, individual component pictures, usage information and market segmentation data. Links are provided to helpful sites, as well as to relevant sections in the tutorial. Learning and practice activities are also presented. This paper and associated web-based materials are intended for educators interested in incorporating Product Platform Planning in the design curriculum as well as practicing design engineers and product planners in industry interested in improving their knowledge and skills in this strategic approach to product development.

1. Introduction

Mass-production started replacing craft-production as the dominant means of manufacture early in the 20th century. This allowed for previously expensive products to be priced low enough to be affordable to a large section of society. Global competition has resulted in further reduced prices. In order to stay competitive, manufacturers need to provide the exact bundle of features that each consumer wants in a product, at the lowest possible price. This is exactly the goal of mass-customization. Over the last few decades, manufacturers are providing an increasing amount of variety in their products. For example, a few decades earlier, there were only a few basic types of vehicles: sedans, sports cars, trucks and station-wagons. Today, there are new kinds of body styles, such as SUVs, mini-vans, crossovers (e.g., a cross between an SUV and a truck), etc. And for each type of vehicle, there is a plethora of options for the consumer.

The classic product development model calls for optimized designs for individual products, and results in one or two mass produced products. Product platforming provides product diversity through shared resources at a reduced price by sharing components, interfaces, knowledge, production processes, etc. Products that are "derived" using components or modules from the platform constitute a product family. Product platform planning (or product family planning) calls for the simultaneous, planned development of a set of related products.

Product platform planning is different from the conventional product development process in that it involves the planned design and development of a few different products at the same time. Being a currently developing methodology, it is rarely a part of the engineering curriculum. Considering its relevance in today's industry, it is important that it is incorporated in the education system. Platform planning involves management of design, and involves management concepts such as market research, customer needs, product management, etc. These concepts are new to an engineering student and have to be presented in a manner that allows for greater understanding and learning. On the other hand, a management student, or product manager in industry may not be familiar with engineering fundamentals and will have to be given a suitable introduction.

All this calls for the integration of platform planning into the engineering and business curriculum. The objective of this paper is to report on an online learning tool that has been developed for product platform planning that:

- reaches a wide audience,
- caters to a variety of needs in academia and industry,
- disseminates information in multimedia format, and
- promotes interest and learning through active learning.

Problem based learning is enabled through a set of three case studies based on a popular family of power tools. Information about the tools is provided, along with detailed information on the new products or family of products to be developed. Specific activities guide learners through a platform planning process. In addition to product platforming, the cases promote learning concepts of function-based family design, component sharing, modularity, customer needs-driven approach, market analysis, decision-making, etc. An overall view of the platform planning process is presented along with details of each step in the process. Additional supporting materials and resources are provided through a glossary of terms and links to other online resources.

Section 2 presents a literature review of some of the important topics in platform planning today. In addition, other resources in family planning are presented. A methodology for platform planning is presented in section 3. Website architecture is discussed in section 4. The sections presenting details of the cases developed, tutorial, glossary and links in the learning tool are discussed subsequently. Finally, conclusions and future work are provided.

2. Literature Review

A product platform is a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced[1].

A platform can also be defined as a collection of assets that are shared by a set of products. These assets can be divided into: components, processes, knowledge, and people and relationships[2]. A modular platform allows for platform based product development. The different types of modular platform architecture are: modular family, modular generations, consumable, standard, adjustable for purchase[3].

Companies that develop products from a common platform realize many benefits. Design and manufacturing costs are reduced. Companies have a greater ability to tailor their products to the needs of different market segments or customers. Product development time is reduced. Systemic complexity is reduced by cutting the number of parts and processes. Also, the lowered investment required for each product reduces the risk[2]. Platform planning can be used as an effective project management tool by using common platforms in order to reduce design and development time[4].

In the early 1970s, Black and Decker had 122 different power tool models which required thirty different motors, sixty different housings and 104 different armatures. The tooling, inventory, labor cost for assembly, and various other expenses made for high costs. Black and Decker aggressively developed motor platforms and started saving $1.28 million annually (in 1974 dollars). Other subsystems were targeted as well. Eventually, costs were reduced to such an extent that there was a price reduction of over 50% for some products[1]. Platform-based products are now being developed in companies all over the world. HP[5], Airbus, Kodak[2], Volkswagen, GM[6], Ford, NASA[7], etc., are using platforms that enable them to save millions of dollars. At the same time, this is not at the cost of product variety. Platforms enable increased product variety. Sony sold almost 250 different walkman models in the US in the 1980s[8].

Designing a product platform and corresponding family of products is a difficult task. It embodies all of the challenges of product design while adding the complexity of coordinating the design of multiple products in an effort to increase commonality across the set of products without compromising their individual performance[9].

Also, there are some dangers in adopting platform based product development. It is easy to lose the balance between commonality and differentiation. An excessive level of platforming can compromise on the quality or appeal of individual products. For example, Audi had to retro-fit a tail-spoiler to its TT sports roadster to fix a rear wheel pressure problem. The cause of the problem was unexpected side-effects from the usage of a shared platform[10].

Product platform planning is a means to achieve the elusive concept of mass-customization. Mass-customization is the production and distribution of *customized* goods and services on a *mass* basis[11]. The outcome of this methodology for consumers is that nearly everyone finds exactly what they want. HP has successfully implemented a mass-customization strategy using delayed product differentiation which used modules. Some components are not assembled until they reach the supply chain. Depending on the global location and customer need, the required module is assembled. This allows for product variety from the same basic platform[5]. There are two basic customizable product architectures: fabricate to fit, and adjustable for use[3]. Four different approaches have been specified for mass-customization[12].

The family planning process starts with the customer. It is important to have an accurate idea of customer needs because the whole family of products being planned is based on the firm's understanding of what consumers want. Yu, et al. describe how customer needs variety and variance can be considered as a basis for selecting architecture for the product family[13]. The mean and standard deviation of customer needs at different times of product usage in the respective market segments are calculated. A flowchart then guides the firm as to which product family architecture is best suited to meet customer requirements. This is extended to using a market survey on which architecture decisions are made[3]. Kurtadikar and Stone[14] propose a method of determining which customer needs are platformed, and which need to be a part of variant architecture. Customer needs weight and frequency are plotted on a chart. The customer needs in the quadrant corresponding to low customer frequency and high weight are made part of the shared platform, while the rest are designed as part of the variant products.

