Product Ecosystems: An emerging methodological approach to study the implementation of disruptive innovations: The case of the CityCar

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Abstract:

The car has arguably had more influence on our lifestyle and urban environment than any other consumer product; allowing unprecedented freedom for living, working and recreation where and when we choose. However, problems of pollution, congestion, road trauma, inefficient land use and social inequality are associated with car use.

Despite 100 years of design and technology refinements, the aforementioned problems are significant and persistent: many argue that resolving these problems requires a fundamental redesign of the car.

Redesigned vehicles have been proposed such as the MIT CityCar and others such as the Renault Twizy, commercialized. None however have successfully brought about significant change and the study of disruptive innovation offers an explanation for this. Disruptive innovation, by definition, disrupts a market. It also disrupts the product ecosystem. The existing product ecosystem has co-evolved to support the conventional car and is not optimized for the new design: which will require a redesigned ecosystem to support it.

A literature review identifies a lack of methodology for identifying the components of product ecosystems and the changes required for disruptive innovation implementation.

This paper proposes such a methodology based on Design Thinking, Actor Network Theory, Disruptive Innovation and the CityCar scenarios.

Key words: CityCar, Design Thinking, Design Driven Innovation, Disruptive Innovation, Introduction

1. Introduction

Innovation is playing an increasingly important role in providing competitive advantage and so planning for and managing innovation is important. There are however varying degrees of innovation, from incremental, where relatively minor changes take place, to radical or disruptive innovation that changes or creates new markets. [1] Risks, cost and uncertainty tend to increase as innovation becomes more disruptive as do the potential rewards of being first or early to market. The literature around disruptive innovation management tends to focus on organizational structure and practices. There is a lack of understanding of how to predict the effects of disruptive innovation in a market place. This research introduces the concept of Product Ecosystems as a means to visualize and evaluate the way in which potential disruptive innovation interacts with other products and services. This paper reports an ongoing research project that aims to develop a method for understanding the requirements for implementing disruptive innovation in a complex interdependent system. By evaluating potential future cars, this case study will contribute to Australia's transition to more socially, economically and environmentally sustainable use of personal urban transportation. The study employs a range of design methodologies as a means to identify the changes required of the components of the new system.

The car is undoubtedly one of the greatest inventions of our time. It gives us freedom and independence and we love them. The car has allowed our cities to grow and shaped the urban form. However the car is also responsible for some significant problems such as pollution, congestion, road trauma as well as the cost burden of ownership and social and urban development problems [2]

The following examples support this position:

- "The greatest contributor to atmospheric warming now and in the near term" is pollution from vehicles[3]
- Air pollution is responsible for about twice as many deaths as motor vehicle accidents [4]
- In Australia the 2005 avoidable social costs caused by traffic congestion were $9.39 Billion. [5]
- Annually around 1300 people die on Australian roads each year, one million worldwide. [6]
- Road crashes in Queensland alone cost an estimated $4 billion annually. [7]
- On average, cars are unused (parked) 95% of the time. Roads occupy on average 30% of the land area of cities and parking space a further 20%. [8] This represents an extremely inefficient system [9]
- In Australia the average cost to own a car is $10,500 per annum [10] or on average 23% of the median after-tax Australian income. Cost of car ownership is increasing and predictions of peak oil suggest this will only accelerate.[11] [12] This creates social inequity for those who cannot afford a car or who are unable to drive as they are at a disadvantage in terms of employment, access to shopping and medical services [13]

Whilst emissions per vehicle have been reducing at around 4% pa in Australia this is offset by an increase in the total number of vehicles. Reducing the number of vehicles on the roads by encouraging alternative travel modes would both decrease congestion and reduce emissions. However efforts so far have been largely unsuccessful with of with around 90% of all trips still by private car [14]

A fundamental redesign of the car has the potential to substantially improve most of these points. Many attempts at this have been made with few getting past the concept stage ([2]). The common themes for redesign seem to be the following:

