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Concurrent structure and process optimization for minimum cost metal additive manufacturing [Texto impreso] / Erva Ulu, Runze Huang, Levent Burak Kara, Kate S. Whitefoot

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061701(8-10)

Metals-additive manufacturing (MAM) is enabling unprecedented design freedom and the ability to produce significantly lighter weight parts with the same performance, offering the possibility of significant environmental and economic benefits in many different industries. However, the total production costs of MAM will need to be reduced substantially before it will be widely adopted across the manufacturing sector. Current topology optimization approaches focus on reducing total material volume as a means of reducing material costs, but they do not account for other production costs that are influenced by a part's structure such as machine time and scrap. Moreover, concurrently optimizing MAM process variables with a part's structure has the potential to further reduce production costs. This paper demonstrates an approach to use process-based cost modeling (PBCM) in MAM topology optimization to minimize total production costs, including material, labor, energy, and machine costs, using cost estimates from industrial MAM operations. The approach is demonstrated on various 3D geometries for the electron beam melting (EBM) process with Ti64 material. Concurrent optimization of the part structures and EBM process variables is compared to sequential optimization, and to optimization of the structure alone. The results indicate that, once process variables are considered concurrently, more cost effective results can be obtained with similar amount of material through a combination of (1) building high stress regions with lower power values to obtain larger yield strength and (2) increasing the power elsewhere to reduce the number of passes required, thereby reducing build time. In our case studies, concurrent optimization of the part's structure and MAM process parameters lead to up to 15% lower estimated total production costs and 21% faster build time than optimizing the part's structure alone.

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Consideration-constrained engineering design for strategic insights [Texto impreso] / Minhua Long, Michael Erickson, Erin F. MacDonald

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 064501(8)

Consumer behavior can be modeled using a decision-making process termed “consideration” in which consumers form requirements, “consideration rules,” in order to narrow their options for further evaluation. One type of consideration rule is the conjunctive rule, where a consumer makes a list of requirements and a product must meet all of the requirements in order to be considered for purchase, such as “the vehicle must get 25 miles per gallon or more”; “it must be priced at $22,000 or less”; and “it must be a standard-sized sedan.” This paper offers a design framework for linking these consideration rules with design. We demonstrate the use of our framework with a case study, namely the Volkswagen (VW) “clean diesel” scandal, which investigates the design strategies used in response to the scandal by capturing considerations within the marketing product planning subproblem and assuring engineering feasibility within the engineering design subproblem.

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3

Designing for trust [Texto impreso] : understanding the role of agent gender and location on user perceptions of trust in home automation / Nicole Damen, Christine Toh

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061101(9-11)

Although trust can have a positively mediating effect on information technology adoption and usage, the concept has not been extensively investigated in the home automation field. Therefore, this work is aimed at exploring the role of agent location and the gender of the agent's voice on users' perception of trust toward automation through two experimental studies (N = 8 and N = 20) and a web-based smart lock simulation. Explicit trust behavior was captured using directly observable behaviors and decisions, while implicit trust behavior was captured using detailed click-level user behaviors with the smart lock simulation as a proxy for reaction time. The results show that users displayed more explicit trusting behavior toward the system when it displayed design characteristics that were stereotype congruent (female-home and male-office) compared to stereotype incongruent systems (male-home and female-office). These results show that users carry over the social expectations and roles encountered in human-to-human relationships to interactions with simulated automated agents. These findings empirically demonstrate the influence of design characteristics on the formation of trust relationships between users and automated devices and provide a foundation for future research geared at critically examining our evolving relationship with technology.

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1. Automated agents 2. Gender 3. Home automation 4. Implicit attitudes 5. Location 6. Stereotype congruence 7. Trust 8. User behavior

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4
Does the preferences for creativity scale predict engineering students' ability to generate and select creative design alternatives? [Texto impreso] / Christine Toh, Scarlett R. Miller

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 062001(11-13)

Creativity is universally acknowledged as an important attribute of successful engineering design, but individual attributes and preferences can influence whether creative ideas come to fruition during the design process. However, few studies have explored the factors that can predict creative concept generation and selection in engineering design education. Thus, the current study was developed to provide an empirical understanding of how student designers' preferences for creativity predicts their ability to generate or select creative design alternatives during the concept screening process above and beyond the effects of personality through an empirical study with 178 engineering students. The factors explored included the Big 5 factors of personality, the preferences for creativity scale (PCS), and the novelty and quality of ideas generated and screened. The results show that the openness personality trait can predict the novelty of generated ideas as well as the novelty and quality of selected ideas during the concept screening process and that the creative confidence and preference factor of the PCS can predict the novelty of generated ideas and the novelty and quality of selected ideas during the concept screening process beyond the Big 5 factors of personality. A similar finding was obtained for the risk tolerance factor of the PCS. These findings demonstrate the importance of an individual's attitude toward risk and their creatve confidence in the generation and selection of ideas in engineering education and provide a foundation for future research geared at building student innovation capacities.