A lot of research is focused on the engineering aspects of platform planning. However, an essential part of the decision making that goes into platform planning is a platform strategy based on market conditions. This should include competing products, technology, market forces and conditions, price sensitivity, etc. Not many decision-making aids have been developed to help decide the firm's strategy vis-à-vis the market conditions. Meyer and Lehnerd[1] mention about understanding the market by studying size, growth rate, the firm's market share, etc., for each market niche. A market segmentation grid can be used as a tool to represent the market. Further, they discuss unit sales by performance tier for a given market. Zamirowski and Otto[15] illustrate a case where the market under study is divided into two different performance levels and different segments. The percentage of users in each performance level is presented to help in the decision making process.

A firm can employ numerous platform strategies in developing its product portfolio: horizontal leveraging, vertical scaling, beach-head approach, etc[1]. These strategies can be represented on the market segmentation grid. A power tower can be used as a tool to represent the company's strategy for its platform approach. This is also a good time to conceptually decide how to differentiate the planned products. Product characteristics can be selected to have Differentiating Attributes so as to appeal to people in different market segments[2]. For a firm that maintains different brands that are marketed in the same basic market, the concept of brand identity is very important. Each brand can be imparted with a set of distinct characteristics, both aesthetic and performance-based[16].

The next step is to determine the architecture and specifications for platform and variant elements. There are a variety of methods available today. A basic chart method can be used to determine configuration issues and other design parameters[3]. For more complicated products, function-based methods can be used. Modules can be identified from an agglomerated family function-model using heuristics of dominant flow, conversion-transmission, and branching flow[17] or those of function and variety[18]. Optimization based techniques have been used in different ways to decide on platform elements and characteristics[7, 10, 19, 20]. A technique that is gaining ground for product family specifications is that of compromise Decision Support Problem (DSP)[21, 22, 23, 24]. Here, the platform and variant requirements and targets are formulated as a multi-objective program in order to optimize conflicting targets. A new approach to platform

planning is the use of agent-based synthesis software[9]. Other approaches to Platform Development include a graph-grammar approach[25], Physical Programming[26], Genetic Algorithm[27]. A simpler approach to platform planning can be taken by using a modularity matrix[28]. Here, a matrix consisting of functions vs. products is used to identify possible shared modules. Embodiment issues of interface design for platforms are decided using cost information[29].

Financial aspects of product platforms such as value of platformed products have been presented by Fellini, et al[30]. The different approaches to platform planning have been classified in two basic categories: top-down and bottom-up[31]. Various indices have been developed in order to give a numerical value to various platform and modularity options[32, 33, 34]. Areas of profitability of a platform based development strategy have been highlighted by Krishnan and Gupta[35].

Various online sources[36, 37, 38, 39, 40] were studied in order to determine the best features of an online learning tool. Our findings revealed that PDF[36], HTML[37], Macromedia Shockwave[38], etc. were the different media used to convey information. Characteristics and implementation techniques were noted in order to improve aspects such as communication, presentation and readability of the proposed online tool. It was found that through use of a combination of pictures, technical diagrams, creative "storylines", audio, animations, and other media, online learning tools in various subjects can be an effective and interesting source of knowledge. A lot of these websites used cases in different ways. A search for online platform planning learning tools returned only classroom lecture files in PDF or PowerPoint formats.

3. Methodology

The aim of the online learning tool is to educate users on platform planning using problem-based learning. In order for the cases to be effective, two things need to happen. One, users will have to gain the basic principles as well as some details on platform planning before they can solve the cases successfully. Second, the cases themselves will need to be based on the knowledge of platform planning gained from the diverse literature that is prevalent today, in addition to being unified and coherent. In order to achieve these twin goals, there was need for a methodology to guide this effort. The methodology behind the implementation of the online learning tool is presented next. It consists of a process description of platform planning followed by a description of each stage of the process. A flowchart is presented for the overall process. Considering the different methodologies that have been proposed, the process flowchart is generic in nature.
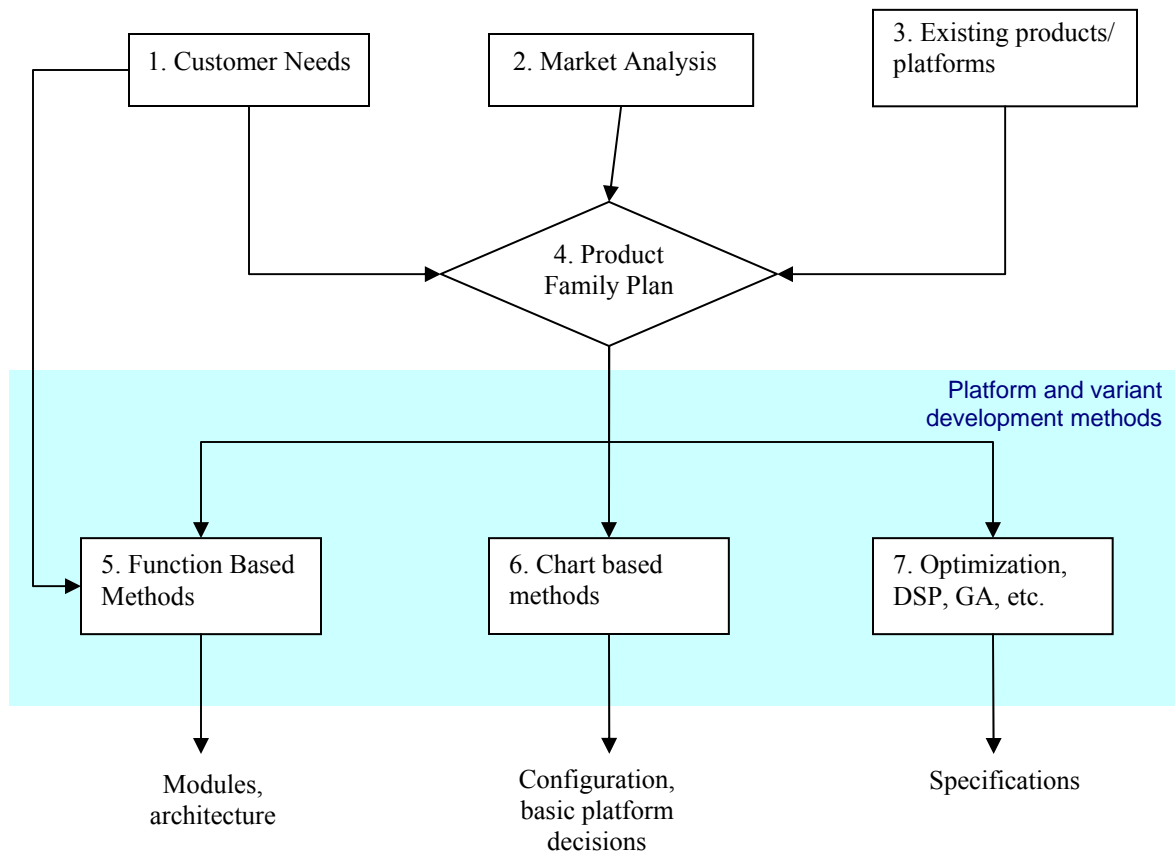
Fig. 1: Platform planning process.