- Smaller cars. Micro cars have a much reduced footprint on the road and depending on the design may only require a third of the parking space. Smaller vehicles have less mass and therefore require less energy and cost less to purchase and run. [15]
- Electric drive. This allows greater design freedom allowing more effective use of internal space. Depending on electricity generator energy source can minimize pollution or at least prevent it from being concentrated in urban areas [2]
- "Smart Cars" use a variety of electronics to avoid collisions and reduce travel times[2]

In spite of a plethora of highly refined and detailed attempts to design vehicles that resolve the problems of the conventional car, these new vehicles designs have failed to appear in any significant way on our roads. Therefore research is required to develop an understanding why this is the case and how a strategy can be developed to promote their implementation.

2. The CityCar as a case study

The term CityCar is used as a convenient term to describe the class of vehicle that is proposed to be used in an urban environment and is designed to minimise or eliminate the problems of pollution, congestion, safety and parking. The term CityCar is used for the design proposal that was created by MIT Media Labs (see figure 1) and at the time of writing is being commercialized as the Hiriko [16] This design has been chosen as the focus for this study as it appears to be a design that addresses the main problems previously identified in a way that appears succinct and viable with an intelligent integration of technology and design. It is also based on a rigorous investigation of alternative designs and social requirements. However the results of this study will be equally as applicable to other similar vehicles such as the Renault Twizy (figure 2). Therefore the term CityCars in this context should be considered to apply to a class of vehicle, of which the MIT proposal is an exemplar. The chief characteristics of this class of vehicle are:

- Electric drive
- Small, lightweight
- Highly maneuverable

The CityCar is an example of Disruptive Innovation and as such requires a deep understanding of the value proposition that this design proposal offers. The entire network of infrastructure and services must also be optimized to support the value proposition of the CityCar. An inability to understand the new value networks is the main reason for why the implementation of Disruptive Innovation fails.[1]

A search of the literature fails to uncover an understanding of the CityCar value network or indeed an established methodology for developing this understanding. However there are approaches that use design methodologies to develop design strategies based on latent user needs. As these latent user needs for the basis of the value proposition, an adaptation of this approach can be used to identify the CityCar value proposition. Actor Network Theory offers a way to identify the components (actors) of the new CityCar network.

Figure 1 - MIT CityCar

Figure 2 - Renault Twizy

2.1 The CityCar as a case of Disruptive Innovation

Proposed design solutions such as the CityCar represent a typical example of Disruptive Innovation according to the definition described by Christensen[1]. This is because it will disrupt and change the market. According to Christensen, the main reason for why companies fail to implement Disruptive Innovation is their inability to understand the new value networks. Initially, disruptive innovation appears to perform less well compared to current offerings. This is due to two reasons:

- Firstly because the new products or services offer different values and yet are judged according to the values of the old system.
- Secondly it is affected by what is known as a “network externality” which simply means that the value increases in relation to adoption.

To illustrate the point, the CityCar has less carrying capacity, is less powerful and has less range than a conventional car. Even though these disadvantages are largely irrelevant given the context of use, these are typical performance characteristics of conventional cars. These disadvantages are potentially offset by values including greater convenience and safety, lower cost and less pollution. However the current car network has been optimised for the conventional car and so many of the potential advantages of the CityCar will not be realised until the network has been adapted to suit. For example a city car can be parked in a parking space that is a third the size of a normal space, costing a third and with 3 times the availability. However these spaces typically do not yet exist and so a CityCar would need to be parked in a full size space with none of the cost and convenience benefits that small parking spaces promise. Until these spaces are available, this benefit cannot be realised.

Disruptive innovation is often technology driven although it does not need to be. For the example of CityCars, there are several emerging technologies that may be incorporated. Some are almost essential such as electric drive with is required to allow the design flexibility and pollution reduction, and others are at this stage simply possibilities. For example autonomous drive is almost certainly a possibility in the not-too-distant future and would have a significant impact on the value proposition offered.

