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Motivating Innovation with a Structured Incentives Scheme under Continuous States

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Abstract

The problem of incentive is an important component of the separation of ownership and control. A large amount of literature focuses on the problem of how to use pay-for-performance schemes to both inspire agents to exert effort and to deter agent-based resource tunneling. Manso (2011) proposes the use of structured incentive schemes with two periods to motivate innovation under discrete states. In combining these two perspectives, this paper proposes a version with continuous states and points out that an agent can, simultaneously, innovate while exerting effort to obtain greater output per unit time. By being offered a suitable incentive contract, the agent will carry out the exploration action plan, although he may fail. In the meantime, he will exert all his efforts to raise production, which determines his reward.

Keywords: Motivating innovation, structured incentive scheme, exploitation and exploration, continuous state

1. Introduction

Since Berle and Means (1932) pointed out drawbacks with the separation of ownership and control, the incentive issue has become a subject of interest for this field. Harris and Raviv (1978) and Holmstrom (1979) have mostly focused on the problems of how to inspire an agent to exert effort or deter agents from tunneling resources away from the corporation by applying principal-agent models. Manso (2011) presents a different view. He studied how to build a certain incentive structure to motivate the agent to be more innovative with a two-period model. He showed that incentive schemes that motivate innovation should be structured differently from standard pay-for-performance schemes used to induce effort or avoid tunneling. Innovation involves the exploration of new untested approaches that are likely to fail. Therefore, standard pay-for-performance schemes that punish failures with low rewards and termination may in fact have an adverse effect on innovation. In contrast, an optimal incentive scheme that motivates innovation exhibits substantial tolerance (or even reward) for early failure and reward for long-term success. Under this incentive scheme, compensation depends not only on the total performance overall, but also on the path of the performance; an agent who performs well initially but poorly later earns less than an agent who performs poorly initially but well later or even an agent who performs poorly repeatedly.

Based on the framework of Manso (2011), this paper studies the incentives for innovation with non-fixed rewards for the agent. Our model absorbs the advantages of the two aforementioned directions: incentive schemes for motivating innovation and

standard pay-for-performance schemes. We give the standard for success, and the reward of the agent depends on the amount of the excess output over the baseline. The fixed wage and non-fixed wage (wage rate) are designed. These structured incentives can motivate the agent to select a more innovative work method and stimulate the agent to exert effort to get a better output in the meantime. The reward for the agent is comprised of two parts: one fixed part which is independent of any situation, and another non-fixed part which depends on the output. The fixed part can mainly be used to tolerate the failure of the exploration, and the non-fixed part is used to stimulate the agent to engage in innovative action and to exert all his efforts to get the best reward.

Similar to Manso (2011), we use a two-period innovation process to deal with the incentive problem. To model the innovation process, we use a class of Bayesian decision models known as bandit problems. We focus on the central concern that arises with bandit problems: the tension between the exploration of new untested actions and the exploitation of well-known actions. For the related literature see Holmstrom (1989), Aghion and Tirole (1994), Arrow (1969), March (1991), Moscarini and Smith (2001), Hellmann and Thiele (2011), Tian and Wang (2014), Ederer and Manso (2013) and other literature cited in Manso (2011). However, there are differences here, too. The model of Manso (2011) just considers two states: success and failure, and the optimal contracts depend only on the probability of success or failure, not on the amount of the outputs. Our model is treated under the continuous states, and the optimal contracts depend on the distribution of the production, not only on the probability of success or failure, but also on the amount of the outputs.

The rest of the paper is arranged as follows: section Π examines the bandit problem for tension between exploration and exploitation; section Ш presents the principal-agent problem regarding tension; section IV gives the solutions to the principal-agent problem, namely optimal incentive contracts for exploration and exploitation, respectively; and the last section concludes the paper.

2. Examining the Bandit Problem for Tension between Exploration and Exploitation

Here, we review the two-armed bandit problem with the one known arm as per Manso (2011) and Zheng and Chen (2013). This illustrates the tension between exploration and exploitation. Exploitation is a well known action, and the agent can receive a reasonable payoff clearly with little cost. However, exploration is a new untested action with a high uncertainty of success. If the agent takes exploratory action and has a success, the output can be very high, but it is more likely to fail and cost more. Basically, the principal expects the agent to take exploratory action, but the agent wants to take the exploitation action. Consequently, there is tension! To solve this problem, a structured incentive scheme must be designed. The original models were proposed under discrete states. We extend these to be one model with continuous states.

We assume that the agent lives for only two periods (More periods can be assumed but the results may be different. Here, we only consider two periods. One reason is this will show some basic insights to this problem; another reason is that the model is not too complex to be treated. The long term will be checked in our future work). In each period, $t \epsilon T = \{1,2\}$, the agent takes an action $i \in I$, producing output R_{ti}, which is a random variable with a cumulative distribution function $F_{R_{ti}}(x) = P[R_{ti} \leq x]$. The principal gives the baseline B_t of the output for each period $t \in T$ to evaluate the performance of the agent. If $R_{ti} > B_t$, the agent is judged as a "success"; if $R_{ti} \leq B_t$ the agent is judged as a "failure". The cumulative distribution function $F_{R_{ti}}(x)$ may be unknown for some of the actions. To obtain information

about $F_{R_{ti}}(x)$ for these actions, the agent needs to engage in experiments during the first period. We let $h(R_{ti})$ denote the return function on output R_{ti}. We also let $E[h(R_{ti})]$ denote the unconditional expectation of $h(R_{ti})$, let $E[h(R_{ti})|R_{t-1j} > B_{t-1}]$ denote the conditional expectation of $h(R_{ti})$ given a success on action j in the last period, and $E[h(R_{ti})|R_{t-1j} \leq B_{t-1}]$ denote the conditional expectation of $h(R_{ti})$ given a failure for action j in the last period. When the agent takes action $i \in I$ in period $t \in T$, he only learns about the information for the distribution of R_{t+1i} for the next period, so that

$$E[h(R_{ti})] = E[h(R_{ti})|R_{t-1j}] \text{ for } i \neq j$$

This means that if the agent wants to know the information for the distribution of R_{t+1i} for the next period, he must engage in the experiment of action i with unknown distribution in this period.

Because there is no new information for the unconditional expectation of $h(R_{ti})$, namely, it is independent of time, so we denote $E[h(R_{ti})] = E[h(R_i)]$ in this situation.

Our main focus of interest is on the tension between two actions: action 1 is exploration and action 2 is exploitation. We assume that in each period $\in T$, the agent chooses between these two actions. Action 1 is the conventional work method, has a known distribution of R_{t1} in any period $t \in T$, namely $R_{t1} = R_1$, such that $E[h(R_{t1})] = E[h(R_{t1})|R_{t-11}] = E[h(R_1)]$

Action 2 is the new work method, has an unknown distribution of R_{t2} such that[1] $E[h(R_{t2})|R_{t-12} \leq B_{t-1}] < E[h(R_{t2})] < E[h(R_{t2})|R_{t-12} > B_{t-1}]$

This means that if the agent has a success with the new work method, then he updates his belief that there is further possibility that the new work method will succeed. Or, if the agent observes a failure with the new work method, then he updates his beliefs that there is more possibility that the new work method will fail.

[1] Here we assume that $h(R_{t2})$ is increasing the function on R_{t2}.

We assume that Action 2 has an exploratory nature. This means that when the agent experiments with the new work method, he is, initially, not as likely to succeed as when he conforms to the conventional work method. However, if the agent observes a success with the new work method, then he updates his beliefs about the probability of success with the new work method, so that the new work method is perceived as being better than the conventional work method. This is captured as follows:

$E[h(R_2)]<E[h(R_1)]<E[h(R_{t2})|R_{t-12}>B_{t-1}]$

In fact, the agent may shirk and not choose either of the two work methods mentioned above. This action 0 is allowed in the model. Shirking has zero private cost, but has a lower expected return than either of the two work methods. Here, we assume that action 0 (shirking) has a return R_0 with a known distribution in any period $t \in T$. Without losing generality, we assume that there exists a stochastic dominant relationship as follows:

$$\left(R_{t2}|R_{t-12}>B_{t-1}\right) \overset{FSD}{\succ} R_1 \overset{FSD}{\succ} R_2 \overset{FSD}{\succ} \left(R_{t2}|R_{t-12}\leq B_{t-1}\right) \overset{FSD}{\succ} R_0$$

Where $X \overset{FSD}{\succ} Y$, it means that X stochastically dominates Y in the first order, namely $F_X(\eta) \leq F_Y(\eta)$, for all $\eta \in R$.

So, if $h(\bullet)$ is a non-decreasing function, we have

$$E[h(R_0)] < E[h(R_{t2})|R_{t-12} \leq B_{t-1}] < E[h(R_2)] < E[h(R_1)] < E[h(R_{t2})|R_{t-12} > B_{t-1}] \quad (1)$$

In fact, the model is a three-armed bandit problem, namely $= \{0,1,2\}$, but we only consider the tension between exploration and exploitation. The agent is risk-neutral and has a discount factor normalized to one. The agent thus chooses an action plan $\langle i_k^j \rangle$ to maximize his total expected payoff. Where $i \in I$ is the first-period action, $j \in I$ is the second-period action if there is success in the first period; $k \in I$ is the second-period action if there is failure in the first period.

Two action plans need to be considered. Action plan $\langle 1_1^1 \rangle$, which Manso (2011) called exploitation, is just the repetition of

the conventional work method. Action plan $\langle 2_1^2 \rangle$, which Manso called exploration, is to initially try the new work method, sticking to the new work method if there is success in the first period, and revert to the conventional work method if there is failure in the first period. Apparently, the total payoff for action plan $\langle 2_1^2 \rangle$ from exploration is higher than that of action plan $\langle 1_1^1 \rangle$ from exploitation if, and only if, $E[R_2] > E[R_1] - E\{1_{R_{12}>B_1}(E[R_{22}|R_{12} > B_1] - E[R_1])\}$

When the agent tries the new work method, he obtains information about R_{t2}. This information is a useful guide for the agent's decision in the second period, since the agent can switch to the conventional work method if he ascertains that the new work method is not worth pursuing. The agent may thus be willing to try the new work method even though the initial expected return $E[h(R_2)]$ with the new work method is lower than the expected return $E[h(R_1)]$ with the conventional work method.

3. The Principal-Agent Problem

In this section, we introduce incentive problems to the three-armed bandit problem with the two known arms as reviewed in the previous section.

The principal hires an agent to perform a task described in the previous section. In each period, the agent incurs private costs $C_i \geq 0$ if he takes action $i = 1,2$, but can avoid these private costs by taking action $i = 0$, shirking ($c_0 = 0$).

We assume that the principal does not observe the actions taken by the agent. As such, before the agent starts working, the principal offers the agent a contract $\langle \overline{\lambda}, \overline{w} \rangle = \{\langle \lambda_1, w_1 \rangle, \langle \lambda_2, w_2 \rangle, \langle \lambda_3, w_3 \rangle\}$ that specifies the agent's wages contingent on future performance. The agent has limited liability, meaning that his wages cannot be negative. Here, w_s $(s = 1,2,3)$ is a fixed wage, which is the minimum wage in any situation, and λ_s is the wage rate for extra returns in the situation of success. This means that if the action is a failure, the agent will still get a fixed wage w_s; if it is a success, he will get a fixed wage w_s plus a flexible wage $\lambda_s(R_s - B_s)1_{R_s - B_s}$. Specifically, $\langle \lambda_1, w_1 \rangle$ is the wage rate and the fixed wage in the first period, respectively. $\langle \lambda_2, w_2 \rangle$ is the wage rate and the fixed wage in the second period on condition of success in the first period, respectively. $\langle \lambda_3, w_3 \rangle$ is the wage rate and fixed wage in the second period conditional on failure in the first period, respectively.

Different from that of Manso (2011), the contract $\langle \overline{\lambda}, \overline{w} \rangle$ in our model is not a fixed wage. While a fixed wage in the case of failure, $\overline{\lambda}$ is a fixed wage rate in the case of success. When the agent succeeds in one period t, according to the baseline of success B_t given by the principal in advance, he will get a payoff w_s plus $\lambda_s(R_s - B_s)1_{R_s - B_s}$, $s = 1,2,3$, which is dependent on the output. The more output it produces, the more wage rewards he gets. So, the contract $\langle \overline{\lambda}, \overline{w} \rangle$ for our Principal-agent model has two functions: one is to motivate the agent to be more innovative and the other is to inspire the agent to exert more effort.

This is different from that of Zheng and Chen (2013), where the w_s is not a minimum wage, which may lead to the situation where the wage for success will be lower than that for failure. Here, we revise this fault.

In addition to these differences, another feature is that the models here are built with continuous states. To illustrate the process of the reward structure, see figure 1 as follows.