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Form defects consideration in polytope-based tolerance analysis [Texto impreso] / Ting Liu ... [et al.]

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061702(15-16)

The polytope-based tolerance analysis in design process uses a finite set of constraints to represent specifications and propagates these constraints to any objective point in the Euclidean space. The operations of Minkowski sum and intersection on polytopes are well suited to serial and parallel assemblies. The polytope model has been applied to complex assemblies which contain a large number of joints and geometrical tolerances. However, the previous studies on this model consider toleranced features as surfaces of perfect form. The ignorance of form defects in tolerance analysis would result in a significant loss in accuracy and reliability. In this paper, an extension of the polytope model for tolerance analysis considering form defects is described in which the skin model shape representing the physical shape of the product is adopted to simulate the actual

toleranced feature in place of the substitute one used conventionally. The combination of polytope model and skin model shape is expected to inherit many of the advantages of each model, combining easy-to-use tolerance propagation and form defects representation with accuracy guarantees. To demonstrate the method and its respective application, a case study of an assembly is illustrated in detail. The proposed method further enhances the capability of the polytope model in handling form defects and provides more realistic assembly results that approximate the actual assembly conditions for design evaluation.

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Generating technology evolution prediction intervals using a bootstrap method [Texto impreso] / Guanglu Zhang, Douglas Allaire, Daniel A. McAdams, Venkatesh Shankar

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061401(9)

Technology evolution prediction is critical for designers, business managers, and entrepreneurs to make important decisions during product development planning such as R&D investment and outsourcing. In practice, designers want to supplement point forecasts with prediction intervals to assess future uncertainty and make contingency plans accordingly. However, prediction intervals generation for technology evolution has received scant attention in the literature. In this paper, we develop a generic method that uses bootstrapping to generate prediction intervals for technology evolution. The method we develop can be applied to any model that describes technology performance incremental change. We consider parameter uncertainty and data uncertainty and establish their empirical probability distributions. We determine an appropriate confidence level to generate prediction intervals through a holdout sample analysis rather than specify that the confidence level equals 0.05 as is typically done in the literature. In addition, our method provides the probability distribution of each parameter in a prediction model. The probability distribution is valuable when parameter values are associated with the impact factors of technology evolution. We validate our method to generate prediction intervals through two case studies of central processing units (CPU) and passenger airplanes. These case studies show that the prediction intervals generated by our method cover every actual data point in the holdout sample tests. We outline four steps to generate prediction intervals for technology evolution prediction in practice.

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1. Bootstrapping 2. Lotka-Volterra equations 3. Moore's Law 4. Prediction interval 5. Technology evolution 6. Uncertainty

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7

Is more less? [Texto impreso] : benefits and costs of high-variety production in nonassembled manufacturing / Rianne E. Laureijs, Erica R. H. Fuchs, Kate S. Whitefoot

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061703(10-11)

While many studies have characterized the costs of product variety in assembly production, there is little research detailing the sources and costs of increased product variety on a nonassembled (fabrication) production line, despite nonassembled products accounting for over 50% of U.S. manufacturing. Our research examines the production-level costs, benefits, and margins associated with producing a variety of nonassembled products, and how design attributes affect these outcomes. We propose a theoretical framework of nonassembled product variety, identifying five general design attributes of nonassembled products that influence product-variety outcomes, and identify potential sources of variety costs and benefits. We then conduct a case study of a plant that produces a large variety of unique products in a single year. We develop a new process-based cost modeling (PBCM) technique to capture the impacts of product variety. Leveraging design of experiments (DOE), we model fourteen representative products, altering the mix of products to focus on each design attribute. In our case study, which has relatively large lot sizes, less customized designs, and less flexible equipment, we find that cost increases related to changeovers between product designs are small relative to cost benefits derived from sharing equipment and labor. We provide a framework illustrating how these results generalize to other contexts, which

shows that changeover costs will dominate sharing benefits in environments with more customized designs, produced in smaller lot sizes, and processed on flexible equipment.