3. Establishing a methodological approach for the case of the CityCar (?)

The term “Product Ecosystem” is used here to describe the interrelated things that surround a product. For example a digital camera cannot exist as a standalone object. It relies on an ecosystem comprised of computers, printers, memory cards, and software etc.

When a new product fits within an existing ecosystem, using all the incumbent products and services, it is most likely to be an incremental innovation. Disruptive innovation not only changes and creates new markets but changes or creates a new Product Ecosystem.

In natural ecosystems, animals and plants rely on each other and the environment for survival. This reliance is based on interdependent values that are shared between species and values that come from the environment. For example a bird might rely on a tree for shelter and food and the tree relies on the sun and rain. The bird gains value from the tree and the tree gains value from the sun. It is the existence of these values that determines the success of a species within a given environment. These ecosystems are dynamic and change over time. The changes may be gradual such as climate change leading to evolution of a species or disruptive such as extinctions caused by the introduction of a feral species.

Importantly, stability of an ecosystem requires a complete value network for its existence. A small change in values may lead to large changes in the ecosystem. For example a change in the water table may lead to a particular species of tree dying with flow on effects to the species that rely on the type of tree.

Manufactured products also share a similar framework, described as a product ecosystem.

In product ecosystems, physical products rely on other products as well infrastructure and legislation (analogous to the environment).

For example a television may rely on a remote control to operate and in turn the remote relies on batteries. The batteries give value to the remote which in turn gives value to the TV. It is the existence of these values that determines the success of a product within a given market.

These ecosystems are dynamic and change over time. The changes may be gradual where products co-evolve with the market/environment as described by the theory of incremental innovation. Or the changes may be disruptive such as obsolescence (extinctions) caused by the introduction of a disruptive innovation.

Importantly, stability of an ecosystem requires a complete value network for its existence. A small change in values may lead to large changes in the ecosystem. For example a universal remote control reduces the value of the TV remote. Technology that allows hand gestures to control the TV may remove the value of the remote control and lead to the "extinction" of that product "species".

A “product ecosystem” is an example of a network of the kind described in the Actor Network Theory (ANT) [17] ANT is used by sociologists to explain how society and technology interact and was developed by Callon, Latour, Law, and others in the 1980s. One of the key concepts in ANT is that objects, technology, knowledge, people and organisations are all “actors” or “actants” (used synonymously) within a network and should be given equal consideration as they all have an influence on the network. An actant can literally be anything provided it is granted to be the source of an action” [17]. Using a research frame based on the Actor-Network Theory, complex socio-technical situations can be considered and the most important aspects identified. This can be applied to both existing networks as well as proposed ones [17]. This approach can be used to identify the actors (in both existing and proposed arrangements) as well as giving a framework to map the links between them. For example a petrol station adds value to a conventional car by allowing it to refuel and continue its journey. The value proposition may be “quick, cheap, convenient refueling.”

Design Thinking is a term that refers to a way of approaching problems using a combination of empathy, creativity and rationality. Design Thinking is an “abductive” process as opposed to a deductive or inductive process. That is, it tends to consider many possibilities and selects a “preferred solution” instead of starting with rigid criteria and using logic and elimination to find something that fits the criteria. The benefit of using design thinking is that it is more likely to uncover options that may be missed by a deductive approach. Therefore Design Thinking is an ideal approach to determine what will need to change.

The discipline of Industrial Design emerged roughly 100 years ago. It was originally seen as an enabler to create manufactured products that use aesthetics to gain a competitive advantage. Aesthetics are just one of the ways that products can appeal to users; functionality and cost are others. The ability of the design process to improve these other user benefits was soon realized and as a result, Industrial Designers began to have influence over form, function as well as the commercial imperatives of manufacturing and cost. This approach is often referred to as “user centered design.”

