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Toward A Decision Support Tool for Selecting Engineering Design Methodologies

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Abstract

A number of systems and design approaches are being taught and used in different engineering and management disciplines, and most student and practitioners involved in product development simply apply the methods and tools that they are most familiar with. As each design approach was developed for a particular context, scope, and type of problem, there is a need for additional support in selecting the most appropriate engineering design methodology. This study began with a thorough review of some of the most common approaches taught for product development: engineering design, design thinking, decision based design (DBD), systems thinking, axiomatic design, vee model, value driven design (VDD), waterfall model, spiral model, agile, total quality management (TQM), theory of constraints (ToC), six sigma, and lean manufacturing. Through this review, a number of criteria were identified to categorize and distinguish the approaches, and each approach was then assessed according to the criteria to aid in comparison and evaluation of fit for any given project. Next, a decision support tool is proposed to help designers or project managers select the best methodology for their specific problems. This decision-making aid takes in information about the nature of the potential project and uses pre-defined metrics to recommend the most appropriate methodology.

Introduction

Design is about addressing problems with solutions that are viable, feasible, and desirable[1]. Currently, a wide variety of approaches to product design and development are being taught and studied in academic institutions and practiced in industrial settings. While these design approaches share many commonalities, they each have strengths and weaknesses, and they have been developed specifically to be best suited towards particular types of applications. However, students are typically taught one or two of these approaches to design, and as a result students, academics, and industry leaders are likely to simply apply the approaches that they are most familiar with, regardless of the problem. This can lead to inefficiencies in the design process resulting from a failure to recognize the most appropriate formalized design approach for the problem at hand.

This paper presents a review and comparison of many of the most common approaches, and it proposes the concept of a decision support tool that can help designers in educational settings choose the best process, method, or design environment to follow for a given project. The tool is built on fourteen common design approaches that were identified in the literature and educational curricula, as well as a number of metrics that were chosen to best categorize and differentiate the approaches. Specifically, this grouping includes approaches that have roots in at least four separate disciplines: mechanical engineering, systems engineering, software engineering, and industrial and operations engineering.

Previous research and review efforts discuss comparisons and classifications of different design approaches. Estefan reviewed a number of model-based systems engineering approaches and classified them as processes, methods, tools, and environments according to a variety of defining characteristics[2]. This study focused mainly on systems-focused methodologies which were optimized for and employed by specific companies, rather than discussing more generalized approaches. Cross presents a number of formalized strategies for product design, focusing mainly on “engineering design” strategies that span from conceptual to detailed design of relatively simple products[3]. Chakrabarti and Blessing compiled a series of papers on design theories and models, focusing on the philosophical underpinnings of different approaches toward design[4]. These and other previous efforts are either too disciplinary-specific or too theoretical for the purposes of the present analysis, which seeks to compare specific processes and methods across a range of engineering and management disciplines.

The paper begins with a review of the fourteen selected design approaches, organized by the disciplines from which they originated, and then identifies seven key criteria on which they can be classified quantitatively and categorically. Each approach was then individually ranked and assessed according to the following metrics: phases of the design process, hardware or software development, complexity, flexibility, project scope, project emphasis, and main objective of the project. Next, a user interface was developed to gather relevant details from designers about their projects, upon which a mathematical comparison is performed against each of the design approaches’ strengths and characteristics. The result is a recommendation for which design process, method, or environment (or combination thereof) is best-suited to the problem at hand.