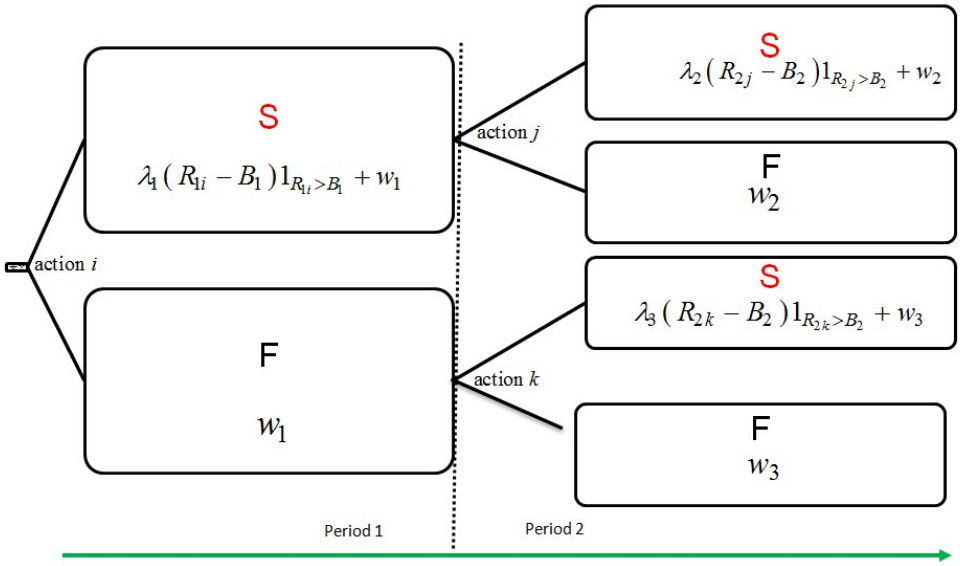

Figure 1: Structured Reward Action Plan $\langle i_k^j \rangle$
S-success, F-failure

We assume that both the principal and the agent are risk-neutral and have a discount factor of one, just for simplicity. When the principal offers the agent a contract $\langle \vec{\lambda}, \vec{w} \rangle$ and the agent takes on the action plan $\langle i_k^j \rangle$, the total expected payments from the principal to the agent are given by

$$W(\vec{\lambda}, \vec{w}, \langle i_k^j \rangle) = E[\lambda_1(R_{1i} - B_1)1_{R_{1i}>B_1} + w_1] + E\{1_{R_{1i}>B_1} E[\lambda_2(R_{2j} - B_2)1_{R_{2j}>B_2} + w_2 | R_{1i} > B_1]\} + E\{1_{R_{1i}\le B_1} E[\lambda_3(R_{2k} - B_2)1_{R_{2k}>B_2} + w_3 | R_{1i} \le B_1]\} \quad (2)$$

Apparently, the model of Manso (2011) and Zheng and Chen (2013) are special discrete cases of our model.

Because $E[(R_{ti} - B_t)1_{R_{ti}>B_t}]$ can be viewed as a call option whose underlying asset is output R_{ti} and strike price is B_t, we denote $op_{ti} = E[(R_{ti} - B_t)1_{R_{ti}>B_t}]$.

Similarly, we denote $\overline{op_{2j}^{1i}} = E[(R_{2j} - B_2)1_{R_{2j}>B_2} | R_{1i} > B_1]$, and $\underline{op_{2k}^{1i}} = E[(R_{2k} - B_2)1_{R_{2k}>B_2} | R_{1i} \le B_1]$.

So equation (2) can be rewritten as

$$W(\vec{\lambda}, \vec{w}, \langle t_k^j \rangle) = \lambda_1 op_{1i} + w_1 + E\{1_{R_{1i}>B_1}(\lambda_2 \overline{op_{2j}^{1i}} + w_2)\} + E\{1_{R_{1i}\le B_1}(\lambda_3 \underline{op_{2k}^{1i}} + w_3)\} \quad (3)$$

It means that the total expected payments are comprised of a series of options.

According to the assumptions in the previous section, we have

$$op_{t0} < \underline{op_{22}^{12}} < op_{t2} < op_{t1} < \overline{op_{22}^{12}} \quad (4)$$

When the agent takes on the action plan $\langle t_k^j \rangle$, the total expected costs incurred by the agent are given by

$$C(\langle i_k^j \rangle) = c_i + E[1_{R_{1i}>B_1}]c_j + E[1_{R_{1i}\le B_1}]c_k \quad (5)$$

Here, we consider a non-cooperative game (Stackelberg game). It needs to be pointed out that the model assumes a common knowledge framework in which all information is known to both agents. This assumption is due to the nature of the Stackelberg game. However, the problem here is a little different from the standard solution. We only want to know what kind of wage structure can encourage the agent to take on the objective action plan $\langle i_k^j \rangle$, such as the innovative action plan $\langle 2_1^2 \rangle$ or the conventional action plan $\langle 1_1^1 \rangle$.

We say that contract $\langle\overline{\lambda},\overline{w}\rangle$ is an optimal contract that implements an action plan $\langle i_k^j\rangle$ if it minimizes the total expected payments from the principal to the agent,

$$W\left(\vec{\lambda},\vec{w},\langle i_k^j\rangle\right) \quad (6)$$

Subjected to the incentive compatibility constraints, $W\left(\vec{\lambda},\vec{w},\langle i_k^j\rangle\right) - C\left(\langle i_k^j\rangle\right) \geq W\left(\vec{\lambda},\vec{w},\langle l_n^m\rangle\right) - C(\langle l_n^m\rangle)$ $(IC_{\langle l_n^m\rangle})$.

This is a linear program with six unknowns and 27 constraints because $l,m,n \in I$. When more than one contract solves this program, we restrict attention to the contract that pays the agent earlier, as per Manso (2011).

The principal's expected profit from implementing action plan $\langle i_k^j\rangle$ is given by

$$\prod(\langle i_k^j\rangle) = Y(\langle i_k^j\rangle) - W\left(\vec{\lambda}(\langle i_k^j\rangle),\vec{w}(\langle i_k^j\rangle),\langle i_k^j\rangle\right) \quad (7)$$

Where

$$Y\left(\langle i_k^j\rangle\right) = E[R_{1i}] + E\{1_{R_{1i}>B_1}E[R_{2j}|R_{1i} > B_1]\} + E\{1_{R_{1i}<B_1}E[R_{2k}|R_{1i} \leq B_1]\} \quad (8)$$

is the principal's total expected revenue when the agent uses action plan $\langle i_k^j\rangle$ and $\langle\vec{\lambda}(\langle i_k^j\rangle),\vec{w}(\langle i_k^j\rangle)\rangle$ is the optimal contract that implements action plan $\langle i_k^j\rangle$, the principal thus chooses action plan $\langle i_k^j\rangle$ that maximizes $\prod(\langle i_k^j\rangle)$.

The assumptions for the principal-agent problem studied here are standard except that there is learning about the technology being employed. This gives rise to tension between the exploration and the exploitation, since there is nothing to be learned about the conventional technology, but a lot to be learned about the new technology.

4. Incentives for Exploration and Exploitation

Here we present the optimal contracts that implement exploration and exploitation.

4.1 Incentives for Exploitation

Recall from Section II that exploitation represented by action plan $\langle 1_1^1\rangle$.

$$W\left(\vec{\lambda},\vec{w},\langle 1_1^1\rangle\right) = \lambda_1 op_{11} + w_1 + E\left\{1_{R_{11}>B_1}\left(\lambda_2\overline{op_{21}^{11}} + w_2\right)\right\} + E\left\{1_{R_{11}\leq B_1}\left(\lambda_3\underline{op_{21}^{11}} + w_3\right)\right\} \quad (9)$$

Given the goal of the action plan $\langle 1_1^1\rangle$, the principal must offer optimal contracts so that the agent implements the exploitation. The optimal contracts $\langle\overline{\lambda},\overline{w}\rangle$ must maximize $\prod(\langle 1_1^1\rangle)$, namely minimize $W\left(\vec{\lambda},\vec{w},\langle 1_1^1\rangle\right)$ subject to the incentive compatibility constraints, $W\left(\vec{\lambda},\vec{w},\langle 1_1^1\rangle\right) - C(\langle 1_1^1\rangle) \geq W\left(\vec{\lambda},\vec{w},\langle l_n^m\rangle\right) - C(\langle l_n^m\rangle)$ $IC_{\langle l_n^m\rangle}$.

We then derive the optimal contract that implements exploitation. The following definitions will be useful when stating Proposition 1:

$$\beta_0 = \frac{1}{1+E\left[1_{R_2>B_1}\right]}\left(\frac{E\left[1_{R_2>B_1}\left(\overline{op_{22}^{12}} - op_{20}\right)\right]}{op_{21}-op_{20}} + \frac{op_{12}-op_{10}}{op_{11}-op_{10}}\right)$$

Because the distribution of return R_2 in the first period is unknown, we use the expectation of $E\left[1_{R_2>B_1}\right]$ to denote it. We also denote $p_0 = E\left[1_{R_0>B_1}\right]$, $\mathrm{p}_1 = E\left[1_{R_1>B_1}\right]$ directly.

PROPOSITION 1: The optimal contract $\langle\vec{\lambda},\vec{w}\rangle_1^*$ that implements exploitation is such that $w_1 = w_2 = w_3 = 0$, $\lambda_2 = \lambda_3 = \frac{c_1}{op_{21}-op_{20}}$ $\lambda_1 = \frac{c_1}{op_{11}-op_{10}} + \frac{(1+E[1_{R_2>B_1}])c_1}{op_{11}-op_{12}}\left(\beta_0 - \frac{c_2}{c_1}\right)^+$ where $(x)^+ = max(x,0)$.

The formal proofs for each of the propositions are omitted and limited to the length. However, the main intuition behind Proposition 1 is as follows. To implement exploitation, the principal must prevent the agent from both shirking and exploring. If c_2 is high when relative to c_1, only shirking constraints are binding. Therefore, the optimal contract that implements exploitation is similar to the optimal contract used to induce the agent to exert effort in a standard work-shirk principal-agent model. If c_2 is low when relative to c_1, the exploration constraint is binding. To prevent exploration, the principal must pay the agent an extra premium if there is success in the first period. This extra premium de-

creases in c_2/c_1, because when c_2/c_1 increases, the agent becomes less inclined to explore.

Similarly, the baseline B_t will affect the result. If $B_1 \geq B_2$, then $\lambda_1 \geq \lambda_2 = \lambda_3$. This can be interpreted as when the baseline standard for success decreases, the difficulty for success in the second period decreases, and the exploration constraint may be binding. To prevent exploration, the principal must pay the agent an extra premium if there is success in the first period. However, if $B_1 < B_2$, the difficulty for success in second period increases, and the exploitation constraint may be binding, indicating that the principal may not need to pay the agent an extra premium if there is success in the first period. It means that the following $\lambda_1 < \lambda_2 = \lambda_3$ may hold at this time.

To encourage the agent to use the conventional method, there are no fixed minimum wages. This means that failure is not tolerated during the whole process.

Proposition 1 is for the optimal incentive contract for the exploitation plan $\langle 1_1^1 \rangle$, which is just a comparison and complements the optimal incentive contract for the exploration plan $\langle 2_1^2 \rangle$ (proposition 2 in the next subsection). From proposition 1, the differences between exploitation and exploration can be checked. For the principal, the action plan he wants the agent to undertake are either $\langle 2_1^2 \rangle$ or $\langle 1_1^1 \rangle$. Therefore, it is important that the incentive schemes for these two plans (proposition 1 and 2) are displayed here.

4.2 Incentives for Exploration

Proposition 2 derives the optimal contract that implements exploration. Recall from Section II that exploration is given by action plan $\langle 2_1^2 \rangle$.

$$W\left(\vec{\lambda}, \vec{w}, \langle 2_1^2 \rangle\right) =$$

$$\lambda_2 op_{12} + w_1 + E\left\{1_{R_{12}>B_1}\left(\lambda_2 \overline{op_{22}^{12}} + w_2\right)\right\} +$$

$$E\left\{1_{R_{12}\leq B_1}\left(\lambda_3 \underline{op_{21}^{12}} + w_3\right)\right\} \qquad (10)$$

Given the goal of action plan $\langle 2_1^2 \rangle$, the principal must offer the optimal contracts that implement the exploration. The optimal contracts $\langle \vec{\lambda}, \vec{w} \rangle$ must maximize $\prod(\langle 2_1^2 \rangle)$, namely minimize $W\left(\vec{\lambda}, \vec{w}, \langle 2_1^2 \rangle\right)$ subject to the incentive compatibility constraints, $W\left(\vec{\lambda}, \vec{w}, \langle 2_1^2 \rangle\right) - C(\langle 2_1^2 \rangle) \geq W\left(\vec{\lambda}, \vec{w}, \langle l_n^m \rangle\right) - C(\langle l_n^m \rangle)$ $(IC_{\langle l_n^m \rangle})$.

The form of the optimal contract that implements exploration will depend on whether exploration is moderate or radical. In the following definition, we classify the exploration into two types: moderate and radical. The reason for this classification is that when we solve the optimization, there are significant differences in the optimal contract, especially for w_1, which is dependent on the possibility of failure and rewards success. This can be described by the following definition.

DEFINITION 1: Exploration is radical if $\frac{E\left[1_{R_2\leq B_1}\right]}{E\left[1_{R_1\leq B_1}\right]} \geq \frac{E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]}{E\left[1_{R_1>B_1}\right]op_{21}}$ but moderate otherwise.

Exploration is radical if the likely ratio between exploration and exploitation of a failure in the first period is greater than the reward ratio between the exploration and exploitation of two consecutive successes. We call this exploration radical one because it has a high expected probability of failure in the first period relative to the probability of failure regarding the conventional action. Alternatively, we call it moderate exploration because it has a lower expected probability of failure in the first period relative to the probability of failure of the conventional action. Apparently, the incentives for the two types of exploration are different.