This methodology forms the direct basis for the tutorial section in the online learning tool. The methodology used in this effort places a greater emphasis on the earlier stages of platform planning compared to current literature. This is because the reason behind platform planning is to offer customers the variety that they need while at the same time ensuring market success of the products sold. This can be achieved only when greater attention is paid to the customer and the competition. Platform planning is as much a management tool as it is an engineering method. Fig. 1 shows the outline of the proposed platform planning methodology. The first 3 phases involve understanding the customer, the market and competitors, and the firms own products and platforms. Phase 4 involves planning details including strategy, products, features and specifications for the planned family. The next step involves actually developing architecture, or deciding on specification of platform and variant elements. Each of these phases is explained below.

(1) Customer Needs

In this phase, the firm collects information on what customers need in a specific product. Each customer might have a slightly different perspective on how the product should be, and what its specifications should be. The only difference here is that since the whole product family is being

planned, customer needs data should be collected from a wider segment of people, and should be representative of the whole market. For this section, the procedure as outline in Otto and Wood's "Product Design"[3] is used. The first step consists of data collection in which customers are surveyed for need target values. The mean and deviation are calculated. Also, the mean and deviation across uses are calculated and tabulated. Depending on the means and deviations, the product architecture is decided. Also, customer needs are used to generate the function model of individual products of the family in case of a function based approach is used for platform development.

(2) Market Analysis

In order for the new products to do well in the market, it is imperative the company is in tune with market realities and trends. In today's fast changing, technology based marketplace, new innovations come and go all the time. Hence each company will have to do an extensive research on the market and determine the following details about competitors: number of competitors and market-share, products, features and specifications, technology, prices, and other important features. Essentially, benchmarking will have to be carried out for all the market segments. Current literature is lacking in methods to characterize features and prices of products available over the whole market. This is a pre-requisite to platform planning as an overall view of the market conditions should be available to base decisions on the family of planned products. A method that can be used here is to tabulate means and standard deviations of all products available in the market, categorized by market segment and performance tiers.

Feature	Small-angle grinders		Med/large angle grinders		Die grinders	
	μ	σ	μ	σ	μ	σ
Current (A)	6.8	2.0	13.4	3.5	5	1.4
Diameter (inches)	4.5	0.1	7.8	1.7	1.1	0.5
Power (Watts)	800	180	1800	700	350	170
Speed (rpm)	10,400	920	6600	580	21,000	5,200
Weight (lbs)	4.4	1.5	8.5	1.5	3.7	1.9
Gear	spiral		spiral	helical	-NA-	
Switch type	-		sliding			
# side handles	2.2	0.4	2.2	0.4	0.3	0.12

Fig. 2: Table showing specifications of grinders currently available in the market.

When compared with a similar table of customer requirements, unsatisfied niches become immediately apparent. Fig. 2 shows such a table that was created while developing Case 3 for the Online Learning Tool. The table gives means and averages of product specifications available in all market segments. The market segment grid[1] can be used to position prominent competitors in order to get an overview of the market. Fig. 3 shows a graphical representation of information such as unit sales, price, and revenue (adapted from a similar graph in Meyer and Lehnerd's "The Power of Product Platforms[1]). This gives the information required to make decisions based on profitability and market share.
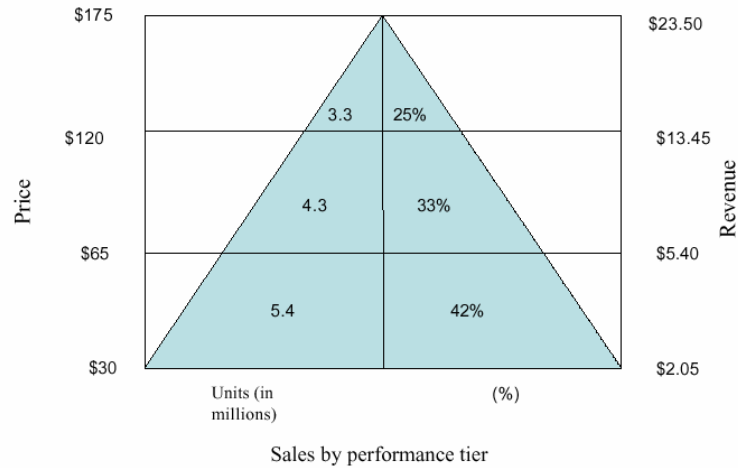
Segment 1: Small angle-grinder