Design Approaches

Mechanical Engineering

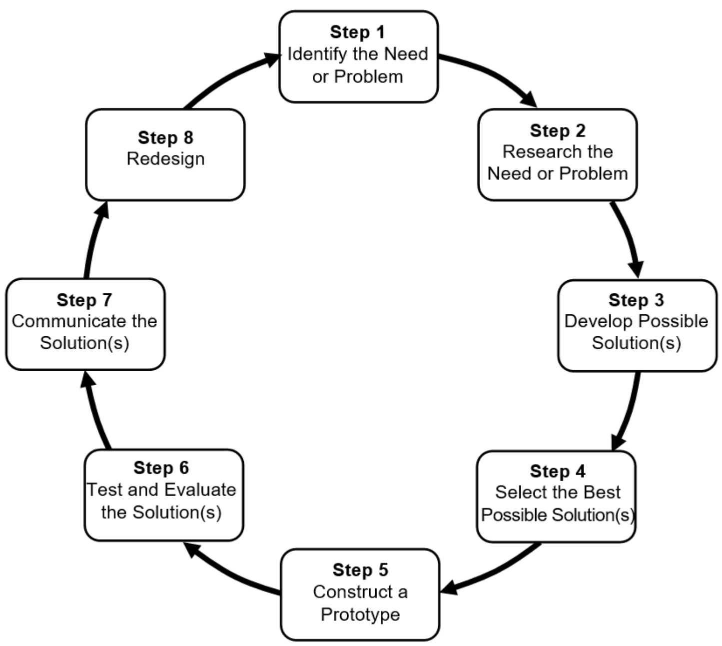

Figure 1. Illustrative example of the engineering design process[5]

Engineering design is one of the most commonly taught mechanical engineering design methodologies, especially within the academic domain[6]. There are many different representations of the engineering design process, and in its simplest form it can be represented by the iterative “design-build-test” cycle. This process was developed in order to provide a structured and easily-replicable method to solving a large variety of engineering problems. Although variations in definition exist, similar core phases typically exist in a more detailed engineering design method, as shown in Figure 1: need identification, research, synthesis of alternatives, analysis, assembly, testing, communication of results, and redesign[5]. Furthermore, this approach is highly iterative, and in many instances, certain phases are required to be repeated multiple times before they are deemed to be complete. This particular approach can be applied to a large variety of engineering projects. However, because of its universal nature, it is not always the best approach for many specialized projects.

Design thinking is a problem-solving environment that was developed primarily by Stanford University's Institute of Design and IDEO during the early 1990s in an effort to highlight the human element that is present within design[1]. This environment was developed based on an analysis of how products are practically used and the waste that occurs as a result of over-designing. This approach suggests that the design process be decomposed into three high-level phases: "inspiration", which involves problem identification, "ideation", which involves the generation of broad solutions, and "implementation", in which a product is manufactured and released[7]. Furthermore, design thinking suggests that the thought process that occurs during a design process is split between "divergent and convergent" thinking during concept generation and selection and "analysis and synthesis" during human pattern recognition. This environment proves useful in that it incorporates an emotional element to design, and thus generates a product that is more favorable to consumers and less wasteful. However, design thinking is limited as it is relatively open-ended in scope and provides a small amount of guidance to users.

Decision based design (DBD) is a relatively recent approach that focuses on the human decision making process and how it applies to the design process. This perspective was introduced by Hazelrigg in 1998, and is taught with an emphasis on considering customer preferences and the business case when making design decisions[8]. Furthermore, this approach highlights the necessity of conducting consistent economic modelling at each decision point throughout a design process[9]. This perspective considers profit as the main driving factor for any project at hand, and therefore any decision made at any point in the design process must consider the relative impact on total profit. The advantages of DBD are its quantitative approach to customer satisfaction and added business value during product development; however, it has not caught on widely in industry due in part to its multi-disciplinary nature and difficulties in practical implementation.

Systems Engineering

Systems thinking is a design environment that was originally developed at the Massachusetts Institute of Technology (MIT) in 1956 and has since been expanded upon by a variety of academic and industry figures[10]. Much like design thinking, systems thinking encourages designers to approach a given problem from a holistic perspective. This approach was promoted as a means for designers to frame a project from a perspective that mainly considers the interactions of the given product with other outside systems, such as the environment and peripheral attachments. Unlike the typical design process ideology, which primarily analyzes the individual constituents of a product, systems thinking encourages the analysis of the product from an expanded viewpoint to the primary and secondary systems affected by it. This environment thus aids in decision making for complex projects that contain multiple actors, or for projects which failed to be effectively solved via traditional methodology. Like design thinking, systems thinking offers little guidance, and it proves to be less suitable when applied to simpler, more established project scenarios.

Axiomatic design is a systems engineering methodology that is taught to help designers understand how customer needs are properly transformed into functional requirements. This approach is commonly followed using matrix mathematics. Overall, the process follows entities that are contained within four design domains: customer, functional, physical, and process[11]. These four domains are intrinsically connected, as any consideration made in one domain directly maps to the following domain. This mapping occurs in practice via matrix mathematics between design parameters and functional requirements, and can be performed for projects of varying scope[12]. Due to the calculated nature of this approach, it provides absolute responses, and thus is useful for eliminating unnecessary design considerations.