The following definitions will also be useful when stating Proposition 2:

$$\beta_1 = \frac{E\left[1_{R_2>B_1}\left(\overline{op_{22}^{12}} - op_{20}\right)\right]}{\left(1 + E\left[1_{R_2>B_1}\right]\right)(op_{21} - op_{20})}$$

$$\beta_2 = \beta_1 + \frac{1}{1 + E\left[1_{R_2>B_1}\right]} \frac{E\left[1_{R_2>B_1}\overline{op_{22}^{12}} - p_0 op_{20}\right]}{(p_1 - p_0)op_{21}}$$

PROPOSITION 2: The optimal contract $\langle \vec{\lambda}, \vec{w} \rangle_2^*$ that implements exploration is such that $\lambda_1 = 0$, $\lambda_3 = \frac{c_1}{op_{21} - op_{20}}$ and $w_2 = w_3 = 0$

If exploration is moderate, then $w_1 = 0$ and

$$\lambda_2 = \frac{c_1}{op_{21}-op_{20}} - \frac{(1+E[1_{R_2>B_1}])c_1}{E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_0op_{20}}\left(\beta_1 - \frac{c_2}{c_1}\right)^+ + \frac{(1+E[1_{R_2>B_1}])c_1}{E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_0op_{21}}\left(\frac{c_2}{c_1} - \beta_1\right)^+ + \frac{(1+E[1_{R_2>B_1}])(p_1-p_0)op_{21}c_1}{\left(E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_1op_{21}\right)\left(E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_0op_{21}\right)}\left(\frac{c_2}{c_1} - \beta_2\right)^+$$

If exploration is radical, then

$$w_1 = \frac{c_1(1+E[1_{R_2>B_1}])op_{21}}{E\left[1_{R_2>B_1}\left(\overline{op_{22}^{12}}-op_{21}\right)\right]}\left(\frac{c_2}{c_1} - \beta_2\right)^+$$

And

$$\lambda_2 = \frac{c_1}{op_{21}-op_{20}} - \frac{(1+E[1_{R_2>B_1}])c_1}{E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_0op_{20}}\left(\beta_1 - \frac{c_2}{c_1}\right)^+ + \frac{(1+E[1_{R_2>B_1}])c_1}{E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_0op_{21}}\left(\frac{c_2}{c_1} - \beta_1\right)^+ + \left(\frac{c_2}{c_1} - \beta_2\right)^+ * \frac{(1+E[1_{R_2>B_1}])(E[1_{R_2>B_1}]-p_0)op_{21}c_1}{E\left[1_{R_2>B_1}\left(\overline{op_{22}^{12}}-op_{21}\right)\right]\left(E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]-p_0op_{21}\right)}$$

To implement exploration, the principal must prevent the agent from shirking or exploitation. The principal does not make any payments to the agent after a failure in the second period, since this only gives an incentive for the agent to shirk. Moreover, the principal does not make payments to the agent after a success in the first period for two reasons. First, rewarding first-period success gives the agent the incentive to employ the conventional work method in the first period, since the initial expected probability $E[p_2]$ of success with the new work method is lower than the probability p_1 of success using the conventional work method. Second, when there is success in the first period, additional information about the first-period action is provided by the second-period performance, since the expected probability of success with the new work method in the second period depends on the action taken by the agent in the first period. Delaying compensation to obtain this additional information is, therefore, optimal.

The principal expects the agent to choose the conventional work method in the second period after a failure in the first period. To prevent the agent from shirking in this situation, the principal pays the agent $\lambda_3 = \frac{c_1}{op_{21}-op_{20}}$.

Then, finally, to encourage exploration, the principal must reward the agent's second-period success following a success in the first period. The wage rate λ_2 depends on the difficulty of implementing the exploration relative to exploitation. With the increase in c_2/c_1, the difficulty of implementing exploration relative to exploitation increases, and the wage rate λ_2 must increase, too.

If $c_2/c_1 < \beta_1$, then exploitation is too costly for the agent, but exploration is not costly for the agent. In this situation, the principal pays the agent $\lambda_2 < \lambda_3$. If $c_2/c_1 \geq \beta_1$, then exploitation is not too costly for the agent, but exploration is costly for the agent. In this situation, the principal must pay the agent $\lambda_2 \geq \lambda_3$. When $c_2/c_1 \geq \beta_2$, the rage rate λ_2 must increase further. In this case, if $\frac{E[1_{R_2\leq B_1}]}{E[1_{R_1\leq B_1}]} \geq \frac{E\left[1_{R_2>B_1}\overline{op_{22}^{12}}\right]}{E[1_{R_1>B_1}]op_{21}}$, namely exploration, is radical, it has a high expected probability of failure in the first period relative to the probability of failure of the conventional action. The expected reward for exploration of two consecutive successes cannot compensate for the risk of failure. So, the principal must pay the agent a higher λ_2, and reward the agent for failure in the first period at the same time.

Similarly, baseline B_t will affect the results. If $B_2 \geq B_1$, then λ_3 and λ_2 increase. This can be interpreted as when the baseline of the standard for success increases, the difficulty for success in the second period increases and the exploitation constraint may be binding. To prevent exploitation, the principal must pay the agent an extra premium if there is success in the second period.

To illustrate the differences in the optimal contracts between these two action plans, see figure 2 as follows.

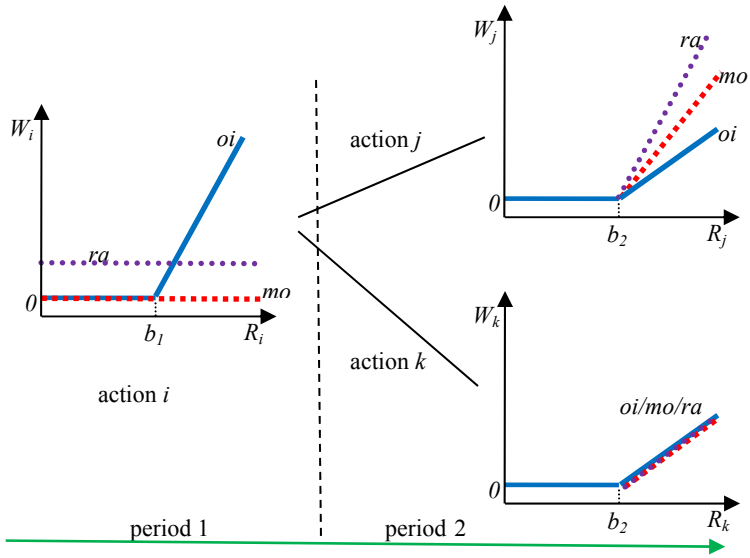

Figure 2: Structured Reward of Action Plan $\langle i_k^j \rangle$

In figure 2, the reward W received by the agent for different action plans are displayed. The blue solid line is for the action plan $\langle 1_1^1 \rangle$ (exploitation, simplified as oi), the red dashed line for action plan $\langle 2_1^2 \rangle$ (moderate exploration, simplified as mo) and the purple dotted line for action plan $\langle 2_1^2 \rangle$ (radical exploration, simplified as ra). The sign *oi/mo/ra* means the three actions of exploitation and exploration (moderate and radical) have the same wage and wage rate in this situation, These three lines coincide with each other. Given the optimal contracts, reward $W\langle i_k^j \rangle$ is dependent on the output $R\langle i_k^j \rangle$ of the action in every period. We can see that when the principal provides the incentive structure as $\lambda_1 \geq \lambda_2 = \lambda_3$, the agent will usually take action plan $\langle 1_1^1 \rangle$ (exploitation) because, in the first period, action 1 can produce most output with the highest probability and he can earn the most rewards. In the second period, whatever action he takes, he will get the same wage rate. In this situation, he will continue to take action 1 because there is no new information about action 2 without the tests from the first period. Therefore, the optimal choice is still action 1. However, if the principal provides the incentive structures as per action plan $\langle 2_1^2 \rangle$, the agent will use the exploration action plan. In the first period, the rewards do not depend on output R_i, but in the second period, the rewards are highly dependent on the output. If he takes action 2 in the first period and gets information about it, he can get more rewards in the second period. If he has a success in the first period with action 2, he will continue to take action 2 in the second period, and get the highest rewards. If he has a failed experience in the first period with action 2, he can turn to action 1 in the second period, and get the same rewards as action $\langle 1_1^1 \rangle$. If the possibility of failure with action 2 is higher, he will get a fixed reward in the first period as compensation. The optimal results in our models show that the rewards of the agent depend not only on the output, but also on the path of the performance of his output.

The optimal contract results for propositions 1 and 2 have several implications in the real world. They can explain many things in relation to managerial compensation, such as a combination of stock options with long vesting periods, and option re-pricing. Stock options can be presented to the managerial staff, and even to the ordinary people in the companies. This is one kind of incentive method that can solve

the problem of the Principal-agent, or be used to motivate ordinary people to exert themselves to earn more rewards in the long term. This compensation policy is more fashionable in high-tech companies or venture capital projects, where innovation is their basic property. They generally required that stock options must be with a long vesting period, which means that the holder of stock options cannot sell the options in the short term. Here, the optimal contracts of our model present a high non-fixed wage rate for the second period that motivates the agent to undertake exploration. In the process of solving the optimization problem, it shows that the rewards the agent can earn are the product of non-fixed wage rates and options. This is consistent with the long vesting period stock options. According to the re-pricing options, because the innovation process is split into several periods in the real world, the innovation path may be changed over time because the conditions and circumstances may change. Therefore, when gathering the optimal results of the innovation practices, the structured reward contracts must be adjusted over time, as this is the re-pricing of options.

The results produced here in our models can be tested in the empirical world. One can test whether the incentive contracts are used in exploration practices; and whether these incentive contracts have an effect and lead to more innovation. Furthermore, as these incentive contracts are structured or similar to the optimal contracts in our model, the question arises whether these structured contracts lead to further innovation. If not, which one is the most suitable?

We are able to undertake some empirical work with Chinese companies, especially high-tech companies. Currently in China, innovations are very important, from the whole country to a single company. How to motivate for innovation is the key to this trend. Using our results, we can undertake empirical work to find the characteristics of innovation practices and revise our theory results further. Additionally, these results will be of help to our innovative country of China. This work will be done in the near future.

5. Conclusion and Limitations

Based on the framework of Manso (2011), this paper has studied the incentives for innovation with non-fixed rewards for the agent. We have explored the standard of success, and the reward of the agent depends on the amount of the excess output over the baseline. The fixed wage and wage rate for success have been designed. These structured incentives can motivate the agent to select a more innovative work method and encourage them to exert effort to obtain a better output.

The optimal contract that implements both exploitation and exploration is comprised of a series of options, which are structured. To stimulate exploration, the principal must offer a proper fixed reward so as to tolerate the possibility of failure; at the same time, a non-fixed reward must not be offered. The optimal contract depends on the baseline of success and the private costs of the agent, especially the cost ratio of exploration and exploitation.

There are some limitations to the paper.

(1) We have only considered the first-order stochastic dominant relationship between the returns. They may be either second-order or higher-order. Therefore, additional real distributions are needed to discuss the problem further.
(2) In the paper, the information has assumed symmetry. In fact, the information may be asymmetrical, which will impact on the results severely.
(3) The interest rate and time preferences are not considered. The span of the periods may have an important impact on the solutions.
(4) Here, we have only considered problems over two periods. Although two periods can demonstrate the basic insights of the problem, new results

may be found over more periods, especially for infinite periods. In fact, whether the innovation test can be obtained continuously is a problem. For example, the termination will be a threat for the agent. Additionally, in the long run, if the exploration has been tested for many times and has success, will it return to a conventional action, namely, the exploratory action turns into an exploitation action, and rewards must be changed accordingly. All these situations must be considered in our next study.

(5) However, some of the predictions of this model remain untested, and additional empirical work is required. Because there are so many moderators in the real world, the basic optimal results, in theory, may not be optimal. Therefore, again, more empirical work must be done. We are going to be doing this in the next step. We will collect enough data to test our model, or look for the properties of innovation motivation in the real world, and revise our theoretical model accordingly. Based on this empirical work, we expect to ascertain several parameters related to this problem. We can then run some simulations for a variety of situations.

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Meaning - An Unexplored Path of Innovation

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Abstract

Over the last ten years, the practice and research around innovation has been dominated by one perspective: innovation is an activity of "creative problem solving". According to this perspective, users have problems or needs, and innovation implies an understanding of those problems and the creation of better ideas to solve them (Kelley, 2001, Chesbrough, 2003, Brown, 2009, Martin, 2009). There is, however, a level of innovation that has been overlooked: the level of meaning. People are continuously searching for meaning. Whenever they do something in life, there is a meaning behind that action, a purpose, and a "why". They also use products and services that support this search for meaning. For example, they use fast robots with the purpose of improving the productivity of a process. Firms often assume that meanings exist "out there" in the market. They just have to be understood, not innovated. Therefore, they search for new solutions, a new "how", to serve this existing purpose better: a faster robot, for example. However, people are not only searching for new solutions to existing problems. They are also searching for new meanings because their life keeps changing and because they are delighted by the discovery of new directions. For example, hospitals buy slow robots, such as the DaVinci system, the leading prostatectomy device, not to replace doctors and increase productivity, but to help them in complex operations. This article contends that there is a third type of innovation that is overlooked by the existing frameworks of innovation, which focus on the innovation of technologies and markets: innovation as driven by meaning. By leveraging case studies of firms in consumer and industrial markets, this article: (1) identifies and defines this third type of innovation, the innovation of meaning (2) positions it in relation to the two other main drivers of innovation (technologies and markets); (3) identifies the peculiar nature of the innovation of meaning; and (4) indicates a possible research strategy to explore the process of the innovation of meaning.

Keywords: Innovation of meaning, innovation strategy, radical innovation, understanding users, design

1. Innovation from the Outlaws

"A robot may not injure a human being or, through inaction, allow a human being to come to harm"(First Law of Robotics.)