Fig. 3: Market segment data (adapted from Meyer and
Lehnerd's "The Power of Product Platforms[1])

(3) Existing products or platforms:

The platform planning approach used by the company could be top-down or bottom-up[31]. The
overall methodology described here is based more on a top-down approach. A bottom-up
approach would kick-in at this point and go about the process of consolidation and
commonalizing components. For companies that already have some existing shared platforms,
companies need to make decisions on whether to continue with the platform, modify it, or
discard it. A family map[1] helps keep track of the creation and development of a platform. Fig. 4[1]
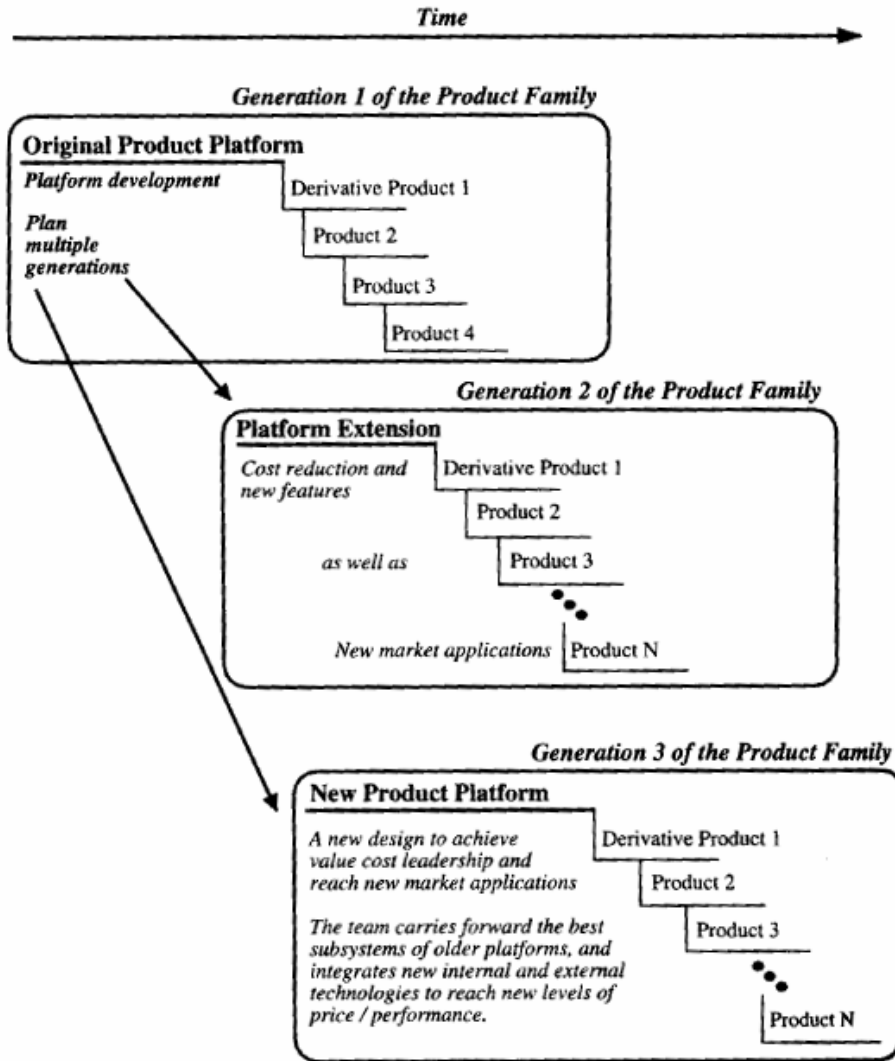gives the details of a family map.

Fig. 4: Product family map[1]

(4) Product family plan

Once the firm has analyzed consumer needs, the market, and its own products, it is in a position to decide upon a strategy that will help it increase market share and revenues. A firm can leverage a given product or platform across to a different market segment (fig. 5), scale performance and price to different performance tiers, or vary both factors and use a beach-head approach.
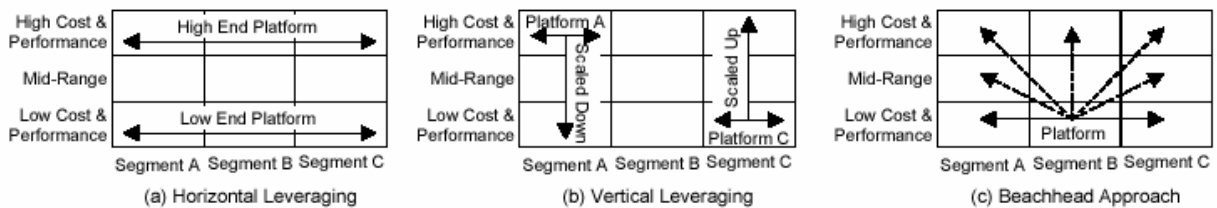

Fig. 5: platform strategies on a market segmentation grid[1]