More recently, Design Thinking has been used as a technique for not just user centered design (or “what users want”) but for creating new propositions of meaning (or “what users will want, only they don’t know it yet.”) This approach is known as Design Driven Innovation (Verganti, 2009). An extension of this is known as Design Led Innovation which uses Design Thinking to develop a strategic approach beyond the physical product and into the business model (Bucolo & Matthews, 2010).

The elements that will make up the proposed CityCar network will be harder to identify than those in the existing car network. This is because the proposed network does not yet exist and the structure will be dependent on a set of assumptions about the future network. These assumptions must be grounded in terms of what is technically achievable in the near term as well as what is socially desirable. The field of Design Led Innovation offers a methodology for using co-generation of scenarios to develop future possibilities [18].

For example it has been suggested that CityCars are offered as completely autonomous vehicles. In this case the value proposition they offer vision impaired people will be very different to that of manual version of the CityCar. Therefore a network entity called “vision impaired drivers” may be part of this network but not exist in the network of manually driven CityCars. This is a good example of the significance of understanding the nature of the network elements as the existence of “vision impaired drivers” will have significant implications for the design of not only the vehicles but also other infrastructure.

There should be a reasonably defensible set of justifications for each one of the assumptions. This set of assumptions can be collated to create a scenario (or scenarios) which can then be used as a framework for this research. This scenario can be presented to the individuals that represent the network elements and questions can be asked about how they see their place in the new CityCar network. As the study progresses and knowledge about the proposed network increases, it is possible that the methodology and theory may need revision. This is supported by the principles behind grounded theory which is a systematic method for developing theory based on gathered data.

Osterwalder et al, [19] describe a methodology for capturing value within a business model. Part of this methodology is the use of tools such as scenarios to generate new business models which are then recorded on a template called the “business model canvas.”

3.1. The Proposed Methodology

The proposed methodology is based on the framework offered by Product Ecosystems; it uses scenario generation based on Design Led Innovation and a Business Model generation technique to capture the value network.

This research will be conducted as a series of interviews with individuals that represent the various network elements. These individuals will be asked a series of questions firstly about the existing car network. The questions will be formulated to understand the role that the network element plays in the network as well as which other network elements they have links to. The second set of questions will be about the proposed City Car network. Before the questions are asked, a short presentation will be given introducing the proposed scenarios that CityCars will inhabit. Questions will then be asked about how the individual sees the role of the network element in this new scenario and again what links the network element will have with other elements.