Isaac Asimov predicted it correctly a long time ago, in 1942, when he wrote the Three Laws of Robotics. A scientist by education, he surmised that technology has immense potential and is a major driver of innovation. A humanist by heart, however, he knew that technology is not the only dimension of innovation: there are other directions of unexpected change, one of which is the *purpose* for which technology is used. The Three Laws of Robotics were incorporated into the robots in Asimov's novels to indicate what constitutes a meaningful purpose and what does not (The Three Laws of Robotics appeared in many novels of Isaac Asimov, who first intro-

duced them in the novel "Runaround", 1942). A novelist by profession, he played on the intersection between technology and meaning: what if technological innovation challenges the laws and enables it to move beyond what is currently meaningful? In particular, to move beyond the idea that robots are meant to be "as far as possible from people".

What Asimov did not expect, in his creative mind, is that there was no need to live in a futuristic imaginary scenario to challenge the first law of robotics. In 2003, the German company KUKA Roboter Gmbh, a major player in the robotic industry, released the RoboCoaster, a robot used in amusement parks to provide a totally new experience to people wishing to enjoy the thrills of a breath-taking ride. It consists of a robotic arm with two seats at its end to host people. During the ride the robotic arm lifts the passengers in the air, swirls, stops suddenly, turns them upside down and in many directions, with different speeds and dynamics, thanks to a practically unrestricted freedom of motion granted by its six axes of rotation and six degrees of freedom. The peculiarity of the RoboCoaster is not only the unique combination of movements it can allow, but also the possibility for passengers to program their 90 second ride themselves. Before sitting in the RoboCoaster, the passengers use a software application in which they can select various motion profiles and speeds, depending on their age and how brave they want to be (more than 1.4 million combinations are possible). They can design a gentle, easy-going ride, or opting for a totally wild experience, whirling them up, down and sideways through the air. From the first ten robots delivered to the Legoland amusement park in 2003, to the recent adoption in the "Harry Potter and the Forbidden Journey" ride in Universal's Islands of Adventure theme park in Orlando, KUKA has sold about 250 RoboCoasters, opening an unexpected application for an industry that has recently experienced major turmoil due to the recession that hit major automotive clients. The RoboCoaster does not require revolutionary technology, being based on an adaptation of a standard heavy-duty robot made by KUKA, the KR 500, which can lift 350 kilograms (two people plus the seat) and simultaneously have a long arm. The technology is accessible to any manufacturer of industrial robots. Yet, after more than ten years, KUKA is still the only competitor in the field. Why have other companies failed to recognize this opportunity? The point is that even if the RoboCoaster uses existing technology, it challenges the existing paradigmatic interpretation of what an industrial robot is. There seem to be two shared laws among the executives of industrial robotic products. The first one is that their firms are in the business of efficiency. Robots are serious stuff, meant to increase productivity. The second one is that robots need to keep a distance from humans, due to their potential to severely harm people. Yet, the RoboCoaster is not used for improving efficiency, but for entertainment. It does not keep a distance from humans but, instead, is the first passenger-carrying industrial robot. The RoboCoaster is a revolutionary change in what industrial robots are meant for. In other words, it is a "radical change in meaning". This new meaning was not within the dominant assumptions of incumbents in the industry. When we talk about this application with robot professionals their reaction is skeptical, sometimes ironic. KUKA is not addressing the innovation puzzles that the innovators in the industry are focused on (speed, precision, strength) to solve the "big problems" that are currently considered meaningful in the industry. The RoboCoaster is "outside of the law". Instead, it is simply a radical innovation of meanings that, by definition, are considered meaningless if looked at through the lenses of traditional paradigms.

The basis of theories of innovation, and especially of radical innovation, are not clear when relating to innovation as connected to meaning, especially in its more

radical form, when meaning changes significantly. In this paper we will first and foremost illustrate the existence of this type of innovation. We will also relate it to other types of innovation and discuss four dimensions to describe its nature. Further, we will show that radical innovations of meaning always occur, in every industry, and as a consequence, have the power to shape the competition thereafter.

2. A New Language and a New Context

2.1 The Technology - Market Discussion

Studies on innovation management typically point to two drivers of innovation: technology and market (see Figure 1 – for an extensive review see Garcia and Calantone 2002 and Calantone et al. 2010). *Technological* innovation has captured most attention, especially as far as *radical* technological change is concerned. The understanding that technology is a major driver of innovation goes back to early investigations on innovation and entrepreneurship (Schumpeter, 1934). In recent decades, this understanding has spurred a rich stream of studies that have explored the antecedents of technological breakthrough (Abernathy and Clark 1985, Henderson and Clark 1990, Utterback 1994, Christensen and Bower, 1996). Consequently, studies on technological innovation are seen as being concerned with the "how" of things, offering novel ways of solving customers' problems.

The innovation of markets has played a secondary role, and gained traction only recently, thanks to studies that have investigated firms' capabilities of addressing new market segments or uncontested markets. The studies of Kim and Mauborgne (2005) and those of McGrath and MacMillan (2009) represent the most extensive investigations in this regard. In these studies, a market innovation is seen as concerning the "who" of things, changing the subject of innovation, the customer.

These two drivers of innovation have been considered not only independently from each other, but also when acting in combination, especially if combined with a consideration for the depth of the innovation, either incremental or radical. Studies have, therefore, proposed matrix frameworks based on two dimensions: innovation can be described as taking place both in an existing market or a new market (horizontal axes). Innovation can also happen with the help of an existing or a new technology (vertical axes). This reasoning is fundamental to the seminal frameworks of innovation management, such as those proposed by Ansoff (1965) with his matrix on products and markets, Burgelman et al. (2004) on technology and market applications and Mcgrath and Mcmillian (2009) with their matrix on technologies and market segments.

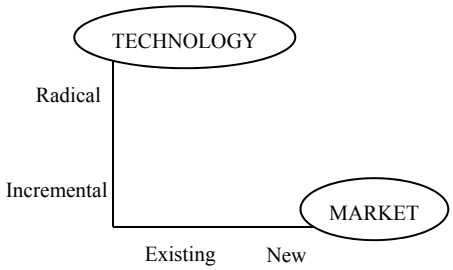

Figure 1: The Technology and Market Dimensions

Despite the combination of this range and depth, none of these theories seem to fully capture a type of innovation such as the one described in the RoboCoaster example. Indeed, on the one hand, the RoboCoaster is not a technological innovation, a new "how". Instead, it is the application of an existing technology (the adaptation of an existing product conceived for the automotive market), to a new context: the market of amusement parks. On the other hand, it is not just a market innovation. There is, indeed, an entrance into a new market but not as traditionally interpreted, using an existing approach to solve the problems of new markets. The RoboCoaster is not merely the transfer of existing technology (and user experience) from one market to another. Nor is it the "lifting capacity for efficiency" that finds a new

market to serve. The revolution is not just moving from one context (car industry) to a new one (amusement parks) and it is not just the "who" that changes. The move includes more than this. What is different is that the purpose of *why* to use this product changes as well. The purpose (and also the answer to the question "Why do we use this product") is no longer "because we are looking to raise capacity to create efficiency and control". That is, the robot is not used in the amusement park to lift and assemble ride equipment. Instead, the answer would be, "because we are looking to raise the capacity to create emotions". The movements, therefore, deliver something else: from being precise and accurate to offering the freedom of selection that makes every ride different and unique. To sum up, *the move to a new context also includes a shift in the purpose*. Innovation, in this sense, has to do with the *why* of using a product (i.e. the meaning of it), not only about *who* uses it (the market) or *how* they use it (the means, functions or technology).

The two dimensions of market and technology, therefore, struggle to explain this type of innovation. There is something that is not captured, namely the perspective of meaning. From this vantage point, a central element is how the user constructs the *purpose* for using the product. If we want to understand and fully capture this type of innovation, we would, therefore, need to introduce a third dimension in the innovation framework, concerning how the user creates their purpose, in other words, their meaning. Even more, when interested in innovation in its radical form, we would need to understand the nature of this type of innovation.

2.2 Innovation in 3D: Introducing the Dimension of Meaning

By introducing the dimension of "meaning" to the debate about innovation, we expand the scope. From a two dimensional construct of technology and market, we include an additional lens, the meaning perspective (see Figure 2). The space of innovation, therefore, becomes a three-dimensional construct.

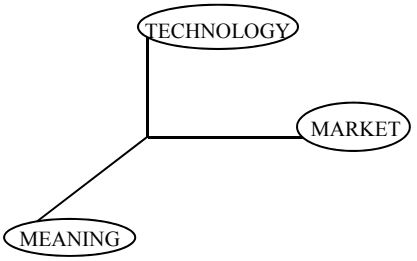

Figure 2: The Dimensions of Innovation: Technology - Market - Meaning

This partially mirrors Abell's model for business definition (Abell, 1980). However, while Abell's third dimension points to the "how" of a product by discussing different "functions" to fulfill customer needs, our proposal stresses the "why" by discussing the "meaning" searched for by users. This meaning, when translated into solutions ("how") may include not only utilitarian and functional needs, but also emotional and symbolic needs. In other words, the question "why" looks at products from a wider perspective, going beyond visible and tangible functions. Another difference to Abell's model is that our perspective is dynamic (on innovation) rather than static (on business definition). We could also call this innovation "design-driven innovation" (Verganti, 2009) as the word design (from the Latin de-signare) is etymologically related to "making sense of things" (Heskett, 1985; Krippendorff, 1989). Design, by definition, includes "to bring meaning".

Note that the innovation of meaning can be based on existing or new technologies. An example of change in meaning associated to new technology is the RobotStudio simulator introduced by ABB Robotics in the early 80s (see Figure 3). RobotStudio was developed thanks to breakthrough software technology that could better predict the movement and efficiency of the robot. Instead of designing, building and trialing a robot in real life on the factory floor, this application enabled car

manufacturers to optimize the performance of the manufacturing process in the "virtual world" of a computer screen. This simulation capacity made it possible to visualize and predict the manufacturing operations before construction of the robot. The meaning, therefore, moved from selling an efficient robotic arm (hardware) to selling the knowledge of how to use it (software). This meant, for example, that the current ideas (at that time) of robots as "fast movers", diminished a bit. Now, even a slow robot could be more valuable than a faster one, if it was used in an efficient way. Studies on radical technological change, especially in the field of socio-technical change and Actor Network Theory, have deeply explored the interactions between meaning and technologies (Latour, 1987; Bijker & Law, 1994). However, the direction of these investigations is the opposite to our purpose. They consider innovation to be driven by technology and a change in meaning as an enabler or a consequence. Here, instead, we focus on innovation driven by the search for a new meaning, with technology being an enabler.

Similarly, the innovation of meanings concerns both existing and new markets. The RobotStudio is targeted toward traditional robotic clients, such as industrial manufacturers. However, it still implies a radical change in the reason why they buy robots, from searching for speed and efficiency, to the quest for knowledge about how to use robots. Instead, the RoboCoaster introduces robotics to a totally new arena, transforming roller-coasting from a ride that is predictable and standard to an experience that is unpredictable and customizable by passengers. The coaster's visitors do not merely get on the ride and sit there, but instead take an active and creative role in the experience. Whichever the case (either an existing or new technology is applied or an existing or new market is targeted), these cases demonstrate that there is a third dimension of innovation: new meanings that are searched for and designed, as a way of providing new values to customers and to compete better, or differently (Verganti 2009; Moon 2010).

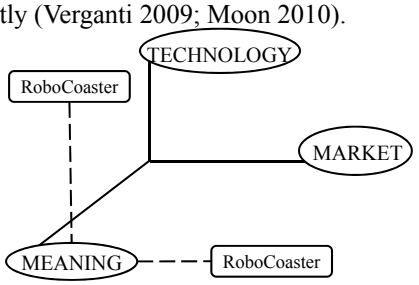

Figure 3: Different Kinds of Innovation of Meaning (The Robocoaster and the RobotStudio)

2.3 Meaning in Other Fields

Meaning, as a driver of innovation, does not make a loud voice in the field of innovation management. In other fields, however, one can find both loud, outspoken and more silent, subtle reflections on meaning. Philosophy for example, and especially the branch of hermeneutics, focuses on how people understand and interpret life, and, thereby, how people create meaning. According to hermeneutics, interpretation comes by addressing both the "parts and the whole", implying the development of new understanding by iteratively considering both the details (the parts) and the context (the whole) (Alvesson and Sköldberg, 2008). In our studies, one of the main inspirations comes from the German philosopher Gadamer, who sees a novel meaning as emerging from a blend of many minds, or as a" fusion of horizons" (Gadamer, 1975). A similar perspective is presented by the French philosopher Ricoeur from the "clash of interpretations", where several critical perspectives collide in the search for new understanding (Ricoeur, 2010). The focus on the individual and her capability to reflect upon herself is also discussed in the field of logo therapy, a branch of psychology where the strive for meaning is believed to be the strongest of human forces. According to Victor Frankl (Frankl, 1988, 1995), this awareness, connected to a person per se, is what makes it possible to understand the meaning of a

certain situation. Another close perspective comes from Mark Johnson who discusses meaning from both a cognitive and an aesthetic perspective (Lakoff and Johnson 1980; Johnson 2007). This theory stresses that meanings, (unconsciously created within us, even before we are aware of them) come to full expression through the arts.

These philosophical and psychological approaches present different ways to relate to meaning. They cover meaning and life, but are not fully applied to research within innovation management that also incorporates discussions on products (or artifact) and business. Nevertheless, product and meaning encourage much discussion, from cultural artifacts and connotations, (Buchanan 2001, Holt 2003), to active contributors in complex systems (Hirschman, 1982), "cultural industries" (Hesmondhalgh 2007) and meaning change in networks (Tuomi 2006). Further, within semiotics and branding (Karjalainen 2004) and in design (Schön 1983, Heskett 1985; Krippendorff 1989, Verganti 2009).