Another important factor is that of competitors. Based on the firm's market analysis, it can choose to not enter into specific niches if they are unprofitable due to a strong hold by a competitor or too much competition. Similarly, if a niche has been under-serviced, the firm should focus on that.
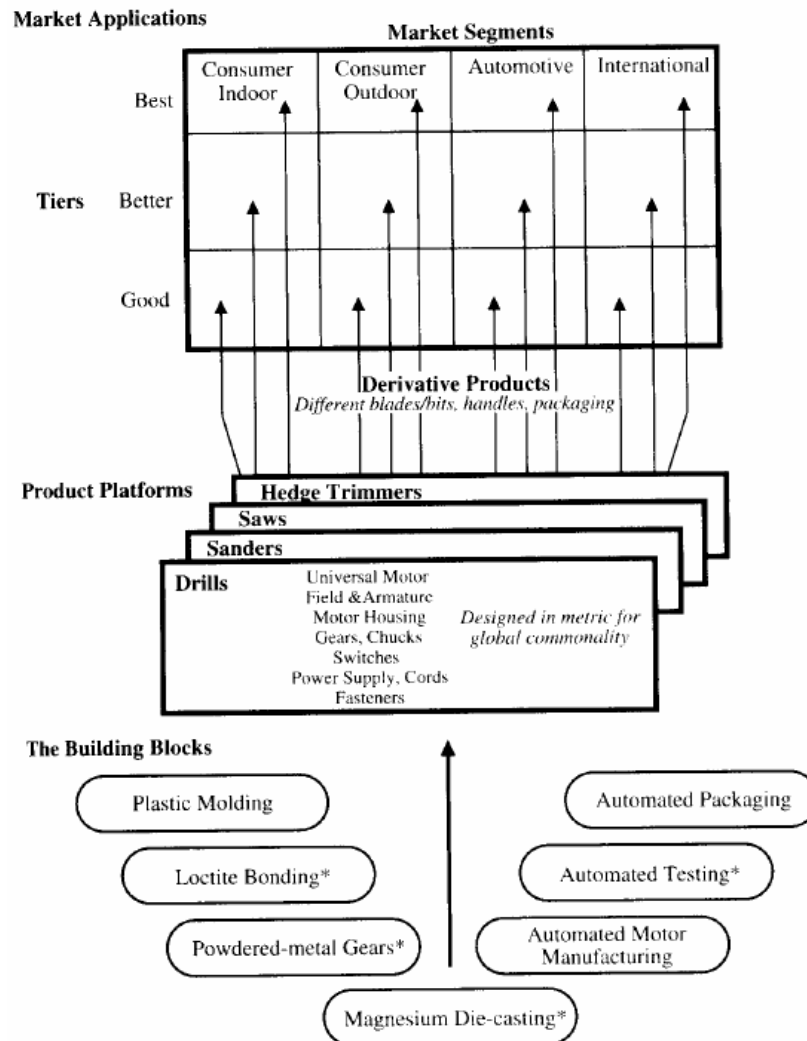

Fig. 6: Power Tower[1]

It is in this phase that differentiation or branding decisions can be made effectively. Some attributes of the product family are selected and given different values so that the products are differentiated from each other and also appeal to different kinds of customers. In case a firm maintains different brands in the same market, this is an ideal time to specify visual and performance cues and traits that set the brands apart. A modularity matrix[28] can be used for this purpose[16].

In order to emphasize and clarify the firms vision, aims and challenges, a power tower can be used[1]. Fig. 6 shows an example of a power tower.

(5) Function-based product family architecting methods

Phases (5), (6) and (7) correspond to the stage where overall specifications for the product family are converted into platform and variant modules, or into platform and variant feature specifications. Function-based methods involve the construction of a functional model of the proposed products and the creation of shared and variant modules. Two methods are discussed here. One is a heuristic based method. The second is a visual, table-based method called the modularity matrix.

Creation of the family function model:

The first step is to create functional models of individual products. In order to do this, each customer requirements is converted into a statement (or statements) that involve flows and functions. These are agglomerated to form a monolithic block of functions and flows. To this, more functions are added in order for the model to be feasible and complete. This requires prior engineering knowledge. Function models of all the products in the family are agglomerated into one family functional model.

Method 1: Heuristics

Heuristics are used to identify modules from the family function model. This method is very useful when creating a ground-up new design. Complicated systems can be modularized using this method. Two sets of heuristics are used: Function Heuristics and Variety Heuristics.

Function Heuristics[17]:
Heuristic 1: Dominant flow: this heuristic examines each non-branching flow of a function structure and groups the sub-functions the flow travels through until it exits the system or is transformed into another flow.
Heuristic 2: Branching flow: each limb of a parallel function chain defines a potential module. Identified modules interface with the products at the flow's branch point.
Heuristic 3: Conversion/transmission: identify conversion sub-functions and look for transmit or transport sub-functions downstream of the converted flow. If none exist, the convert sub-function is a module by itself. If there is an adjoining transmit/ transport sub-function, the convert and transmit (or transport) sub-functions form a module. If there are intermediate sub-functions that operate on the converted flow, they all form a module.

Variety Heuristics[15]:
Heuristic 1: Isolation of Variety: functions that are affected by market variety requirements can be clustered separately from those that are not. a function that relates to variety can be isolated in a module so that it can be part of any variant products required.
Heuristic 2: Function Structure modification for variety reduction: if the sub-functions adjacent to a group of common sub-functions can be made common across all products, then it can also be made a part of the platform. The idea behind this is similar to delayed product differentiation.

Method 2: Modularity Matrix

The modularity matrix[28] lists sub-functions from the family function diagram as rows in the matrix with possible products in the columns of the matrix. Each matrix element contains a specification value for the sub-function listed. If the specifications of a sub-function are common or similar across products, it can be shared as a common platform. Modules can be identified both at the individual product level and at the platform level.

(6) Chart method[3]

This is a basic method which is used to determine design layouts and basic platform options for a product family. A combination of configuration and platform options are listed out on top of the chart with the various criteria such as costs listed out on the rows. The cells consist of a "score" which can be a positive, negative or zero. The option with the highest positive score wins.

(7) Optimization, Decision Support Problem, and other methods

These methods are beyond the scope of the online learning tool as they are complicated and some are not completely feasible yet and are hence not discussed here.

4. Website

The website has been designed to provide users with easily accessible information. The content has been organized to allow for simple, uncomplicated reading to allow for maximum learning. Pictures, diagrams, explanations and helpful links have been placed wherever needed. The website has been given six major sections in the form of index tabs: Introduction, Tutorial, Design Concepts, Glossary, Case Studies and Links. Sections with more than one major topic of content have a sub-menu as shown on the left side panel in figure 7. Sequential links in the form of arrows are located to the left and right of the heading of a given topic. The color scheme of the website has been chosen to be pleasing to the eye and at the same time be effective in directing the user's attention to relevant areas. Arial was chosen as the font to allow for maximum readability. Links are highlighted in blue. Also, the selected topic on the left panel is highlighted in light-blue. The sub-menu allows for easy access to any part of a given section, as opposed to a strictly sequential access. The page width has been limited to approximately 800 pixels so as to be viewed correctly on most web-browsers. Also, care was taken that the page displayed correctly in different browsers. Names of the participating universities were listed as icons below the left panel. These icons are linked to the corresponding faculty's website in their universities. The website was created using Macromedia DreamWeaver in HTML (Hyper Text Markup Language). Some information has been linked to the main website in the form of Adobe's Portable Document Format (PDF). This allows for the presentation of data including graphs, tables and pictures to display as it was designed, irrespective of the browser used.

