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THE INFLUENCE OF PROCESS AND BUSINESS ANALYTICS ON PRODUCT INNOVATION IN THE FOREST PRODUCTS INDUSTRY

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Abstract
The paper presents a theoretical framework for improved process and business analytics during the innovation phase of forest products. Forest products companies exist in highly competitive markets; product innovation and differentiation advantage are keys to survival. The ‘experience curve’ from early product development, manufacturing of new products, to market adoption is expensive; and the length of time a company has on the ‘experience curve’ may greatly affect the costs per unit of manufactured product. The rich data of our ‘knowledge society’ from both processes and marketplaces has many advantages for forest products companies. Process analytics used in the context of Taguchi Robust Product Design (TRPD) may lead to higher product value while lowering costs of manufacturing. Successfully implementing a process metric such as the signal-to-noise ratio in the context of TRPD may greatly reduce the time a company spends on the experience curve and improve competitive advantage.

Key words: *process analytics; product innovation; forest products; signal-to-noise ratio.*

INTRODUCTION

The ‘democratization of knowledge’ and the emergence of social media and multimedia, smartphones, computers, and other consumer and industrial devices (used within privacy guidelines and assuring anonymity) has become a rich source for behavioral insights and consumer preferences (Deming 2010). This ‘knowledge society’ can become a rich source of knowledge for forest products companies interested in gaining competitive position through product innovation. The challenges however, of capturing business value should not be underestimated. Technology, as everyone knows, changes much faster than people (Drucker 1995).

The classic definition of *innovation* is that it is comprised of the generation, acceptance, and implementation of new ideas, processes, products, or services (Thompson 1967). A *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses (OECD/Eurostat 2005). This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment, and/or software (Stendahl and Rose 2008). This paper attempts to provide a template for analytics in developing innovative forest products in a reduced time frame relative to traditional trial-and-error methods.

Historically, forest products companies are slow in product innovation. Rogers (2003) defines the process of product innovation as the “diffusion of innovation”. Many companies struggle with going beyond a “commodity” focus for their products and must compete based on cost-advantage only. Some forest product companies with a strong competitive position have gone beyond the “commodity focus” and have a *product differentiation advantage* by developing new products adopted by the marketplace. Some examples of successful innovative forest products adopted by the marketplace are: cross-laminated timber (CLT); multi-functional ready-to-assemble (RTA) furniture; wood plastic composites (WPC); cellulosic insulation; lignin reinforced carbon-fiber; biobased adhesives; wood-based nanomaterials such as nanotubes and nanofibers used in the textile industry to make waterproof and tear-resistant fabrics; wood modification treatments (wood acetylation and furfurylation); etc. (Espinoza and Laguarda-Mallo 2015).

The purpose of this paper is not to present an exhaustive list of innovative forest products, but to discuss the potential influence of process and business analytics on product innovation in the forest products industry. Improved business competitiveness for many companies exist if such companies can successfully navigate the *diffusion process of innovation* (Rogers 2003); while decreasing per unit costs along the "experience curve" of manufacturing new products (Wagner 2014).

This paper is conceptual and is an attempt to facilitate constructive thought on how process and business analytics can help companies accelerate product innovation and adoption, while rapidly decreasing per unit costs during the manufacturing new products. Taguchi Robust Product Design (TRPD) is highlighted as a template for reducing the time along the experience curve.

PROCESS DEVELOPMENT AND PRODUCT VARIANCE ANALYTICS

Process development research is important during product innovation. Such research involves data gathering and analyses that attempts to quantify the variability of the manufacturing process and product attributes during a sequence of events over time. Variance is cumulative in most forest products manufacturing processes (i.e., 'series-systems') and this accumulated variance during manufacturing leads to high per unit costs of manufacturing. Manufacturing of new products has many challenges, e.g., new feedstocks and/or binders, uncertain or untested operational targets, long process setup times, slower than necessary processing speeds, unique product testing requirements, smaller than required manufacturing runs etc. Some authors call this phenomenon the "experience curve" (Wagner 2014), Fig. 1.

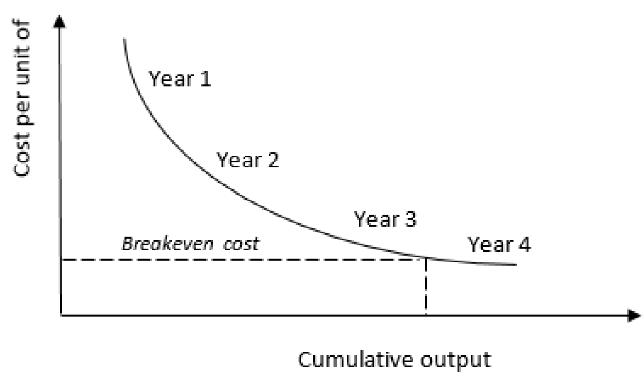

Fig. 1.
Illustration of the 'experience curve'

Taguchi Robust Product Design (TRPD) is a proven method for reducing variation during new product development and production, which focuses on improving product value while reducing variation and the costs of manufacturing. A key metric of TRPD is the signal-to-noise ratio (SN ratio), see Taguchi (2005). The SN ratio is defined:

$$SN\,ratio = \frac{power\,of\,signal}{power\,of\,noise} = \frac{(sensitivity)^2}{(variability)^2} = \frac{\beta^2}{\sigma^2} \qquad (1)$$

The SN ratio is the ratio of sensitivity to variability squared. Therefore, its inverse is the variance per unit input. The business justification for TRPD as related to the SN ratio is the Taguchi Loss Function (Taguchi 2005), see Fig. 2.