Close business perspectives that connect to meaning instead, are primarily those within organizational studies focused on sensemaking (Weick 1995) and sensegiving (Gioia and Chittipeddi 1991) and on the capacity to see and reflect upon changes (Ocasio 1997; Ocasio 2011; Weick and Sutcliffe 2006). But, also studies on how humans interact through conversation, through "communities of practice" or the use of a common language, also show how people create meaning (Brown and Duguid 1991, Wenger and Snyder 2000, Boland and Tenkasi 1995).

Our perspective, though, that embraces both meaning, product and innovation management, does not make a loud voice in these studies. Focus is either on product meaning, but less on innovation, or on context, and less on changes to product meaning. It seems that explicitly seeking for meaning (such as the meaning of a product and service in the context of its use) is absent from these studies. A valuable perspective though, is the one of "meaning making" (Jahnke, 2012, 2013). This approach sets designers as the catalysts of meaning change by stressing the importance of a critical, even humoristic or ironic perspective of innovation. Nevertheless, the focus is on design and product. There is no explicit framework for a third dimension of innovation.

These streams of literature all relate to meaning and have served as a valuable basis for our investigation (for a more extensive literature review see Öberg, 2012). Still, as we have identified, there is room for a more extended discussion on meaning in the context of innovation. Many theories relate to meaning independently from each other (in socio-cultural contexts, in product design, in organization theory), but none bring together the three notions of meaning, product and innovation management that are core elements in this study.

3. What Is Innovation of Meaning

… something with implied or explicit significance, with an important or worthwhile quality, a purpose…

The English Oxford Dictionaries

There are mainly two types of explanation for meaning. First, a semiotic explanation, or, more precisely, a *semantic* acceptance, where meaning indicates the relation between signs and the things to which they refer (as semantics is the meaning of words and phrases). Second, the definition also includes a philosophic, less tangible and visible function by including the words "implied, explicit, important worthwhile, quality and purpose". These terms suggest a personal involvement and judgment and could be connected to philosophy (as the study of theories about the meaning of things, such as life, knowledge, and beliefs, and as the study of general and fundamental problems, such as those connected with existence, knowledge, values, reason, mind, and language).

When talking of the "innovation of meaning" we refer to *"a user, the product and the surrounding context to interpret a product or service proposal in the way that the purpose changes*". This implies that we refer more to the second part of the definition, the philosophic perspective, rather than the semantic. More specifically, we focus on the *purpose* of a *product or a service*, on the *"why"* rather than on the "*what*". Our perspective of meaning, therefore, is rooted in a tradition that looks at the meaning of *life* (such as in philosophy, sociology and psychology), applied to *artifacts* (as in design and in product semantics) and within the dynamics of *businesses* (as in organizational sensemaking and in the management of innovation).

Therefore, by *product meaning* we relate to the *purpose* of a product or service as perceived by the user. It is connected to the user experience of the product and it comes from their interpretation of a product. It stems from both emotional and symbolic values (such as in the product language and message sent out from the product) but also from the technology and functions connected to the product, delivering a certain performance. The meaning, in the RoboCoaster case, comes both from the appearance of the unexpected movements from the robot (creating emotions and representing different ideas to every spectator) and also from the physical experience of the movements when using the ride (related to the functionality of the robot). Meaning, therefore, is created when moving from discussing the *what* (functions and messages) to the *why* (from efficiency to emotion).

Hence the *innovation of meaning* is a change in the purpose of a product or service, coming from a user's interpretation, in a given context of use. From the perspective of a business, an innovation of meaning is present when the company's message for a product changes and builds on values that express a new reason, a new meaning for why to buy and use this product. These arguments stem from the user perception and can be expressed both by a company and its clients.

4. Methodological Approach

So far we have learnt about two robot products, the RoboCoaster by KUKA and the RobotStudio by ABB Robotics. They are both examples of innovations of meaning; one uses the help of existing technology in a new market, the other with the help of new technology in an existing market. One shows the change from raising accuracy in the strive for control, to raising unpredictability in the quest to create emotions. The other example shows the changes in buying hardware and raising capacity (a robot) to buying software and knowledge (an application system). We will examine these cases closely further on. However, before that, we describe the methodological approach of this study.

The study started in 2010 with the aim of explaining the dynamics within radical innovation. To this purpose, we organized two workshops with 15 managers at ABB Robotics. These resulted in a map of revolutionary cases within the robotic industry covering the last 30 years. When classifying these cases according to traditional innovation frameworks, we realized that not all of them would fit into the existing dimensions of technology and market. Therefore, we moved to an exploratory investigation in the search for an additional dimension to explain the nature of these innovations. Rather than being explanatory, our methodology, therefore, is exploratory, aimed at identifying the nature of a novel phenomenon (a new dimension of innovation) to be further explained through more extensive, future studies. This exploratory stage of the research consisted of in-depth, semi-structured interviews with nine managers within product and project development both at ABB and KUKA, in Sweden, Germany and UK. The interviews aimed to explore how executives involved in projects perceived these innovations differently to other traditional technology and market innovations. The material was tran-

scribed, codified and analyzed in light of the literature review, especially regarding connections to the field of hermeneutics. To increase the external validity, the study also included case studies of innovations in completely different industries, such as durable goods, fast-moving consumer goods and business-to-business settings, using the same interview protocol and analysis. Early insights were then presented at conferences on innovation management and design management, and also at conferences on hermeneutics and qualitative research. The insights were then further elaborated at universities both in Sweden and Italy and discussed by scholars from both management, design and product development as well as with editors of both books and academic journals. The scientific approach would best be described as a participatory research perspective, or as an innovation action research perspective (Kaplan, 1998) where companies and researchers, together, relate to and create new knowledge.

5. Meanings Are Everywhere

Now, we turn our attention to three other examples of innovations of meaning because innovations of meaning do not only exist within the field of robotics. They can be found in any industry, shaping competition and competitive advantage.

We considered the Swedish sports gear company POC, most famous for their ski helmets that combine new technology with a strong visual appearance. By reflecting and understanding several signals, this company has developed a new meaning for downhill ski helmets. Instead of offering supportive headgear to avoid injuries, the company has added a playful, seductive touch to this life-saving equipment. When visiting the POC website, the visitor can dive into a world of protection, where helmets can be personally designed regarding color, size, connection to ski goggles, body armor, gloves and clothes. The visitor can meet the team of athletes and the special laboratory behind the new semi-hard shell technology and learn that the company works with biomimetics (the science of adapting biological structures and functions to the purposes of engineering). Visitors are also offered tips on movies, competitions and links to the partners of the company as well as a local talent program, both within ski and bicycling. This offer is not accidental. It is a result of careful listening to signals within skiing technology, life style studies and fashion. POC is clearly not offering just a product. They propose a scenario of meaning in a market that did not ask for the use of helmets (the meaning associated with ski helmets was indeed that of a device for fearful, inexperienced skiers). The founder of POC did not consult users to find out the new proposal. Instead, he worked with sports medicine experts (back specialists), brain scientists, neurologists, material specialists, experts in social media and graphic design, industrial designers, professional athletes and top gravity athletes to elaborate on these signals and create a new scenario. The result is that POC have now altered the perception of what personal protection is all about from being "a boring must" to a fashionable and attractive feature.

The innovation of meanings can also be found in service contexts (see for example Katarina Wetter Edman, discussing meaning in relation to a service design perspective, (Wetter Edman, 2014)). Let us look at one example within accountancy services. In the 60s, the accountant was the anchor of the finances in a company, keeping the overall picture in his head and not willing to release too much information. He was the bookkeeper that kept things under his wings. Similarly, with private clients, the accountant was a general consultant who provided advice on several financial schemes (pensions, savings, etc.). With the increase in technology in the 70s, the accountant became an informatics-expert, delivering masses of numbers and statistics to the company managers. With increasing speed and more complexity, the accountant

of today has gone from a local or country-specific focus to a global work environment. Analogously for private clients, the accountant has become a very specialized role, focusing mainly on bookkeeping and tax consultation. Accountants have turned a piece in a puzzle of stocks, insurances and pension funds, derivatives and mortgages. Holistic analysis and control is an extremely tough exercise, if not impossible. Therefore, the accountant has to be specialized in certain areas. The meaning has changed significantly, from a "whole-picture" Godfather delivering peace and calm to the top managers and people, to becoming a well informed and detailed expert.

Another example is the development of diapers by Kimberly Clark who, in 2007, released the "Huggies Little Mover Jeans Diapers". The blue denim design was launched as a fun and stylish fashion for babies during the summer months, allowing children (and parents) to feel relaxed, even when strolling around without any trousers. The diaper has a printed pattern that resembles blue denim jeans, with stitched seams and pockets on the back, due to new technology that allowed a clearer and less transparent print than the one normally visible on diapers. Still (but obviously), it kept the core value of leakage protection and great mobility for toddlers that crawl and scoot around their surroundings. But, more than just a fun and colorful way of dressing a child, this also connected to the life-style and preferences of parents and their interests in fashion. The diaper was not developed for the child per se. Instead, the deep blue diapers have become a way of expressing personal style, as a parent. Instead of using arguments, such as "feeling safe", giving your baby the best" and allowing free movement and fun (by taking assistance from famous Disney, or other, commercial characters), this appealed to the "needs" of parents, far away from teddy bears and children's toys. This product talked to parents in the search for self-fulfillment as a not only caring parent, encourages an "up-to date", playful and fashionable one. As a result, the meaning of diapers has changed from a practical and necessary support, one that is bulky and less glamorous to buy, to a self-expressive and prioritized fashion item. This new meaning is not to be seen as a shallow superficial statement because children with "fashionable" diapers can move around and play without the necessity of wearing clothes (trousers) on top. This allows more freedom for the child. Additionally, it is a convenient situation for the parents. In fact, it is a more open, "no frills" attitude in parent-child bonding. Due to the higher engagement among parents, the value of the brand, hereafter, has come to incorporate a more affective connection between customers and the product, similar to the engagement of a loved and attractive fashion brand. This is an example where the meaning changes from being practical-oriented to also including feelings of affection and good spirit.

6. Analyzing the Peculiar Nature of the Radical Innovation of Meaning

From the analysis of our cases, it emerges that managers perceive innovation of meaning, especially in its radical form, as considerably different in its nature than other forms of innovation, such as technology or market driven ones. In this section, we propose four identified dimensions for the nature of this type of innovation; it being dependent, un-optimized, outlandish and co-generated. We show how these dimensions differ compared to more classic approaches to innovation and why these might fail when being applied in a meaning-driven innovation search. These insights, which come from our exploratory case studies, are proposed as a basis for further extensive exploration in future studies.

6.1 Being Context Dependent

Let us start by going back to KUKA and the case of the RoboCoaster. In the robotics industry, most innovation projects imply a search for solutions that can (al-

most exclusively) be technically described. In other words, most innovation (typically driven by technology or new market applications), consists of solving problems. Research studies have typically focused on this type of cases where innovation is perceived as the result of problem solving processes. See for example, the design hierarchy model (Clark, 1985), the problem-solving cycles (Clark & Fujimoto, 1991), and the frameworks of system engineering design (Pahl & Beitz, 1988). As an innovation strategy with reference to, for example, the resource-based view of corporations (Wernerfelt, 1984) and their dynamic capabilities (Teece, 1997), innovation, in this sense, is dominantly directed to finding a solution.

Is the innovation of meaning concerned with problem solving? In other words, is an innovation of meaning defined by the technical problem it addresses, independently from the cultural context it is used in?

The managers at KUKA assert that, no, the aim of the RoboCoaster project was not to solve a technical problem (indeed, the technology of the product already existed), but rather to reframe the interpretation of what a robot may be. This robot delivers amusement and human emotions rather than precision and speed. They designed a new context around it, a new scenario, a new experience, before moving on to technical problems.

Similar findings emerge in the POC case, where a traditional product meant to provide safety (a ski helmet) is reinterpreted in the socio-cultural framework of fashion and style.

Innovation of meaning, therefore, works on a higher level and with a broader scope than when solving a technical problem. It implies to step back from a close focus on the problem at hand, and instead consider the overall user experience, beyond the specific interaction with a product. By reinterpreting the relationship between the product and the surrounding context, an innovation of meaning redefines the purpose of this product. As suggested by hermeneutics, the novel interpretations come when a company has the capability to see both parts (the individual events, one of which is the product at hand) and the whole (the overall user experience, which is the envisioned course of action).

A consequence, and very central to the interpretive process, is the role of external networks. However, differently to classic models of innovation where actors in a network are considered to be providers of the ideas or solutions to a specific problem (Chesbrough, 2003), these networks provide new, different understandings of the context. For KUKA, for example, this first included the request of an entrepreneur in the entertainment industry, later included interactions with clients and theme parks. For POC, it included interactions with doctors, fashion trends and lifestyle experts. The network is not only providing answers but brings about possible interpretations of what could be meaningful to users.

To conclude, both the KUKA and the POC cases show that radical innovations of meaning are context dependent. It is not just about designing a product, but about designing a scenario of meaning. In our cases, this scenario took the shape of a report, of mood boards (POC) or a storyboard (ABB). It can also be a physical realization, such as a concept project, shown in public by a company to indicate future aspirations (this is a strategy typically adopted by KUKA).

6.2 Being Not Optimized

Another major characteristic of dominant innovation theories is that problem-solving is seen as a process of the progressive reduction of uncertainty (the earlier in the process the better, see for example Clark & Fujimoto, 1991) and that, assuming there is an optimal solution out there, it is just necessary to find it (Terwiesch & Ulrich, 2009).