Fig. 7: Case #1 in the website

The Introduction section gives users an introduction to the field of platform planning, the online learning tool, and a link to a page giving details about the people behind the website. The Tutorial section expands on the Methodology section of this paper by giving examples of some of the concepts. It functions as a resource to people using the case studies. As a standalone (used without the case studies), it functions as a source of knowledge about Platform Planning. Links from sections of the cases are directed to relevant portions of the Tutorial section.

The Design Concepts section (fig. 8) consists of topics not directly related to platform planning but are related to it, and would be helpful to users. Concepts explained are architecture, function based design, Pugh method and House of Quality.
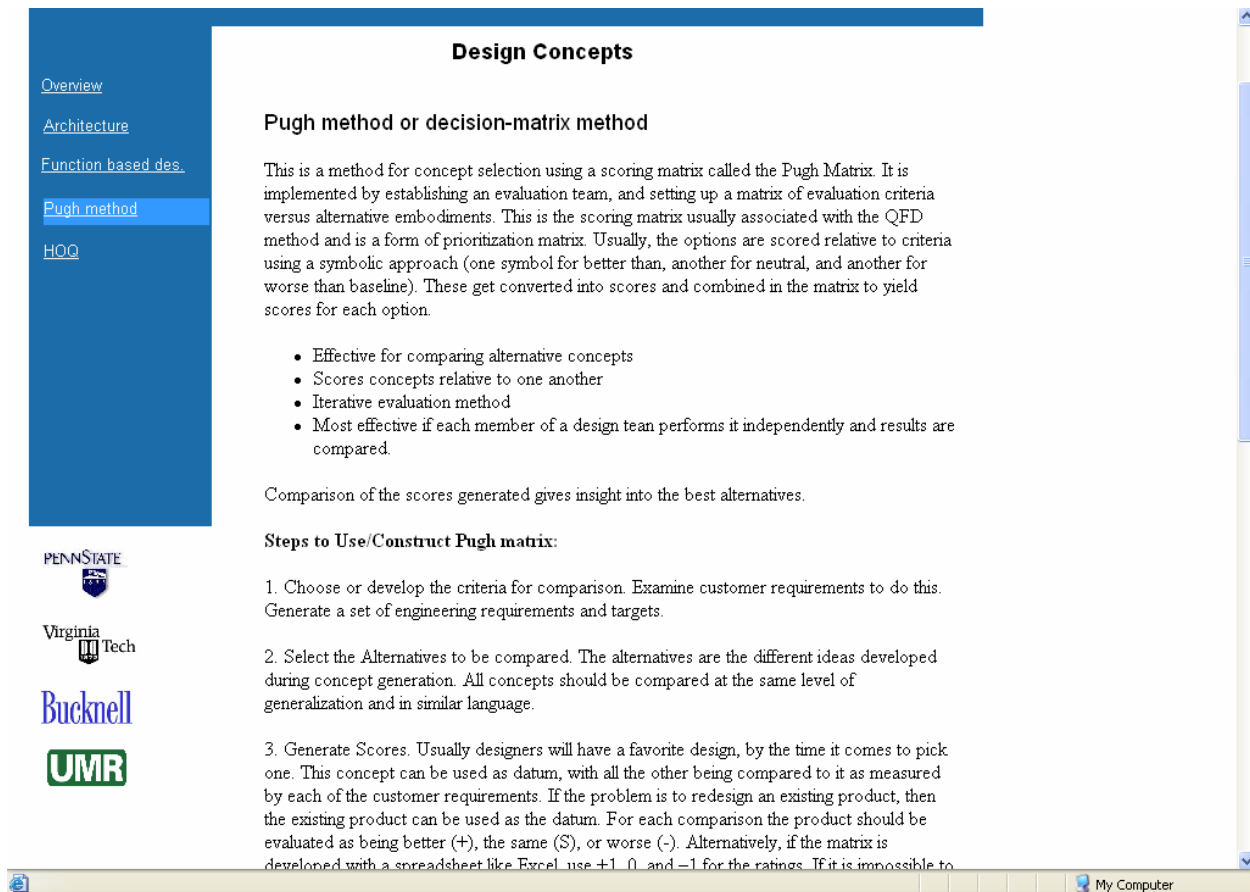
Fig. 8: Design Concepts section

The Glossary section contains terms in two major topic areas: platform planning and function-based design. The terms in function-based design are further partitioned into flow definitions and function definitions. Fig. 9 shows a screen-shot of the Glossary page.
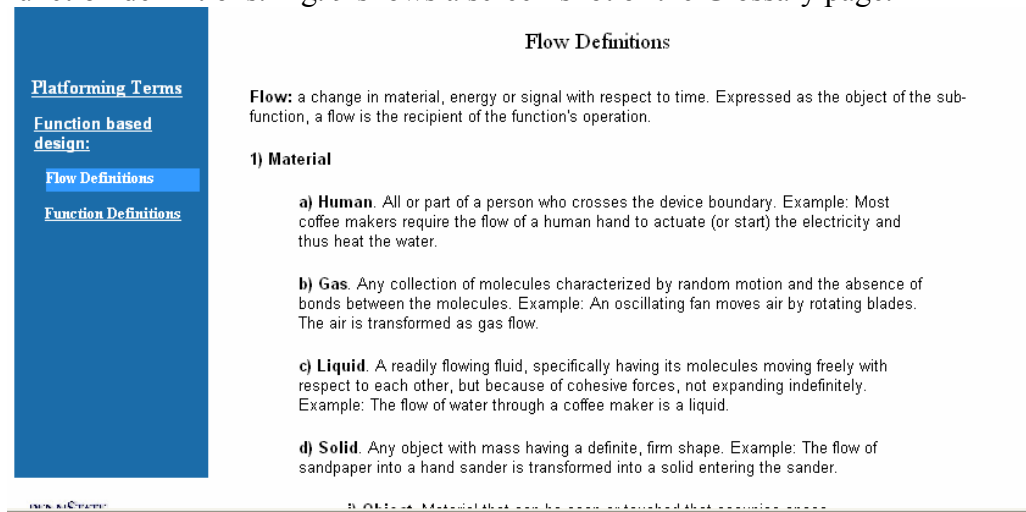