In the loss function, the loss is proportional to variance. Therefore, Taguchi (2005) argues monetary evaluation is possible. As a company use the SN ratio of new product development and production, variance is reduced over time which improves value and lowers cost per unit of output (Fig. 3). Thus, the rate of decline on the 'experience curve' (Fig. 1) is faster, reaching the breakeven price in a shorter period of time when compared to traditional trial-and-error methods.

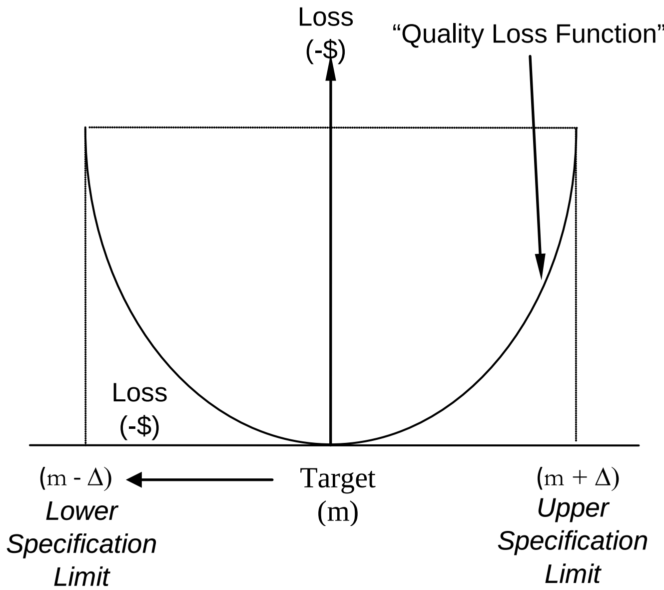

Fig. 2.
Illustration of Taguchi loss function

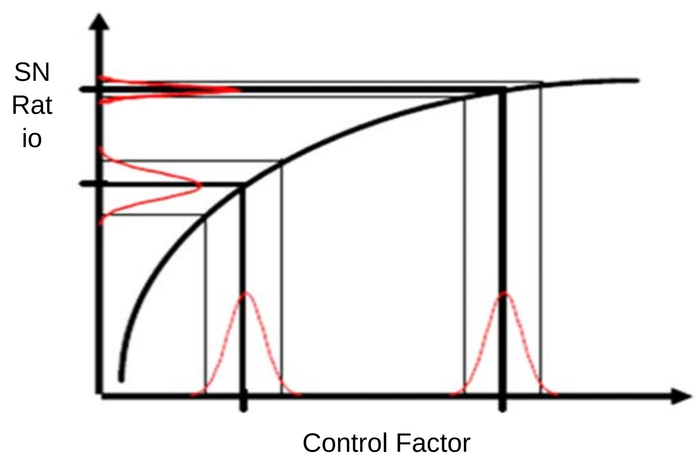

Fig. 3.
Illustration of SN ratio (response) as a function of a control factor

Taguchi (2005) argues, this is the most important benefit of the SN ratio in product or process development and design. As Taguchi (2005) notes: *"Using traditional methodologies, engineers tend to design a product or a process by meeting the target first instead of maximizing robustness first. This 'hitting the target first' approach is very inefficient. After the target is met, the engineer has to make sure the product works under noise conditions (e.g., temperature variation). If the product does not work for a certain extreme temperature during processing, the engineer has to adjust the design parameters to meet* *the target."* Taguchi (2005) further argues that this type of trial-and-error experimentation is tedious and time consuming, and it is not always successful, which is costly.

Variance research can also be used in conjunction with TRPD. Sources of variation acting on key process parameters and product attributes can be diagnosed by examination of covariances and correlations. This can benefit the product development stage for further improvement in operating targets and reduction of costs by variance reduction. TRPD can help many businesses by reducing the time to product development and avoiding negative cash flow problems that sometimes occur in the 'experience curve'. Avoiding negative cash flow is critical for the small business owner.

CONCLUSIONS

The paper is a theoretical discussion on the use of improved process and business analytics to reduce the time frame for product innovation on the 'experience curve'. The experience curve, in a business context is expensive and non-competitive for forest products companies.

Taguchi Robust Product Design (TRPD) provides an analytical framework of the process that accounts for process variance or 'noise' while maximizing product value. The TRPD framework with the key metric of the signal-to-noise ratio (SN ratio) is better than traditional trial-and-error methods of attaining a target during manufacture. The TRPD framework may greatly shorten the product development process during innovation for forest products companies and lower manufacturing costs per unit.

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