Is innovation of meanings concerned with uncertainty reduction and optimization?

Again, the managers at KUKA assert that no, they were not aiming to find an optimal solution to a problem, nor had they aimed to skim uncertainty off early in the project. Conversely, they started their work with the RoboCoaster by listening to a proposal from an entrepreneur related to the amusement park business. The first tentative product presented to the market was a standard product, adapted for the use of a private person with the help of suitable software. Over the years, the company had carefully listened to what the network looked for and had constantly refined their offer. Among other things, the seat was extended to include a top cover, equipment for laser guns (to fire at themed targets) and other special effects. Recently, the RoboCoaster has been further developed to also include a virtual rollercoaster, experience of avalanches, and the concept has been incorporated to be a part of interactive exhibits that combine math and science with sport activities for children.

Starting from an adapted assembly robot, the RoboCoaster has ended up offering a total experience. Through an iterative development process, different actors have added new knowledge and proposals along the way, and this has helped KUKA to reinterpret the meaning of the product. The strategy has been to listen and adapt the product continuously. In short, this second characteristic suggests a new theory of innovation, where focusing on convergence towards an optimal solution is based on continuous and iterative debates, which firms take an active part in.

To conclude, innovations of meanings cannot be optimized. They belong to an ever-shifting sphere of knowledge, opinions, and proposals and, therefore, can never be constant. In the process of information gathering and processing, external actors may be considered as an important source of new arguments. They express different ideas, use different voices and create different perspectives. Interpretations, therefore, are combined and can lead to new ones by stressing some and abandoning others. Or, as Gadamer would have put it, by a "fusion of horizons".

6.3 Being Outlandish

So far, we have elaborated the two themes of context dependency and non-optimization. These two themes are giving new implications to the theories of innovation as a consequence of our focus on meanings and interpretation. Our discussion, however, considers a specific type of innovation of meaning: a radical change. The next two sections will illustrate characteristics that provide a useful lens to capture the nature of this radicalism.

Recent studies on innovation have deeply analyzed the dynamics of radical change, with a focus on a major challenge: the need to develop the new capabilities required to achieve a breakthrough (see for example Christensen and Bower 1996, Teece at al. 1997). External networks, in particular, are considered crucial to providing access to new competencies (Christensen 1997, Chesbrough, 2003). The perspective is that innovation comes from the additive process of accessing, absorbing and retaining new knowledge (Cohen and Levinthal 1990).

Is the innovation of meanings concerned with the development of new capabilities deemed to be useful in the new scenario? Is this an additive knowledge generation and absorption process?

Our cases indicate a two-sided answer of both yes and no. Yes, because all cases implied the development of new knowledge (not on technical issues but especially on what makes sense to users). No, because radical new meanings are coupled with a criticism of the existing dominant socio-cultural paradigm, not alignment with it.

Considering ABB Robotics and the development of the RobotStudio, when some employees suggested they should start to work on software (instead of hardware) this was not the most popular move within the organization. This is because it meant that some of the competence of how to design robots and their movements

would be handed over to clients through this new service. Still, a group of believers, who were not just internal staff, persisted and continued working with the new software application. And they were not only internal – instead great competence joined from other external partners belonging to totally other fields than robotics, as the software industry. When the product was launched, it was so radical that even clients were not explicitly asking for it. When it came out they were actually felt threatened instead of being thrilled! For example, car manufacturers have internal experts whose expertise is to understand how to use robots. These experts within the client organization interpreted the simulator as a threat to their expertise and, therefore, to their organizational power. The whole idea looked bizarre, strange and different, almost outlandish.

A similar pattern, where a radical innovation of meaning is treated with arrogance by incumbents in the industry, emerges in the RoboCoaster case. This was not considered to be serious robotics by traditional players, but rather as a marketing exercise. Managers at competing companies laughed at this innovation instead of jumping at its imitation.

Developing a radical change in meaning implies, therefore, it is necessary to overcome dominant assumptions about what a product is meant for. It implies the necessity to question the existing socio-cultural paradigm. The importance of questioning the current picture, therefore, links to the ability to build critical capabilities, not only complementary ones. This leads to the peculiar role of outsiders in this type of innovation: rather than being a source of complementary capabilities (that have been identified and that are currently missing), outsiders are used as a source of questioning, even criticizing the current situation. In particular, as we have seen, the interpreters who enable to develop these outlandish interpretations are not customers or suppliers (who belong to the same ecosystem of a company and often share the same frame of making sense of things). Rather, the most effective interpreters are alien to a firm's environment. Software experts looked indeed strange to robotic experts in the 80s, as did experts in entertainment for KUKA or fashion experts for POC. The development of the RobotStudio application by ABB and of the RoboCoaster by KUKA have also been benefited by the contribution of executives who originally came from other industries than industrial robotics (indeed, the entrance of KUKA in new markets has been anticipated by the significant influx of an entire team of new young executives who were not experts in the industry). These executives could, to use the words of Ricouer, take a critical stance on the shared assumptions in the industry and pave the way to the development of breakthrough meanings

To conclude, a radical innovation of meaning is not additive, but is rather "outlandish". It requires the development of critical capabilities thanks to outsiders who enable a firm to make "detours" from the current dominant interpretation, to lose themselves to find themselves another, with a new perspective, as explained by Ricouer (Ricoeur, 2010, Kristensson Uggla, 2002).

6.4 Being Co-generated

Most theories of innovation advocate a closer look on users in order to realize innovation. This perspective is supported, especially within the realm of studies on user-centered innovation (Von Hippel, 1988), design thinking (Brown, 2009; Martin, 2009) and crowdsourcing (Chesbrough, 2003).

Is innovation of meaning user-driven? Does innovation of meaning emerge by getting closer to users?

Our cases show that no, innovation of meaning does not come from users but is as a result of an interactive process that starts from a vision proposed by a firm.

The RoboCoaster, for example, is not the result of market analysis (no one in the amusement park market was asking for this kind of product). Rather, it is the outcome of a clear and forward-looking strategy by

KUKA, searching for new applications by redefining what a robot is, by taking robots outside of the industrial (automotive) interpretation of efficiency and productivity, and taking them closer to humans. Perhaps the most evident proof of the strategy of KUKA is given by the visual and experiential language of their website (www.kuka-robotics.com/en/), especially as far as new applications in the field of entertainment are concerned (www.kuka-entertainment.com). The websites show catalogues of ideas for new applications; the images are playful combinations of products creating complex shapes in the style of Arcimboldo's vegetable portraits. In addition, KUKA collaborated with digital designers Clemens Weisshaar and Reed Kram to create an artistic installation in Trafalgar Square during the 2010 London Design Festival, where the festival visitors and the global Internet community could take control over eight robots via a website by sending short text messages that were then "painted" in the air by the robots using LED lights. KUKA's robots have also appeared in Hollywood movies, such as James Bond's "Die Another Day" and "Tomb Raider" and the company has been honored with a number of design awards. There is a new and entirely radical strategic vision behind the idea of the Robocoaster. It does not come from the users of amusement parks.

Whereas recent theories of innovation place the major focus on the role of users, innovation of meaning places the focus on the visionary role of a firm's executive team. Our research shows that radical innovation of meaning, being a proposal of a new radical purpose, implies the direct involvement of these top executives in the team of interpreters. Indeed, interpretations, eventually, cannot be outsourced. Executives cannot ask others to listen to outside interpreters. They have to be in the design team themselves to internalize the new interpretation. A vision is something that is never brought on a golden tray: it requires interior action. This perspective is coherent with studies on entrepreneurship and strategy that assert that new visions come from the co-construction of understanding (Santos & Eisenhardt, 2009) in a network where both entrepreneurs and stakeholders take an active part (Sarasvathy & Dew, 2005).

In conclusion: a radical change in meaning hardly ever emerges as an answer to a clear market need. Rather, it implies a step back from current needs and proposes a new vision that still does not exist in the market. This vision comes from a combined effort to see and interpret new things, involving both internal, external and "outlandish" networks. Therefore, an innovation of meaning is co-generated.

7. Conclusions

In this article we have shown that there are innovations that cannot be classified according to traditional frameworks focused on the innovation of technologies and markets. Therefore, we propose a third type of innovation dimension: innovation of meanings. On the basis of the analysis of studies in different industries (with a major focus on industrial robotics) we have explored the peculiar nature of this innovation. In particular, we have identified four interesting characteristics that make the radical innovation of meanings different to technological or market innovations. Innovation of meanings is context-dependent, not optimized, outlandish or co-generated.

The purpose of this article has been exploratory, i.e. to identify and define the nature of this type of innovation. This now enables us to set an agenda for future research.

The first direction of research is confirmatory: are the four characteristics of the nature of innovation of meaning constantly present? Do they also characterize innovation of meanings in industries other than robotics, ski helmets, consulting services and diapers?

The second direction of research is exploratory: what is the process of innova-

tion of meanings? How do firms successfully create and launch new meanings?

Both these directions require a new research design and data set, which goes beyond the purpose of this exploratory article.

The aim here has been to give a picture of what an innovation of meaning can be and what its nature looks like. We hope now to expand and give further depth to this peculiar type of innovation in our future work. But, this can only be done by a vivid and constantly ongoing discussion among peers and outlandish, in known and unknown waters, among visionaries and critics, embracing open minds as well as closed ones. For this reason, we hope that this article may inspire other outlanders to join us in this exciting research journey.

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Deer in the Headlights: Response of Incumbent Firms to Profit-Destroying Innovations

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Abstract

Scholars and managers consider innovation to be the holy grail because it allows firms to sustain or enhance performance. However, contrary to the common perception, sometimes innovations go awry and threaten to destroy the incumbents' profits. Since innovation literature has largely underemphasized such innovations, this paper takes the first step in examining these innovations through a study of three industries. The paper shows that existing literature predicts two opposite reactions of incumbents to such innovations. Rationality literature suggests that incumbents would embrace such innovations whereas behavioral decision-making literature suggest that incumbents would avoid such innovations. This research finds that, in the main, incumbents avoid such innovations in line with behavioral decision-making literature. As a result, incumbents often suffer a loss of profits and loss of market share. This paper not only fills an important gap in innovation literature but also paves the way for future research on several unanswered questions about profit-destroying innovations. It also documents some key learning aspects for managers dealing with such innovations.

Keywords: Profit-destroying innovation, innovation decision-making, incumbent response, cognitive biases, innovation management

1. Introduction

Scholars have long pursued greater understanding of innovation and their enthusiasm is mirrored by that of managers who allocate enormous resources in pursuit of innovation. This enthusiasm is justified because successful innovation leads to business success. If we observe leading firms in any industry, it becomes clear that these firms became leaders due to innovation. Sometimes innovators are pioneers whereas at other times they are fast followers (Methe, Swaminathan, & Mitchell, 1996). While innovators reap the rewards of innovation, incumbents that fail to innovate lose market share and die (Banbury & Mitchell, 1995). The fact that the competitive advantage of a firm cannot be sustained over long time periods (Wiggins & Ruefli, 2002) makes innovation an imperative. In short, innovation is the vital fluid of a business without which firms cannot survive for long and the pursuit of innovation promises profits and success.

In light of the obvious fact that innovations are desirable because they enhance firm performance, it comes as a surprise that some innovations, instead of enhancing profits for incumbents, threaten to destroy profits, even when incumbents succeed at such innovations. For example, the emerging innovation of LED lights in the lighting industry will destroy incumbent profits, even if they succeed in the innovation of LED lighting (Sullivan, 2008, 2009). The life span of an LED light is 25 times that of an incandescent bulb; if LED technology replaces incandescent technology, the total annual demand for light bulbs

will diminish significantly. Since the market is not able to price LED lights at 25 times the price of incandescent lights, the average incumbent would see a drastic reduction in its profits even if they were pioneers or fast followers in this technology. This would ensue because light bulb demand will decline by over 90% and competition in the industry will significantly increase due to dozens of new entrants. Unlike normal innovations, such as those of the cellular phone service or flat screen televisions where, if incumbents successfully embrace innovation, they witness an increase in profits, in the case of LED, the incumbents would witness a decrease in profits even when they succeed in innovating LED technology. Since such innovations threaten to destroy the profits of incumbents, this paper calls them profit-destroying innovations. Several industries have witnessed a similar phenomenon of profit-destroying innovations. For example, cultured pearls destroyed the profits of pearl divers by creating an abundance in pearl supplies (Wong, 2005). Similarly, voice over IP (VOIP) destroyed the profits for wireline telecommunication incumbents (Reinhardt, 2004). MP3 played the role of profit destroyer in the music label industry (Goel, Miesing, & Chandra, 2010).

In spite of the fact that this phenomenon of profit-destroying innovations is neither new nor rare, it has been underemphasized in the literature. As a result, we have little understanding of such innovations. We do not know where such innovations come from and how they destroy profits. We do not know whether firms find it challenging to deal with such innovations or whether firms just take them in their stride. We also do not know if the prescription from innovation literature applies to such innovations. This is a critical gap in our understanding of innovation. Furthermore, due to a lack of systemic study of this phenomenon, managers are not aware of effective ways for dealing with such innovations.

This paper takes the first step in examining the phenomenon of profit-destroying innovations. It first establishes that the phenomenon exists and explores various aspects of such innovations. It shows that our prior knowledge of decision-making literature predicts two opposite reactions of incumbents to such innovation. Using data from three industries, it examines the reaction of incumbents facing a profit-destroying innovation. As a result, it not only fills an important gap in the literature but also finds some effective and ineffective ways of dealing with such innovations.