Fig. 9: Glossary

Case Studies Section:

Three cases were developed. These cases are based on platform planning for a set of power tools. The first two are based on Black and Decker's cordless tools and the third based on a hypothetical firm, Essel tools. The cases have been designed to have an increasing level of complexity, from easy through to refined.

Case 1: The first case deals with "bottom-up" design of a platform. Figure 7 shows a page in the first case. The function model and assembly model of a Black and Decker Versapack drill are presented to the user. The assembly diagram consists of component names which are linked to their corresponding pictures. This gives users an idea of size and shape. Background on the Versapack family of tools is provided. Also, helpful links are provided. Links to relevant sections of the tutorial are provided. Information and pictures about grinders are given. The student is asked to design a cordless grinder with shared components from the drill. Specifically, the user is first asked to draw a common function diagram from which common sub-functions can be selected. Based on this, and information provided in the Resource page, the user reasons which components can be shared. The Resource Page gives links to the function diagram and assembly diagram for the drill, an exploded diagram of a B&D grinder, drill and grinder photos, and an interactive listing of drill and grinder component assemblies. Clicking on drill (or grinder) assemblies opens up a list of drill assemblies. Clicking on any of the assemblies gives a listing of components. Clicking on any other assembly closes this assembly and opens the other.

Case 2: This case teaches the concept of a vertical scaling strategy using Black and Decker's circular saw. The user is first familiarized with circular saw usage and features with corresponding pictures, description, and an exploded view diagram. Architecture concepts are then explained. A market segmentation grid for B&D products, as well as the proposed saw, is presented.
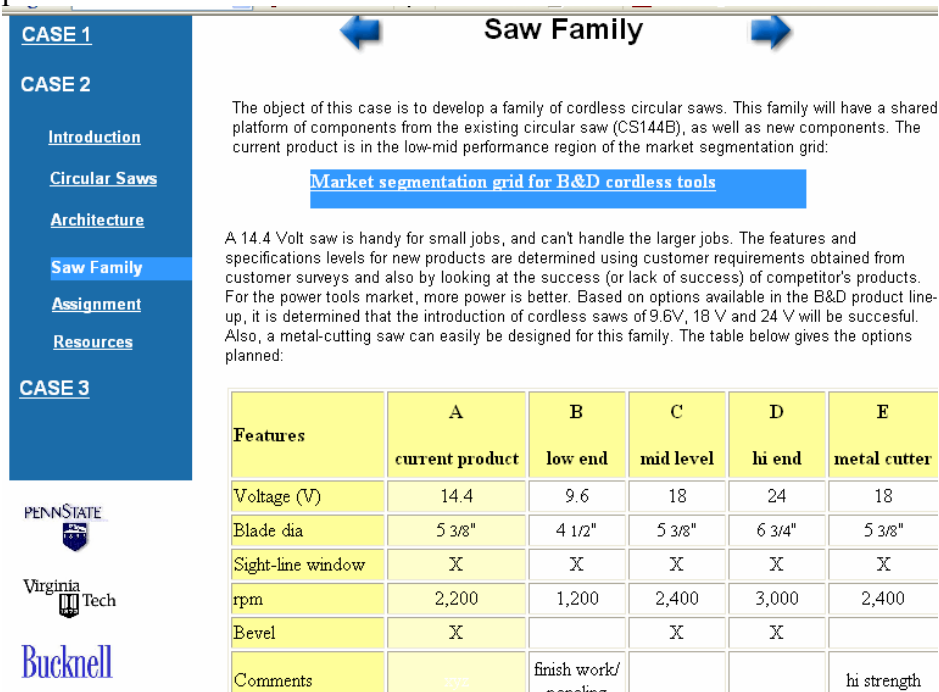

Fig. 10: proposed family of circular saws.

Fig. 10 shows a table giving specifications for the proposed new family of cordless saws. A function model of the existing saw is given. The user is then asked to develop modules for the platform as well as variant products. The choice of method (modularity matrix or heuristic) is left to the user. Links to relevant tutorial section will be provided. Again, the Resources page contains helpful information.