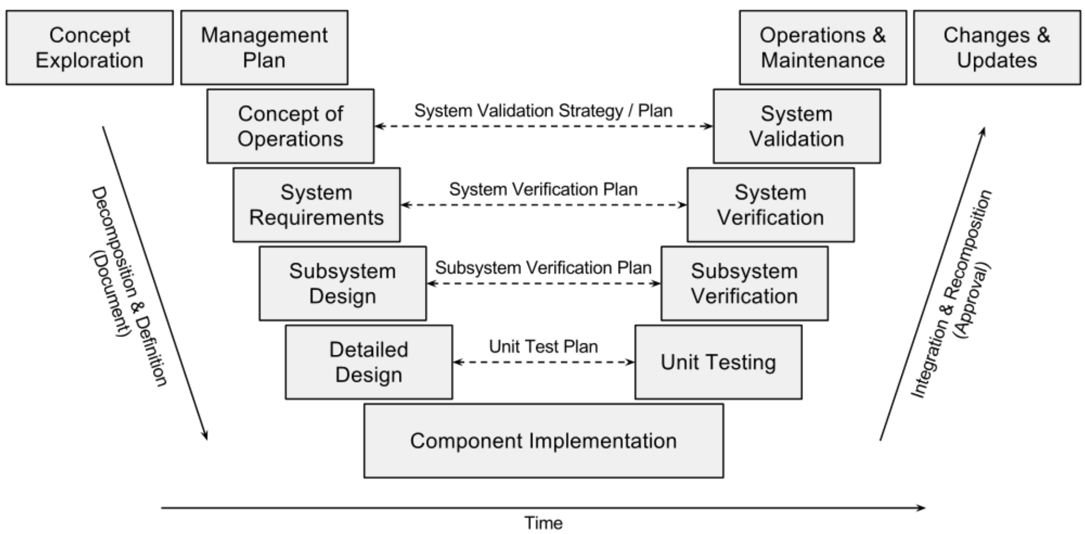

Figure 2. Vee model[13]

The vee model, depicted in Figure 2, is a commonly taught systems engineering approach for the design of complex products. This approach was first introduced by the German and U.S. militaries in the 1980s, and has since been adopted for use in commercial and academic applications[14]. The model is depicted as having two separate prongs, which can be referred to as the “decomposition and definition” stream and the “integration and verification” stream. This approach is comprised of a variety of phases which include: defining user requirements, generating system concepts and validation plans, developing performance specifications and verification plans, subsystem and component decomposition, subsystem assembly and verification, system validation, and system operation and maintenance planning. Although the vee model was not developed to be entirely iterative, each of the steps present within the decomposition and definition stream need to cross-verify or validate against corresponding steps in the integration and verification stream before the process can be considered complete. The high level of consideration of decomposition and verification within this approach makes it most suitable for projects with multiple sub-teams and high complexity.

Value driven design (VDD) is a design approach that was created by the American Institute for Aeronautics (AIAA) that centers on the value of a project and its components[15]. As it is taught, this perspective aims to optimize the attributes of a system to achieve the highest possible value to stakeholders. Generally, this approach considers mainly the objective functions of a system in a mathematical analysis, which typically contains fewer parameters and dimensioning than design functions. The application of design functions in such an analysis would likely overcomplicate the result, leading to poor correlation between design objectives and an optimized final product. This simplified approach does yield a single "score" to an analyzed design, and thus proves useful within some industrial applications. There are drawbacks to using this approach, however, as the omission of performance requirements within this model may lead to an incomplete design.

Software Engineering

Perhaps the most simplistic design formalism is the waterfall model, which is frequently applied to software development. This process was introduced by Royce in 1970, and was defined as having six or seven sequential phases, as can be seen in Figure 3, beginning with the establishment of requirements and culminating in an operations plan[16]. Although the waterfall model has evolved in the past few decades, the original phased decomposition remains as the main framework to the process. Due to the well-defined nature of this process and its ease of implementation with clear-cut milestones, it has often been used within the industry. However, the application of this approach could prove disadvantageous, as it does not prescribe any feedback loops and encourages compartmentalized design, thereby supporting little to no iteration throughout the development process.