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A new stance control knee orthosis using a self-locking mechanism based on a planetary gear train [Texto impreso] / Gaspar Rodríguez Jiménez, David Rodríguez Salgado, Francisco Javier Alonso Sanchez, Jose María del Castillo Granados

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 065001(10)

The objective of this work was to design and build a fully mechanical knee orthosis. A knee orthosis should both allow control of the angle of flexion of the knee during the stance phase of the gait cycle and leave the joint free during the swing phase. Knee orthoses are normally used to assist the walking of people suffering from muscle weaknesses or gait pathologies in order to avoid excessive knee flexion during the stance phase. The design of the orthosis proposed in the present work is characterized by allowing the knee to be locked at any angle of flexion during the stance phase, and because the orthosis can be unlocked to allow the joint to be released in the swing phase without the action of any external agent, i.e., without requiring external electrical or electronic systems for the control and performance of the orthosis. These characteristics mean that the design can be adapted to the gait of any user. The proposed design consists of a set of three rods, one attached to the user's thigh, another to the calf, and the other to the foot, connected to each other by a self-locking planetary gear train (PGT).

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On the use of symmetries in building surrogate models [Texto impreso] / M. Giselle Fernández-Godino, S. Balachandar, Raphael T. Haftka

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061402(14)

When simulations are expensive and multiple realizations are necessary, as is the case in uncertainty propagation, statistical inference, and optimization, surrogate models can achieve accurate predictions at low computational cost. In this paper, we explore options for improving the accuracy of a surrogate if the modeled phenomenon presents symmetries. These symmetries allow us to obtain free information and, therefore, the possibility of more accurate predictions. We present an analytical example along with a physical example that has parametric symmetries. Although imposing parametric symmetries in surrogate models seems to be a trivial matter, there is not a single way to do it and, furthermore, the achieved accuracy might vary. We present four different ways of using symmetry in surrogate models. Three of them are straightforward, but the fourth is original and based on an optimization of the subset of points used. The performance of the options was compared with 100 random designs of experiments (DoEs) where symmetries were not imposed. We found that each of the options to include symmetries performed the best in one or more of the studied cases and, in all cases, the errors obtained imposing symmetries were substantially smaller than the worst cases among the 100. We explore the options for using symmetries in two surrogates that present different challenges and opportunities: Kriging and linear regression. Kriging is often used as a black box; therefore, we consider approaches to include the symmetries without changes in the main code. On the other hand, since linear regression is often built by the user; owing to its simplicity, we consider also approaches that modify the linear regression basis functions to impose the symmetries.

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Overall image of the tooth surface properties of skew gears [Texto impreso] / Yoshichi Otake

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 063301(10)

The geometrical tooth surface properties of skew gears have a significant influence on gear performance. We consider the contact line angle, slip rate, and relative curvature as tooth surface properties. An overall image of the tooth surface properties is an effective means of optimization. However, this whole image is unknown, because the tooth surface properties are represented by four elements of the tooth surface, and it is difficult to express them in one coordinate space. This problem is overcome by expressing the tooth surface properties using three elements. First, three-element expressions for the tooth surface properties are derived and the tooth surface property space, which expresses the overall image of the tooth surface properties, is constructed using the three elements as coordinate axes. Next, the characteristic surface of the tooth surface property space is clarified and an image of the space is simulated. From this, it is possible to visually and intuitively capture the features of the tooth surface property space, i.e., the whole image. Finally, the wide range of applications of the tooth surface property space is discussed. This demonstrates that the tooth surface property space provides important indicators and standards for the future development and designs.

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Topology optimization of three-dimensional woven materials using a ground structure design variable representation [Texto impreso] / Seung-Hyun Ha, Hak Yong Lee, Kevin J. Hemker, James K. Guest

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 061403(10)

Three-dimensional (3D) weaving has recently arisen as viable means for manufacturing metallic, architected microlattices. Herein, we describe a topology optimization approach for designing the architecture of such 3D woven lattices. A ground structure design variable representation is combined with linear manufacturing constraints and a projection mapping to realize lattices that satisfy the rather restrictive topological constraints associated with 3D weaving. The approach is demonstrated in the context of inverse homogenization to design lattices with maximized fluid permeability. Stokes flow equations with no-slip conditions governing unit cell flow fields are interpolated using the Darcy–Stokes finite element model, leveraging existing work in the topology optimization of fluids. The combined algorithm is demonstrated to design manufacturable lattices with maximized permeability whose properties have been experimentally measured in other published work.

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