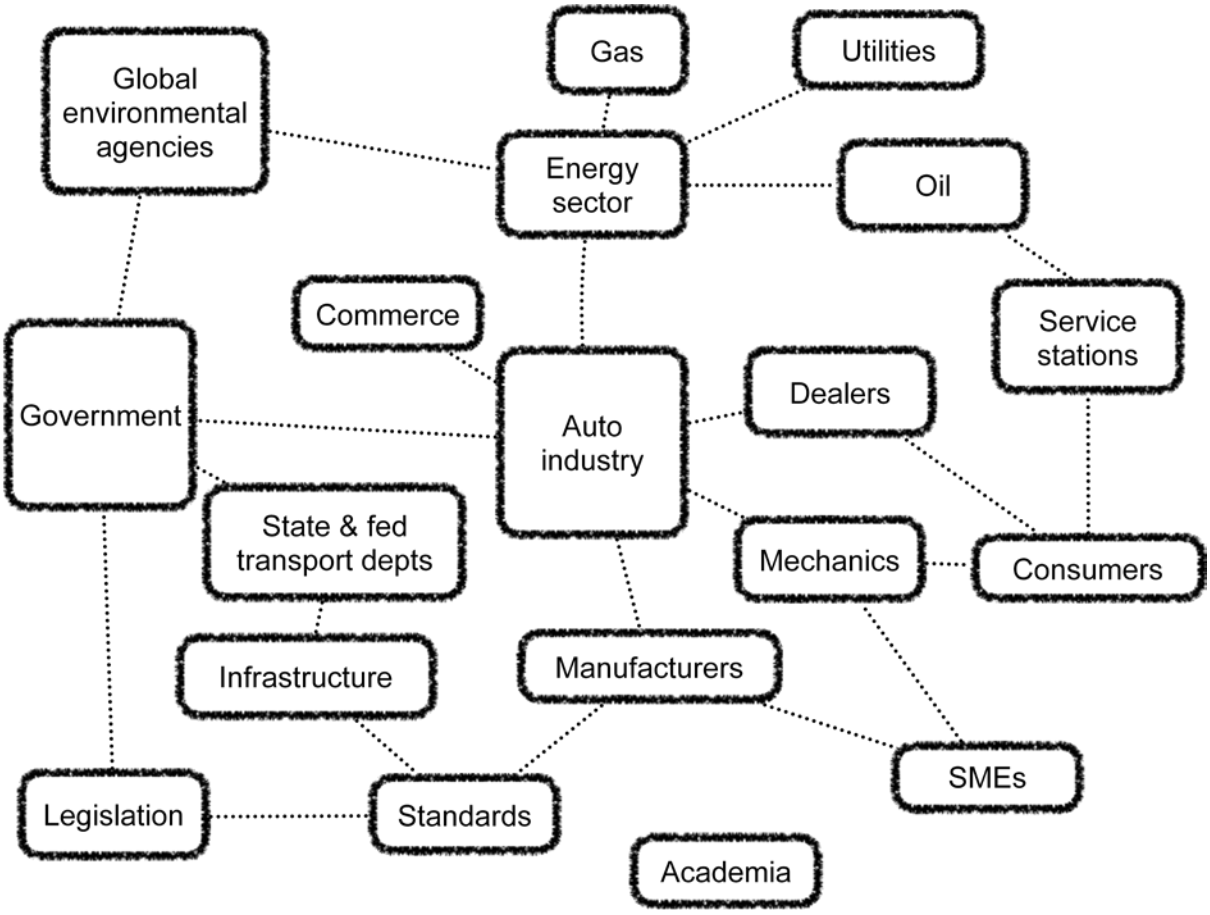

Figure 3 - shows an example of how the car network will be diagrammatically represented.

The aim of the first interview question (or questions) is to determine which elements in the current network are linked with which other elements. The approach to discover this will be to ask who they give value to and who they get value from. In the example above, service stations have links with oil companies. The oil companies provide value by supplying oil. Value is returned in monetary form. Service stations also have links with consumers. The value to consumers is the convenient supply of fuel and the value to the service station is the income from the fuel sales. In this case these links are obvious but it is anticipated that other links will be discovered.

The aim of the first set of questions will be to identify value propositions :

In relation to your current business, who benefits from what you produce?

In relation to your current business, who supplies your goods or services?

The value flowing in reverse is financial. Value typically needs to be bi-directional to be sustainable. Entities can have a negative influence on each other as well. For example the widespread introduction of electric vehicles may to lead to a reduced demand for petrol resulting in a negative impact on petrol stations.

As the CityCar will be part of a multisided market it will be subject to what is known as the “network effect” or “network externality.” This term describes the way in which products in multisided markets offer a greater value proposition in proportion to the number of products sold. To use the credit card example again, the value to a purchaser of owning a credit card increases in proportion to the number of places that accept the credit card. City Cars have the ability to park in much smaller spaces than conventional cars, increasing the number of vehicles in a given area. But this is not an advantage until dedicated car parks are created specifically for CityCars. So the interdependency between car parks and the CityCar is crucial to the value proposition.

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4. Conclusions

The need to transition to a more sustainable form of personal urban transportation is clear however this transition will almost certainly be very disruptive. The conventional car has enjoyed 100 years of coevolving within its supporting ecosystem. As the current ecosystem has not been designed to support the proposed CityCar and to gain full value from CityCars, the ecosystem must change.

This research proposes an application of the theory of Product Ecosystems as a means to understand the implications of disruptive innovation. This understanding will lead to a greater ability to manage the risks associated with this type of innovation.

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