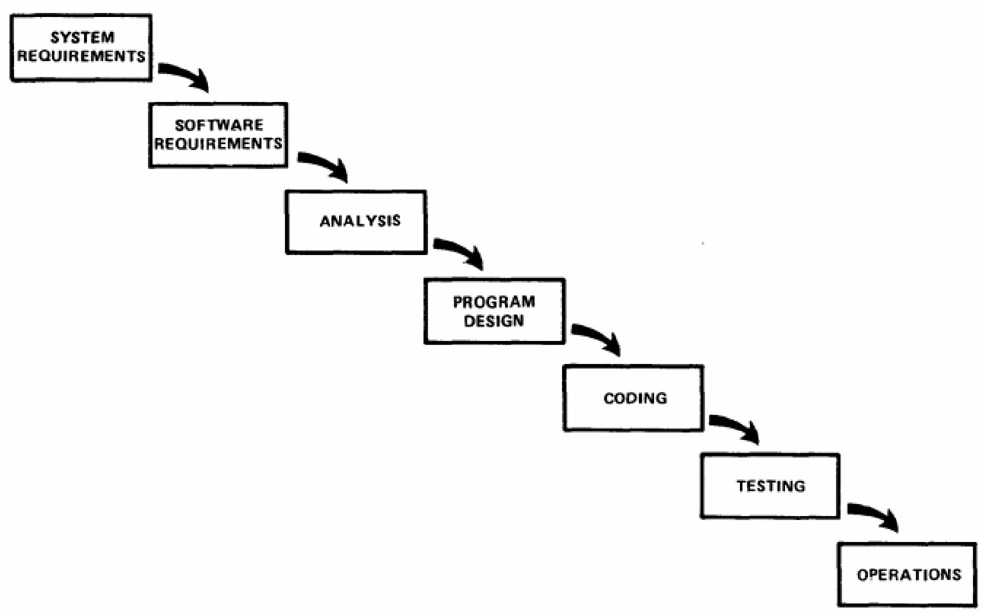

Figure 3. Waterfall model[16]

The spiral model is another highly iterative systems design approach, and it was first developed by Boehm, a software engineer, in 1986[17]. This approach shares similarities with the waterfall model, and both are extremely common in software engineering applications. The spiral model differs from the other approaches, however, as risk is the main driving consideration for design decisions. This model is applied through a series of iterative stages, and the development process can be altered or stopped completely as a result of a risk assessment at any point in the process. Though it is possible to implement this type of frequent assessment of risk with many of the other methods, the spiral model is the only approach that explicitly requires risk assessment through a series of iterative loops. Even though this consideration of risk can help to ensure a more complete project delivery, it may lead to additional delays throughout the development process.

Agile design is an approach introduced in 1999 by a team of software engineers in an effort to create a lightweight development methodology for rapid development and deployment[18]. It has since been enhanced by a variety of developers, but maintains the same main four values in the design process: continuous collaboration, consistent delivery of working prototypes, sufficient collaboration with customers, and timely response to change or challenges[19]. This approach encourages a flexible and iterative design process, in order to allow for adaptability at points in which a decision is to be made. Furthermore, unlike other processes, agile design promotes integrated testing throughout the development phase, as opposed to the traditional method of performing testing separately. Agile design proves to be beneficial in fast-paced industries as it allows for quick creation or alteration of a project. This approach does have drawbacks, however, as it has limited application to projects that are complex in scope.

Industrial and operations engineering

Total quality management (TQM) is a management environment for product development, which was initially developed in the late 1970s in the United States in an effort to match the high level of quality production by Japanese manufacturing[20]. This mindset was adapted and formalized by the U.S. Navy in 1984, and later developed by various national and international standard-setting organizations. Overall, this approach aims to improve customer satisfaction through constant enhancement of the way in which design and manufacturing processes are managed. In order for this approach to be fully effective, a solidified design process and/or manufacturing plan for a given project must be established, to which improvements are made. Furthermore, all actors present in an organization, ranging from designers to manufacturers to managers, are expected to adopt this mindset in order to achieve full effectiveness. This high-level approach has been further expanded upon and adapted into more detail-oriented design approaches, such as six sigma and lean manufacturing.

The theory of constraints (ToC) was developed by Goldratt, a business analyst, in 1984, and it is taught as a management perspective which focuses on the identification of a single limiting factor in a design or production process[21]. Following this identification, a scientific approach is followed to alter each particular process in an effort to either improve or eliminate this constraint[22]. The approach is designed to be iterative, as new constraints are prone to arise throughout the duration of a design or manufacturing process. This perspective can be applied to a variety of projects of differing scopes, as each is bound to contain an ineffective element. ToC does have its limitations, however, as its application is most effective when a top-level constraint can be identified, which is often a difficult task in practice.

