Chapter 14
Innovation in Product Design:
IoT Objects Driven New Product Innovation and Prototyping Using 3D Printers

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ABSTRACT

The IoT and 3D printing can become a potent combination when it comes to launching new business initiatives driven by hard-core data and analytics and not really based on human perceptions or limited survey data. Previous empirical research has shown that drivers of new product performance are a mix of strategic, development process, organizational, and market environmental factors. This chapter attempts (1) to understand how introduction of IoT sensors embedded in customer appliances or wearable's sending real time customer information coupled with rapid prototyping using remotely located 3D printers can help address design considerations for new products, and (2) to provide an overview of how using IoT data and 3D printers for new product development and prototyping as an early stage activity can be done without using human imagination of restricted market survey data.

INTRODUCTION

Entering new markets and predicting customer behaviour and analysing his purchase pattern for a market driven product design and development is a risky proposition. The primary advantage of the Internet of Tings (IoT) in such business cases is their ability to create situational awareness and enable applications, human beings and machines to better understand surrounding for timely informed decisions in a dynamic daily changing environment. Sensor generated data related to our physical world can help us understand better and create newer products and services. 3D printing will help convert such data into visible prototypes (Nashiya, 2015).

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"The worldwide 3D printing industry in expected to grow from $3.07B in revenue in 2013 to $12.8B by 2018 and 3D printing technology is destined to transform almost every major industry (Allied Market Research, 2015). 3D printing also called additive manufacturing is a process of making three dimensional solid objects from a digital file using specific raw materials which can vary from plastic to metal. 3D printing starts with providing a virtual design of the object to be printed in a Computer Aided Design (CAD) file format. Also of relevance are 3D scanners which use different technologies to generate a 3D model such as time-of-flight (uses laser light to probe the subject), structured / modulated light (project a pattern of light on the subject and look at the deformation of the pattern on the subject) or volumetric scanning (industrial computed tomography) (David, 2014).

The next step is to convert the 3D model using specialised software by a process called "Slicing" which is dividing a 3D model into hundreds or thousands of horizontal layers.3D printing has several ways of printing and all are additive with differences in the way layers are built to create the final object. These methods range from melting, selective laser sintering (SLS) and fused deposition modelling (FDM) or curing a photo-reactive resin with a UV laser or another similar power source one layer at a time (known as stereo lithography SLA).

The American Society for Testing and Materials (ASTM) developed a set of standards that classify the Additive Manufacturing processes into 7 categories as below (ASTM52900, 2015):

- **Vat Photo Polymerisation:** This uses a container filled with photopolymer resin which is then hardened with UV light source.
- **Material Jetting:** In this material is applied in droplets and overlapped layer by layer to build an object by using a small diameter nozzle.
- **Binder Jetting:** In this two materials are used: powder base material and a liquid binder, powder is spread in equal layers and binder is applied through jet nozzles that "glue" the powder particles in the shape of a programmed 3D object.
- **Material Extrusion:** This uses a technology called fused deposition modelling (FDM) in which the plastic or metal filament is heated and sprayed from a nozzle, which can move bi-directionally, into layers which gets hardened immediately.
- **Powder Bed Fusion:** The technology involves high power laser to fuse small particles of plastic, metal, ceramic or glass powders into a mass of desired 3D shape.
- **Sheet Lamination:** This involves sheets of metal, paper or polymer welded together by ultrasonic waves or adhesive glue.
- **Directed Energy Deposition:** This consists of a multi axis Robotic arm and a nozzle depositing metal powder with an energy source which can be laser, electron beam or plasma arc.

IoT and 3D printing can become a potent combination when it comes to launching new business initiatives driven by hard-core data and analytics and not really based on human perceptions or limited survey data which are generally bound to fail and may not be fully exhaustive or indicative. Previous empirical research has shown that drivers of new product performance are a mix of strategic, development process, organisational and market environmental factors (Geroski, Machin and Van Reenen 1993, Soni, Lilien and Wilson 1993, Capon, Farley and Hoenig 1990). Entering new markets and predicting customer behaviour and analysing consumers' purchase pattern for a market driven product design and development is a risky proposition.