2. The Phenomenon

Contrary to normal innovations that help improve profits and market position (share), profit-destroying innovations do exactly the opposite. Strictly speaking, *a profit-destroying innovation is an innovation that ex-ante threatens to reduce an incumbent's total profits if the incumbent successfully embraces the innovation and maintains market share in the industry.*

Such innovations threaten to reduce profits because they either lower profit margins without a commensurate increase in revenues or they lower revenues without a commensurate increase in profits, or both. It is important to note that the definition removes the impact of market share on profits by assuming the market share of the incumbent remains the same, although in reality market shares will and do change. This assumption is placed only to make the phenomenon clear. Furthermore, although innovation literature acknowledges the risks and uncertainties involved with innovation, this paper focuses on the scenario when the innovation in question would succeed because profit-destroying innovations differ from profit-enhancing innovations only when the innovation succeeds. This is also done to focus on the core differences between profit-destroying innovations and profit-enhancing innovations.

2.1 Some Commonly Seen Profit-Destroying Innovations

Custody service incumbents witnessed a decline in total profits when the industry moved from paper-based certificates to electronic certificates. Custody service firms provide several back office services to mutual fund houses. During the era of paper-based stock certificates, custodians made money by fulfilling the trades and safekeeping the stocks of fund houses. When the markets moved from paper-based certificates to electronic certificates, custodians no longer needed vaults and logistics resources but continued to need the information processing services (Rao, 2004). As the need for several core services disappeared, the price of custodial services declined by over 80%. Although the move to electronic stock led to higher trading volume, this increase in trading volume did not compensate custodians for the decline in prices. The drop in prices for custody services was so large that the incumbents witnessed a decline in their business profits.

Voice over IP (VOIP) technology also illustrates the same phenomenon. When VOIP technology emerged, it threatened to reduce the profits of wireline business incumbents through free and virtually free phone call services. Prior to VOIP technology, firms owned their private telecommunication networks, which acted as high entry barriers to the business. However, VOIP eliminated the need for an exclusive telecom network and allowed new entrants to offer telecom services using the Internet infrastructure. This resulted in higher competition and a drop in prices, thereby reducing the profits of wireline incumbents. The loss of exclusivity for the telecom networks threatened their profits (Reinhardt, 2004).

In the music distribution industry, the MP3 format for digital music was also a profit-destroying innovation (Goel et al., 2010). Music labels, such as EMI, make their profits by selling the music of various artists. They pay their artists an advance and have to sell a minimum volume to break even on that advance. Sales above the break-even volume provide surplus profits to the music labels. MP3 format allowed users to freely copy music and consume it without paying for the music. Peer-to-peer file sharing services, such as Napster, allowed large scale music piracy over the Internet. This led to a significant reduction in music sales, making several albums unprofitable. Even after the courts shut down such services, the MP3 format changed the industry significantly. It allowed the unbundling of music albums and the sale of singles. The overall effect of the innovation was a reduction in sales, revenues and profits for the music labels.

These three profit-destroying innovations behaved differently from normal innovations that enhance profits when successfully embraced by incumbents. These innovations reduced the profits of incumbents, even if the incumbents embraced such innovations and maintained their market share. These examples illustrate an intriguing phenomenon that needs further examination.

2.2 Profit-Destroying Innovations Are Ex-ante Profit Destroying

Although profit-destroying innovations could be an ex-ante or an ex-post phenomenon, this paper focuses on ex-ante profit-destroying innovations. An ex-post profit-destroying innovation would be one that we know destroyed profits only after such an innovation became successful. An ex-ante profit-destroying innovation would be one where we can predict the profit destruction, as in the case of LED lighting. This paper focuses on ex-ante profit-destroying innovations because if incumbents cannot differentiate between a profit-destroying and a profit-enhancing innovation upfront, they would demonstrate no difference in their reaction to these two different types of innovation. As a result, such research would neither help to predict the response of the incumbents nor provide effective ways to deal with such innovations.

2.3 Profit-Destroying Innovations Are Different From the Natural Evolution of Industries

A general trend across most products is that profits tend to fall over time due to competition and other factors. Incumbent firms innovate, essentially, to prevent profit erosion over time. For example, when Apple succeeded with the iPod, Microsoft entered the market with its own media player called Zune. If Apple had not innovated, it would have been forced to reduce its prices to compete with the lower priced Zune. Such actions would have lowered the profits for Apple. However, it innovated with a touch screen iPod and the iPhone to enhance profits and protect its position in the mobile media player market.

Whereas industries experience pressures on profits over time, profit-destroying innovations force profit destruction in a rather short time period. In this sense, such innovations are distinct points in the evolutionary trajectory of an industry and a distinct phenomenon. Furthermore, industries trend towards lower profits because incumbents are unable to innovate enough to compensate for the increased competition. However, profit-destroying innovations threaten to lower the profits of incumbents even when the incumbents aggressively embrace the innovation. For example, in the wireline telephony industry, although huge entry barriers (due to proprietary telecom networks) prevented competition from new entrants, the inability to innovate quickly against other incumbents was pressurizing the profits of the incumbents. However, with the emergence of VOIP (Voice over IP), even non-incumbents could enter the telecoms industry without having to build large scale telecom networks. VOIP allowed a firm to use the Internet infrastructure to provide telephone services. Since the wireline market was saturated, an increase in competition and lower prices could not have increased sales volumes. As a result, at the time of the emergence of VOIP, it was apparent that such a technology would destroy the profits of incumbents, irrespective of whether the incumbents embraced the innovation or not.

Another fact of industry evolution is the phenomenon of price cutting at various times in industry history. Such price cutting maneuvers, whether they reduce prices temporarily or permanently, are not part of the phenomenon of profit-destroying innovations. Incumbents or newcomers sometimes cut prices to gain market share. When Barnes and Nobel introduced a new E-book reader, Nook, it entered the market with a significantly lower price compared to Amazon's Kindle. This move has probably reduced the prices of single purpose E-book readers permanently. Nook involved no major innovation that would account for a reduction in the prices of e-readers. Consequently, it reduced the margins of its competitors. At other times, companies reduce prices and take a profit hit with a view to expanding the industry.

When such pricing decisions involve expected revenues and market share decisions and do not involve any innovation that would account for a profit decline, this does not represent a profit-destroying innovation. Other than the fact that such price cuts do not involve any innovation, incumbents can, and often do, overcome such challenges from many profit-enhancing innovations and avoid price cuts.

2.4 Profit-Destroying Innovations Are Distinct from Product Cannibalization

Although profit-destroying innovations may appear similar to product cannibalizations, it is a broader phenomenon. Marketing scholars care about product cannibalization (Guiltinan, 1993; Mason & Milne, 1994; Mazumdar, Sivakumar, & Wilemon, 1996; Sundara Raghavan, Sreeram, & Scott, 2005) as it has direct implications for several marketing decisions. The term cannibalization refers to the eating of one's own kind and is often used in this context. For example, when a firm, such as Gillette, launched a 5 blade razor after being successful with a 3 blade

razor, some customers of 3 blade razors started purchasing 5 blade razors. In this sense, the 5 blade razor cannibalized other razor blades made by the same firm. When a product introduction reduces the market share of products made by other firms, it is not called cannibalization. Consequently, cannibalization literature has focused on brand and product extensions rather than the broader phenomenon of profit-destroying innovations. At times, the term is also used for one channel of distribution cannibalizing another channel (Barbara, Inge, Katrijn, & Marnik, 2002). However, such cannibalization research has not focused on innovations across product categories and technologies to examine the profit-destroying innovations.

2.5 Profit-Destroying Innovations Are Defined From an Incumbent's Perspective

A profit-destroying innovation is defined from an average incumbent's perspective and assumes that the incumbent will maintain their market share. Although some incumbents may dramatically increase their market share and show greater profits, the outcome for a single incumbent does not change the nature of the innovation. To avoid any confusion arising from changes in market share, the definition includes a no change in market share clause for an average incumbent.

Furthermore, it is important to note that profit-destroying innovations are different from profit-enhancing innovations because they lead to different business performance when the incumbent and the innovation succeed. If the incumbent fails to innovate and the innovation is successful, the incumbents are expected to lose market share and profits, irrespective of the kind of innovation faced by the incumbent (Banbury & Mitchell, 1995). As a result, the definition focuses on the impact of innovation when the incumbent succeeds in innovating and the subsequent innovation succeeds in the marketplace.

2.6 Can Profit-Destroying Innovations Be Beneficial?

The unit of analysis for this paper is an innovation and the aim of this paper is to understand the response of incumbents to a phenomenon. It is important to note that such an innovation could be a product innovation, a process innovation or another kind of innovation, such as business model innovation. In fact, the cultured pearl example shows how a change in the process of procurement/production became a profit-destroying innovation for the pearl industry. Similarly, the VOIP example shows that the product did not change but the supply chain behind the product changed to destroy the profits of the incumbents.

Although such innovations may threaten to hurt incumbents, they may or may not be hurtful to society as a whole. For example, although the Internet has been a driver of many profit-destroying changes, it has perhaps helped society in many other ways by making information accessible to the masses. Very often, such innovations may destroy the profits of the incumbents but may increase consumer value. For example, while the dematerialization of paper stocks led to the profit decline for custodial service businesses, it reduced the fund management fees for investors. Similarly, while the cultured pearl innovation destroyed the profits for pearl divers, it made cheap pearls accessible to the masses. Although, this may appear to be a great benefit to consumers, one should also consider that profit-destroying innovations often lead to massive job destruction. While dematerialization led to a reduction in fund management fees, it also led to the elimination of jobs that involved the manual processing of the securities at custodians.

Similarly, while a profit-destroying innovation may hurt one industry, it may benefit another. For example, when automobiles arrived on the scene, it destroyed the horse and buggy maker industry but led to the explosion of the automobile industry. In fact, a broad systems view of a prof-

it-destroying innovation may demonstrate overall value creation for society.

Irrespective of the fact that such innovations may be valuable for society, they are still a threat to a set of incumbents that face such innovations. The aim of this paper is to understand the response of incumbents and help firms make better decisions.

2.7 Mechanisms of Profit Destruction

Although profit-destroying innovations threaten to destroy profits, not all such innovations use the same method to destroy profits. We have identified three ways in which such innovations can destroy profits. We thank an anonymous reviewer at the International Journal for Innovation in Management for helping us to make these distinctions in the mechanisms of profit destruction.

2.7.1 Demand Destruction: The most obvious way of destroying profits is through the destruction of demand. The LED example above shows that LED lighting will reduce the demand for annual light bulb consumption by over 95% by increasing the life of a bulb by 25 times. At other times, the demand destruction is quite straightforward whereby the need for the product disappears. The earlier example of the custodial service industry shows how the need to safeguard physical certificates disappeared with the advent of electronic shares.

2.7.2 Price Point Substitution: A second major way by which some innovations destroy profits is through a change in price point in the minds of customers. Earlier, music was sold as albums that were priced at USD 15 or above. However, with the rise in digital music, Apple was able to begin selling music singles at a price point of 99 cents. This led to a change in the perceived price of a song in the minds of consumers. Earlier, a consumer had to buy an entire album in order to listen to a handful of songs. However, now consumers can buy just a handful of songs that they like. Here, demand destruction and price point substitution worked together to destroy profits.

2.7.3 Capability Commoditization: A third way in which profit-destroying innovations have an effect is by making the critical resources and capabilities of an industry commoditized. Prior to the advent of VOIP, a firm needed an extensive telecom network to compete in the telecoms industry. However, with VOIP technology, any firm could piggyback on the Internet infrastructure to offer voice calling. Since any firm could leverage the Internet infrastructure to offer voice calls, the price of voice calls began moving towards the marginal cost, which was effectively zero.

3. Literature Review

As this study focuses on the response of incumbent firms to profit-destroying innovations, we review two critical types of literature. First, since innovation literature has dealt with the response of incumbents to different types of innovation, we conduct a focused review of the innovation literature to learn about incumbent response. Second, as we are interested in predicting the response of incumbents to such innovations, we also review the relevant parts of decision theory literature.

Innovation literature has extensively focused on the response of incumbents to innovations. As a result, we now understand the pitfalls in several incumbent responses to innovation.

Early work in innovation highlighted the fact that it is difficult for incumbents to respond to innovation when the technological changes involved in the innovation are large. This literature made a distinction between radical and incremental innovations. Radical innovation involves large-scale changes in technology whereas incremental innovation involves minor changes in technology.

Early work by Cooper and Schendel (1976) found that radical innovations came from outside the industry and led to significant position loss for incumbents because the incumbents found it harder to respond to them. Tushman and Anderson (1986) found that incumbents introduced incre-

mental innovations that built on their previous capabilities, whereas newcomers and outsiders introduced innovations that used different capabilities from those of the incumbents. In effect, newcomers introduced innovations that made the competencies of the incumbents irrelevant. Utterback (1996) found similar results across many industries – incumbents were hesitant or unable to respond to radical innovations. Abernathy and Clark (1985) further distinguished innovations based on whether an innovation destroyed marketing capabilities or technical capabilities, or both.

Although early studies found that radical innovations often come from outside an industry and displace the incumbents (Hill & Rothaermel, 2003), later studies found contrary evidence. Methe, Swaminathan, and Mitchell (1996) found that, sometimes, incumbents were responsible for major innovations in an industry, and at other times, incumbents could quickly incorporate radical innovations in their product offerings. Moreover, Banbury and Mitchell (1995) showed that, sometimes, some incumbents were unable to innovate even with incremental innovations.