Six sigma is a methodical approach to manufacturing that aims to optimize the quality of the product of manufacturing processes. Six sigma was introduced by engineers at Motorola in 1985, and has since been adopted by a number of large corporations[23]. This approach is taught with a main emphasis on reducing the variability present within a manufacturing process, which helps to remove causes of product defects[24]. Additionally, this perspective is applied to a particular company's employee base to ensure the proper assignment of personnel. The application of six sigma adds value to a company by reducing the waste that is produced during manufacturing. Some limitations exist, however, as this ideology is only effective when applied to a fully developed manufacturing methodology.

Lean manufacturing is an approach to design of manufacturing methods that places value within the elimination of waste within assembly processes. This perspective was developed from the Toyota Production System (TPS) in the early 1990s, and it is still widely implemented in industry[25]. This approach proves useful for industrial applications, as it encourages the development of more efficient processes that produce the same (or better) results as existing methods[26]. Thus, the approach is centered on the identification of the most and least valuable elements of a particular manufacturing process, in an effort to cut costs wherever possible. Benefits to using this approach include enhanced customer relations and lowered overall manufacturing costs. Much like six sigma, this approach is also limited, as it works best when applied to processes that are fully defined and already nearing completion.

Key Criteria: Metrics and Ratings

Following the review of these fourteen commonly taught and practiced approaches to design, and with informal input from several design faculty from different universities, seven key criteria were identified for characterizing the unique capabilities of an approach. These criteria include phases of the design process; hardware or software development; complexity; flexibility; project scope; focus on product form, organization, or manufacturing; and main objective. Each approach reviewed was placed on a scale or in a category for each of these criteria. These seven were selected from a larger group of originally-identified criteria, as they proved to be the most useful for differentiating among the various approaches being reviewed. These criteria were also selected and formulated to be easily assessable using simple questions, which is essential to creating a successful decision support tool.

The phases of the design process are a useful criterion because many approaches are applicable for only specific portions of the overall design process. For example, a designer is not likely to use six sigma to develop an innovative new product for a newly-identified market need, as six sigma is not suitable to the early-phase design steps. However, if the manufacturing process of that new product were being designed to maximize efficiency, six sigma would be valuable. Therefore, asking the user about the phases of design he or she believes the project covers can provide insight into which approach will be most useful.

Differentiating between a hardware or software development project can also be used to determine an appropriate approach for a new project. The literature review showed that a number of approaches, like the waterfall process and the agile process, are uniquely developed for software engineering projects. It is logical, then, that an engineer might develop a hardware or software project in different ways, necessitating different approaches for either type of project.

As some approaches were specifically designed for software, these are likely to be more suitable for software projects than others.

The complexity of a project is another useful metric by which to choose a design approach. A small, relatively simple object or part may be easily designed using the relatively generic engineering design method. However, a large collection of systems and subsystems is not likely to be best designed using only the engineering design method. This is, of course, why approaches for large systems like value driven design and the vee model were created.

The flexibility of an approach is also easily identifiable, and this is often one of the most obvious characteristics of an approach at first glance. However, this is a subjective requirement. Some designers or project managers may prefer more freedom within an approach, and for them, an approach like design thinking is appropriate. Others might prefer a rigid set of steps to follow; approaches like the waterfall process and the engineering design process provide that structure.

The scope of a project, and in particular whether it focuses on the detailed design of the product versus the interaction of the product with the outside world, is another key characteristic of design approaches. This criterion does overlap with the design phase, but it is different in subtle ways. For example, although systems thinking is intended to be applied through nearly every phase of design, it focuses on how the product or system interacts with its environment, making its scope larger, or "outwardly focused." In contrast, axiomatic design is used more in the middle phases of design, even though its scope is considered smaller, or "inwardly focused."

The emphasis of a project on product form, organization, or manufacturing is another useful piece of information in determining an appropriate design approach. Though some approaches, like the vee model, may be useful for any of the three categories, others are best applied to a single category, like engineering design for addressing product form, or agile design for addressing organization.