Case 3: Case 3 portrays an ideal top-down approach to family planning. The user is exposed to customer needs and market based approach to product design and management. In addition, the user is expected to use his or her decision-making skills. The case is based on the grinder platform of a fictitious tool company. Detailed information on grinders has been presented in order to make users thoroughly familiar with the types, usage and parts of a grinder. An exploded view of a diagram is presented. Subsequently, the market presence of the tool maker (Essel tools) is presented on a market segmentation grid. Fig. 11 shows customer requirements data being presented in the form of a table of means and standard deviations corresponding to different market segments and performance levels.
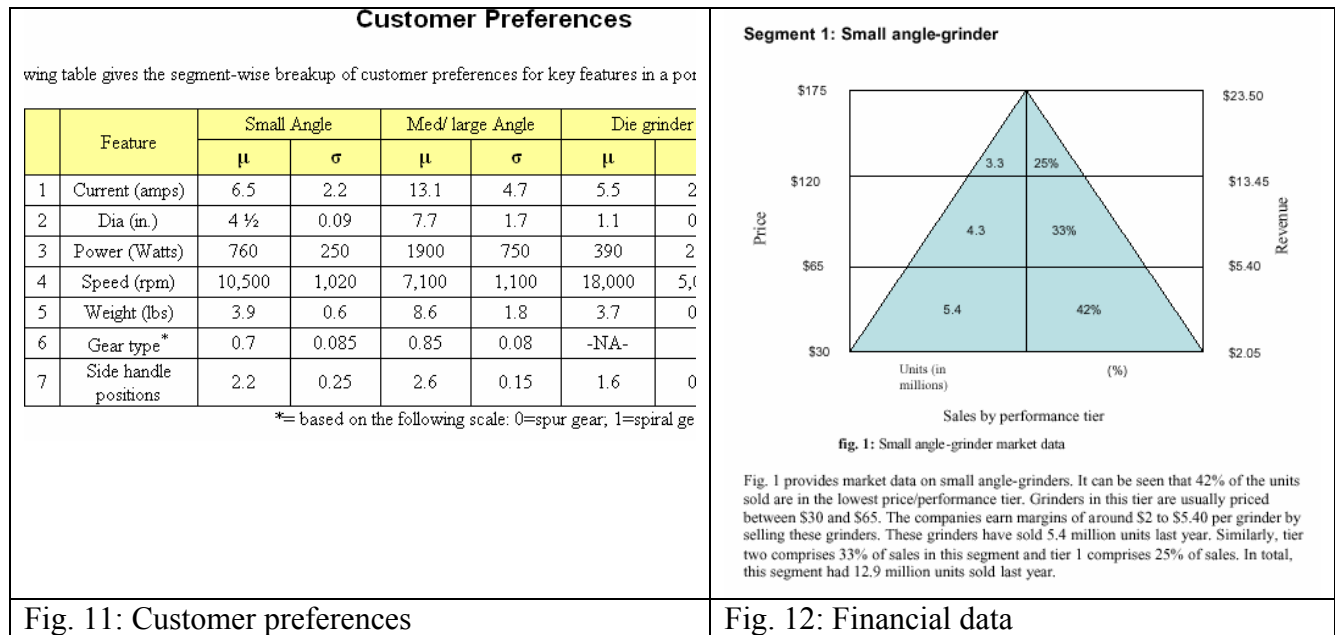
Customer Preferences

wing table gives the segment-wise breakup of customer preferences for key features in a por

	Feature	Small Angle		Med/ large Angle		Die grinder	
		μ	σ	μ	σ	μ	
1	Current (amps)	6.5	2.2	13.1	4.7	5.5	2
2	Dia (in.)	4 ½	0.09	7.7	1.7	1.1	0
3	Power (Watts)	760	250	1900	750	390	2
4	Speed (rpm)	10,500	1,020	7,100	1,100	18,000	5,0
5	Weight (lbs)	3.9	0.6	8.6	1.8	3.7	0
6	Gear type*	0.7	0.085	0.85	0.08	-NA-	
7	Side handle positions	2.2	0.25	2.6	0.15	1.6	0

*= based on the following scale: 0=spur gear; 1=spiral ge

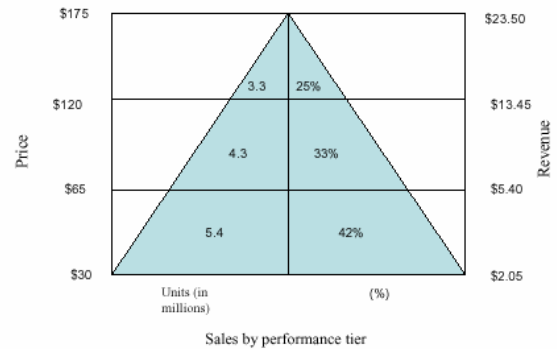**Segment 1: Small angle-grinder**

Sales by performance tier

fig. 1: Small angle-grinder market data

Fig. 1 provides market data on small angle-grinders. It can be seen that 42% of the units sold are in the lowest price/performance tier. Grinders in this tier are usually priced between $30 and $65. The companies earn margins of around $2 to $5.40 per grinder by selling these grinders. These grinders have sold 5.4 million units last year. Similarly, tier two comprises 33% of sales in this segment and tier 1 comprises 25% of sales. In total, this segment had 12.9 million units sold last year.

Fig. 11: Customer preferences	Fig. 12: Financial data

Fig. 12 shows financial data being presented to represent market conditions for a market segment in the grinder market. The representation used in Meyer and Lehnerd's "The Power of Product Platforms"[1] was improved upon to show important financial data that is required while making decisions on whether or not to enter a given niche in a market segment. The assignment section asks users to study the competition by actually studying online websites like Amazon to get details on prices and features. The users then need to decide which segment the company will enter first. Product specifications are provided by the users who then identify modules and draw a power tower and a family map. Again, helpful links are provided in the Resources section.

The Links section of the website has links to resources like platform planning efforts at participating universities and other universities, links to tutorial, etc.

5. Conclusions and future work

A literature survey of product family planning was conducted from which an overall process of platform planning was developed. A comprehensive online learning tool was developed to further knowledge and awareness of platform planning. The tutorial for this tool was based on the platform planning methodology developed. The website has been designed for students and faculty, as well as engineers and managers in industry. It consists of a tutorial, case-study section, glossary of terms, design concepts section, and links to useful resources. The tutorial section introduces the user to product platform planning and gradually builds on that knowledge by giving an overall, as well as an in-depth tutorial in this field. The case study section consists of three cases based on a family of power tools These cases presented information in pictures, technical diagrams, tables and graphs. Users are presented with a wealth of information and asked to perform assignments. The cases view the field both from an engineering as well as management perspective. The website and this paper form a useful resource, both in research and teaching. The literature review and methodology sections constitute an overall view of platform planning. The website can also form a template for future learning resources in other fields. Also, further cases and information of platform planning can be stored as part of this website.

During the creation of this website, we realized the many advantages, as well as some of the disadvantages of HTML. HTML is not as interactive as one would like. Future tools could have some features in media such as flash, or some newer, more interactive tool.
A greater number of cases could mean separation of cases by difficulty level to allow for use in classes of different levels. Future websites could build upon these 3 cases to provide more variety.

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