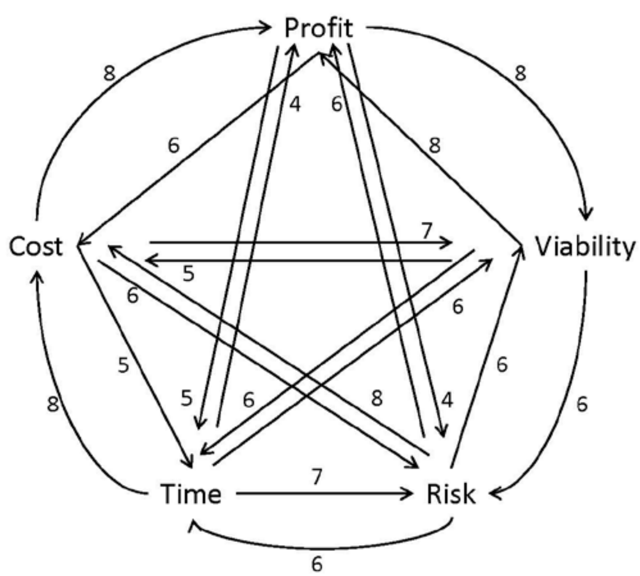

Figure 4. Correlation Mapping of Objectives

Finally, the main objective of the project can also be used to select the most appropriate design approach. Main objectives that are most easily identifiable include optimizing cost, maximizing profit, ensuring business viability, limiting risk, and minimizing time. Each of these main objectives can be linked to one or more design approaches, ensuring that the overarching purpose of the project is accounted for. This particular ranking criterion was identified to be less one-to-one than the others, as most projects seek to achieve multiple objectives concurrently. Thus, each of these main objectives is intrinsically linked, and contains some level of internal interaction. For example, there exists a strong correlation between attempting to both minimize the time of a project's completion while optimizing its total cost. In an effort to explore these correlations, and to analyze the effect that each would have on the functionality of the decision support system, a visual mapping of objectives was generated. This mapping features correlation values for each interaction (based upon a 1-10 scale) and is depicted in Figure 4. For all seven criteria, the ranking and categorization of each approach is shown in Table 1.

Table 1: Rankings of approaches within key criteria

Approach	**Phase: Early (1) vs Late (10)**	**Hardware, Software, or Both**	**Complexity: Low (1) vs High (10)**	**Flexible (1) vs Structured (10)**	**Scope: Inside, Outside, Both**	**Product Form, Organization, Manufacturing**	**Main objective**
Engineering Design	1-6	Hardware	4	9	In	Form	Viability
Design Thinking	1-6	Both	3	2	Both	Form	Viability
Decision Based Design	2-9	Both	7	4	Out	Form, Org	Profit
Systems Thinking	1-10	Both	6	2	Out	Form, Org	Viability
Axiomatic Design	3-6	Both	5	5	In	Form	Viability
Vee model	2-7	Both	10	6	In	Org	Risk
Value Driven Design	3-4	Both	7	5	Out	Org	Cost
Waterfall	2-9	Software	4	9	In	Org	Time
Spiral	2-6	Both	5	7	Out	Form, Org, Mfg	Risk
Agile	3-9	Software	6	6	Both	Form	Time
Total Quality Management	7-10	Both	8	5	Both	Org	Profit
Theory of Constraints	7-10	Both	6	4	Out	Mfg	Cost
Six Sigma	8-10	Hardware	8	7	Both	Mfg	Profit
Lean	9-10	Hardware	6	7	Both	Mfg	Cost

Decision Support System Development

The creation of a decision support tool is not a novel idea, and it has been previously explored in a variety of applications and using different tools and logical structures[27]. These software-based tools are intended to aid the process of decision making for particular contexts. The proposed decision support tool was constructed using Excel, and it contains an interactive front end that directly corresponds to the determined ranking scales from the previous section. As shown in Figure 4, the interface consists of a list of questions, prompting the user to provide input about the project at hand. Each of the yellow fields includes a drop-down menu with options for the user. These questions directly correspond to the key criteria from Table 1, as each possible input phrase maps to a numerical rating along these criteria in a separate sheet on the back end of the Excel tool. The tool includes additional worksheets that perform comparison calculations on the back end, each of which contributes to the resulting recommendation. The selections of the user are mapped to weighting values through a series of Excel functions. The driving functionality for this workbook is contained within a comparison table, which assesses the proximity of each user input to the previously assigned criteria ranking for each approach. The main objective query allows for users to input multiple selections, which link to a separate correlation chart contained within the back end of the spreadsheet. This proximity is also represented numerically, and the approach with the highest overall comparison table value, which is obtained through a sum of the comparison values for each input and respective ranking, is determined. This approach is deemed to be the most suitable methodology for a given project, and presented to the user as the green field at the bottom.

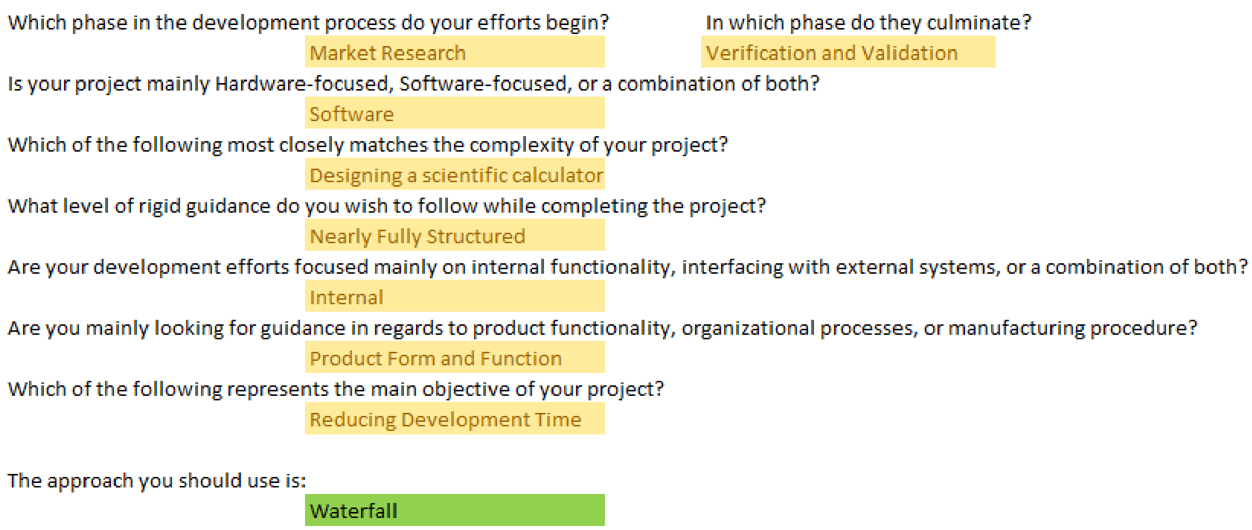

Figure 5. Decision Support System User Interface

This tool was conceived with a high consideration for modularity to allow for future iterations. Additional criteria can easily be incorporated within this decision support framework, which would contribute an increased level of robustness. Furthermore, supplemental design approaches can be added by following the same assessment approach using the key criteria. Such extensions would increase the utility and applicability of the tool for the user, while also expanding the population of potential users.

Example Cases

To showcase the utility of this decision support tool, it was applied to a series of hypothetical sample projects. The sample projects were chosen with the intent to showcase a range of project scopes and complexities to broadcast the potential range of utility of the decision support tool.

The first project is a senior-year undergraduate-level mechanical engineering design project, which tasks a group of four students with developing a small mechatronic commercial product. The second project was the development of a mobile application in a software engineering class, which incorporates input from multiple small teams contained within a (mock) fledgling software engineering company. Lastly, in an industrial engineering class, groups were tasked with assuming the roles of managers within a medium-sized automobile tire company, in order to assess its manufacturing process.

University Project – Mechatronic Device

The first case study is a group project that takes place during a senior-year college engineering course. This project tasks students with the development of a small commercial product which features both mechanical and electrical features. The parameters which were assigned for this project included a maximum group size of four students, a $250 budget, and a total development time of 6 months. In this particular case, the team decided to construct an automated houseplant maintenance device. Based on the objectives of the project and the preferences of each of the members, the group applied the decision support tool with the inputs shown in Table 2, resulting in the recommendation that the project team should apply the engineering design process to their development efforts.

Mobile Application

The next case study follows a software engineering class completing a collaborative final project, which involves the development of a mobile application. For this assignment, the class assumes the role of a small software engineering company, which was contracted to develop an application for a mid-sized movie theater chain. The objectives of this application are to offer users a means to display available movie times, implement payment options, purchase and manage purchased tickets, and deliver a scannable “QR” code that can be used for admission. Furthermore, this application is required to contain a significant level of social media integration. Based on these project parameters and objectives, the development team made use of the decision support tool with the inputs shown in Table 2. For this case, the recommendation was for developers to follow the agile approach.

Tire Manufacturer

The final case study involves groups within an industrial engineering class who were tasked with assuming management roles within a (mock) large-scale automobile tire producing company. In this case, the production managers of this company have chosen to analyze the currently established manufacturing process using the decision support tool in an effort to optimize product output. Presently, profit margins are acceptably high, but several managers have expressed concerns about possible wastes of human resources throughout the production model. Furthermore, this company has just been contracted to exclusively supply an international automobile company with tires for all of its new makes and models. With these considerations in mind, the decision support tool recommended that the managers follow the lean manufacturing approach.

Table 2. Case study inputs and outputs

	Case 1: Mechatronic device	Case 2: Mobile application	Case 3: Tire manufacturer
Input 1 (Phase):	Problem Identification – Verification and Validation	Market Research – Verification and Validation	Manufacturing Specification – Supply Chain and Logistics
Input 2 (Hardware vs. Software vs Both):	Hardware	Software	Hardware
Input 3 (Complexity):	Designing a scientific calculator	Designing a small robot	Designing a laptop computer
Input 4 (Guidance Level):	Nearly Fully Structured	Nearly Full Flexibility	Some Flexibility
Input 5 (Internal vs External vs Both):	Internal	Both	External
Input 6 (Functionality vs Organization vs Manufacturing):	Product Form and Function	Product Form and Function	Manufacturing
Input 7 (Main Objective):	Ensuring Viability	Maintaining Sustainability	Maximizing Profit
Recommended Approach:	Engineering Design	Agile	Lean Manufacturing

Discussion

As can be seen in the cases described above, this decision support system can be used by design teams, student groups, and even project managers to select a suitable structured design methodology for projects in both academic and industrial settings. The prompts provided to the user in the interface directly correspond to the key ranking criteria, which are applicable to a large array of projects of varying type, complexity, and scope. Thus, nearly any development process can be analyzed in an effort to optimize product quality, reduce production cost, or expedite completion time. Additionally, this tool provides designers with an educational resource to discover structured approaches for which they may have not been previously exposed to. This consideration is important, as most design practitioners are inclined to only follow an approach that they have previous educational or professional experience with, regardless of its value or specialization towards a given project.

Naturally, the presently-developed tool contains some limitations, and this is intended to be a first iteration. The main limitations in the current version are related to the ambiguity of the questions that are posed to the user. This vagueness is mostly intentional, however, as it would be impractical to provide considerations for the infinite number of project types which can be assessed using this tool. An attempt to do so would result in an over-complicated and inaccessible tool. Limitations also exist in the scope of the included design approaches. For the purposes of this initial version, fourteen design approaches and environments were ranked according to the identified key criteria and thus considered for output. This limitation can be mitigated with the inclusion of additional approaches and perhaps updated key criteria in future iterations of the decision support tool.

The future of this work lies mostly in the expansion of the decision support tool developed. There are many other useful approaches to design that are not included in this review, but with further research and time, other approaches can be added. Additionally, following more expert input, both from the educational and industrial sectors, the rankings of each approach along the seven criteria can be fine-tuned to more accurately represent each approach. The tool can also be tested in university classrooms to confirm its usefulness and to identify shortcomings that need to be addressed. Other ways of fine-tuning this support tool include interviewing practitioners or holding focus groups to better understand how people unfamiliar with the concept interact with a tool like this one. Finally, additional resources may be added about each approach. This will be most useful in an educational setting, as instructors can utilize this tool in the classroom to teach students about different approaches to design. Making these resources easily available to students within the tool will make the approaches themselves more accessible, and will make students better future designers.

Conclusion

This paper reviews fourteen design approaches, establishes key criteria to compare and differentiate them, and develops and proposes a decision support tool for selecting structured design approaches, which is intended as an educational tool for designers involved in academic and industrial projects alike. This system has the capability to accommodate a large variety of project parameters in an effort to recommend the most suitable design approach for any given project, and it can serve as a key resource for students and project planners looking to discover and select design approaches that can best help them achieve their goals. Currently, fourteen design approaches and environments are included, with each methodology ranked according to a set of seven criteria that consider the relative applicability toward particular aspects of a development process. Future iterations of this decision support system will include a wider range of design approaches and additional ranking criteria to produce a more robust and comprehensive tool, as well as further development of the existing criteria and the user interface.

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