Clayton Christensen and his colleagues (Adner, 2002; Christensen, 1997; Christensen & Bower, 1996; Christensen, Suarez, & Utterback, 1998) examined another class of innovations that Christensen termed disruptive innovations. Unlike the earlier innovation classes that focused on changes in technology involved with products and services, such innovations involved a change in the purchase criteria of customers. Christensen found that when such innovations appeared on the horizon, they were inferior to mainstream technologies for key customer purchase criteria and thus did not appeal to mainstream customers. As these innovations did not appeal to the mainstream customers but to a small segment of peripheral customers, the incumbents did not invest in these technologies. Although such innovations began as inferior technology for the key purchase criteria of mainstream customers, they eventually surpassed the mainstream technology for the key customer criteria. Once disruptive innovations surpassed the mainstream technology, they not only provided parity performance with the mainstream technology but also provided a new benefit. As a result, mainstream customers began to value a new attribute that the disruptive innovation provided. Since the incumbents failed to invest in disruptive technologies, they were unable to match the newcomers and were displaced by them.

Christensen (1997) found that the reason incumbents were unable or unwilling to respond to disruptive innovations was that the big customers were not interested in disruptive innovations. Since organizations often focus on their biggest mainstream customers, major incumbents found that disruptive innovations did not make an impact in the beginning. On the other hand, when the innovations were sustaining innovations – the ones where the purchase criteria of the customer did not change, the incumbents proactively innovated.

The above mentioned literature showed that the scholars found incumbents unwilling or unable to respond to some innovations but eager, able and willing to respond to other innovations. While incremental and sustaining innovations posed little or no challenge to incumbents, the same incumbents found it hard to respond when the innovations involved a major new technology or a significant change in the purchase criteria of their customers. The same literature demonstrated that there were also several barriers to innovation that prevented incumbents from responding effectively.

When the change in technology was radical, it required firms to learn new technologies and incorporate them in their products. The key barrier preventing firms from incorporating radical technologies was the lack of information. Chopra (2007) found that X-ray firms, such as GE and Picker, were unable to develop their own

CT scanners because they lacked the required knowledge of a critical technology used in CT scanners. This lack of information behaves as an informative barrier to innovation that reflects on incumbents who are unable or unwilling to respond to major changes in technology.

However, the barriers involved with disruptive innovation were often of the normative kind. Christensen (1997) found that the lack of knowledge never acted as a barrier to innovation and major firms had developed early prototypes of disruptive innovations. However, the firms often discarded the prototypes and stopped working on their innovations. The key barrier to innovation in the face of a disruptive innovation was more of a normative barrier. The norms of the firms involved greater focus on core customers rather than peripheral customers. These norms eliminated disruptive innovations from being funded when the core customers showed little interest in these innovations.

Although innovation literature has examined the response of incumbents to different innovations, it has mainly focused on profit-enhancing innovation; the literature has underemphasized profit-destroying innovations. It may be instructive to examine the nature of choices involved in responding to profit-enhancing innovation and see if our understanding of these choices enables us to predict how incumbents would respond to profit-destroying innovation.

Figure 1a shows the choices that incumbents face when dealing with a profit-enhancing innovation. Literature has recognized this choice set (Mitchell, 1991) and it shows the emphasis of literature on profit-enhancing innovations. The figure shows that incumbent firms have two options when faced with an emerging innovation – embrace it or avoid it. At the same time, the innovation itself could succeed or fail in the market. If the firm avoids the innovation and the innovation fails, the firm loses nothing; however, if the innovation succeeds, the firm may go out of business or lose significant market position (Christensen, 1997). Kraft and Unilever did not imitate P&G's innovation of fat free oil and, as a result, when the innovation failed, these firms were spared the waste of resources that P&G suffered. On the other hand, disk drive makers (Christensen et al., 1998; King & Tucci, 2002) avoided the innovation for too long and thus lost position in the market. If a firm embraces an innovation and the innovation fails in the market, the incumbent loses the resources expended on this innovation activity. However, if the innovation succeeds, the firm stands to benefit from supposedly more profitable technology. Procter & Gamble spent enormous resources on their fat free oil Olestra but the technology did not succeed in the market following which P&G lost the resources it used on this major innovation (Canedy, 1999). On the other hand, when GE embraced the CT scanner innovation, it improved its profits when the technology succeeded in the market (Teece, 1986).

Due to the uncertainty associated with innovations in the early stages, incumbents are best served when they pursue a fast second mover strategy (Christensen et al., 1998; Mitchell, 1991). This strategy prevents excessive upfront costs associated with testing the innovation concept and allows incumbents to build on the early successes of the first movers. When firms fail in the face of a radical or disruptive innovation, it is usually because they were unsuccessful in being a fast second mover. The literature shows that informative as well as normative barriers prevent firms from being successful fast movers in many cases.

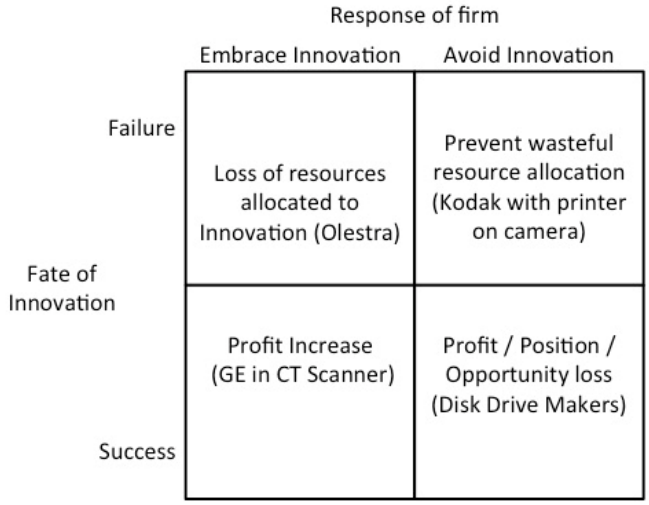

Figure 1: Decision set associated with profit-destroying versus profit-enhancing innovations

Figure 1a: Profit-Enhancing Innovations

Figure 1b shows how the choices associated with a profit-destroying innovation are different from the choices associated with profit-enhancing innovations. One point that stands out in figure 1b is that, unlike incumbents facing profit-enhancing innovations who see an improvement in profits when they successfully embrace innovation, incumbents facing profit-destroying innovations expect a drop in profits when they succeed in embracing the innovation. Furthermore, incumbents facing profit-destroying innovations would also legitimize the innovation and perhaps accelerate the success of the innovation, thereby accelerating their profit destruction. However, if they avoid the innovation, they could lose market position or face exit from the industry if the innovation succeeds. This is because the innovation could potentially make the incumbents obsolete.

Literature on product cannibalization (Barbara, Inge, Katrijn, & Marnik, 2002; Sundara Raghavan, Sreeram, & Scott, 2005; Sundara Raghavan et al., 2005; van Heerde, Srinivasan, & Dekimpe, 2010) has studied the impact of one product cannibalizing other products. Chandy and Tellis (1998) connected cannibalization literature with incumbent response. They highlighted the role of the willingness to cannibalize as an important driver of incumbent response to radical innovations. However, this literature did not examine how willing the incumbents would be to cannibalize a higher profit product with a lower profit product.

A comparison between figures 1a and 1b show that as an innovation turns to profit-destroying, it changes the set of choices facing incumbents and their implications in a meaningful manner. The challenge of a profit-enhancing innovation is not just to embrace the innovation but to do so rapidly, something that incumbents often find hard to do. However, if they succeed in embracing the innovation, they witness an increase in profits. On the other hand, incumbents facing a profit-destroying innovation face only the downsides and no upside. If they succeed in embracing the innovation, their profits would decline but if they avoid the innovation and the innovation succeeds, they could be driven out of the market.

Although innovation literature does not help us predict the response of incumbent firms facing profit-destroying innovation, a review of the decision-making literature provides us with two reasonable but

opposite predictions about incumbent responses to profit-destroying innovations.

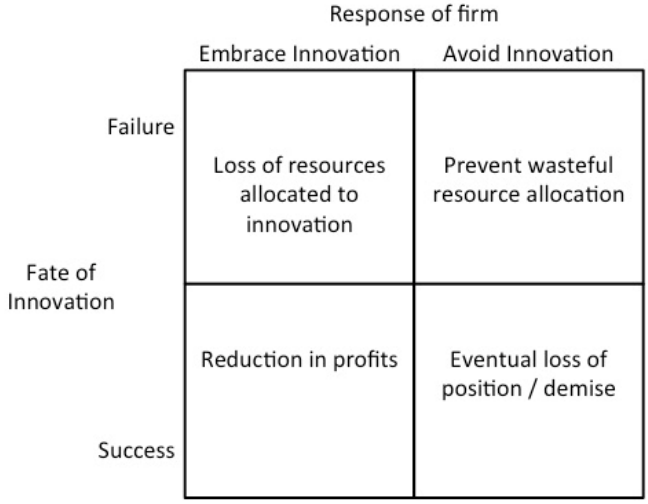

Figure 1b: Profit-Destroying Innovations

The literature on decision theory has had two distinct proponents who approach decision-making from two distinctly different directions. The first branch of this literature is based on the notion of rationality whereas the second branch is based on behavioral decision theory (Goldstein & Hogarth, 1997).

The notion of rationality permeates economic theory and has been an important basis in many sciences. The classic book by Von Neumann and Morgenstern (1944) used this notion to model human behavior. It assumed that economic actors are rational beings who maximize their subjective utility. This notion eventually became an edifice of economic theory (Becker, 1976; Coleman, 1986; Elster, 1986; Hargreaves Heap, Hollis, Lyons, Sugden, & Weale, 1992).

Synthesis of this research by researchers (Goldstein & Hogarth, 1997; Payne, Bettman, & Johnson, 1993; Shafir & LeBoeuf, 2002) points to the notion of a rational decision maker who attempts to maximize subjective utility through his choices. Such a rational decision maker can not only estimate the probability of success of an innovation but also take the path leading to the greatest potential profits.

Based on probability-weighted returns of the various options, a rational decision maker would choose the option with the highest probability-adjusted returns. Such a decision maker would find that embracing a potentially successful profit-destroying innovation leads to higher returns than avoiding such an innovation. From this perspective, incumbents would tend to embrace a potentially successful profit-destroying innovation because it is much better to survive with lower profits than to exit the industry. This leads to the first proposition:

Proposition 1: When faced with a profit-destroying innovation, incumbents embrace the innovation.

However, behavioral decision theory literature and organizational behavior literature have found decision makers to be less than fully rational. These literatures have found that decision makers often become influenced by their context and fall prey to several biases that veer them towards choices that may not be explained by a rational model. This literature would predict that, irrespective of what a rational choice may be, firms facing a prof-

it-destroying innovation would tend to choose the opposite course of action. It predicts that incumbents would avoid the innovation, as discussed below.

Incumbents facing a profit-destroying innovation face two choices, both of which leave them worse off. If incumbents embrace the innovation they would witness a reduction in profits. However, if they avoid the innovation they may have to exit the industry when the innovation succeeds. Scholars have found that when decision makers face two choices, both of which leave a decision maker worse off than the status quo, the decision maker tends to avoid making such a decision (Anderson, 2003; Dhar & Simonson, 2003; Luce, 1998). Consequently, this research would predict that such an incumbent would avoid making the decision and thus would appear to choose "avoid profit-destroying innovation".

Another vein of the decision-making literature provides more support for the avoidant response of the incumbent. According to prospect theory (Camerer, 2000; Hastie, 2001; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), when a decision maker faces the choice between a probable loss and a definite loss, the decision maker systematically underestimates the probability associated with the probable loss. Incumbents facing a profit-destroying innovation also face the choice between a probable loss and a sure loss. Embracing a profit-destroying innovation is akin to a definite loss because this course of action involves voluntarily lowering a firm's own profits. Ignoring or trying to prevent the innovation is akin to choosing a probable loss because if the innovation fails, the incumbent would not lose much but if the innovation succeeds, the incumbent may lose their entire business. Consequently, prospect theory would suggest that the incumbents would systematically underestimate the probability of success of a profit-destroying innovation.

Furthermore, some organizational forces could prevent incumbents from freely going down the rational path of embracing an innovation even if it appears likely to succeed. Power in the organization lies with the leaders of the largest businesses, and leaders maintain that power due to their business success (Pfeffer, 1981). If business profits decline, business leaders would lose credibility and power. Consequently, embracing a profit-destroying innovation would not only decrease business performance, it would also reduce the power of the business leaders. Thus, these business leaders would actively avoid embracing such innovations. Research results (Puffer & Weintrop, 1991) and empirical evidence (Lubin, 2009) show how CEOs lose their jobs when they do not deliver expected results. These results also show how difficult it is for management to take the rational path of embracing such innovations when they lead to the loss of power.

In short, the literature on behavioral decision theory and organizational behavior, taken together, leads to the second proposition:

Proposition 2: When faced with a profit-destroying innovation, incumbents would avoid rather than embrace the innovation.

In short, although rationality literature predicts that incumbents would embrace a profit-destroying innovation, behavioral decision theory and organizational behavior literature predicts that incumbents would avoid embracing a profit-destroying innovation.

In summary, although scholars have looked at innovation by incumbents and newcomers in significant detail, they have often focused on innovations that would lead to higher profits but have underemphasized profit-destroying innovations. As a result, the literature is almost mute on whether some innovations may be bad for incumbents even when incumbents succeed in imitating the innovation. Given that the literature does not sufficiently inform us about innovations that destroy, or threaten

to destroy, the profitability of incumbents, there is a compelling need to understand these innovations better. Our inability to predict the response of incumbents facing such innovations highlights the major gap in our understanding. This research attempts to fill this critical gap in the literature.

4. Data and Methods

As the research question in this study involved a lesser known phenomenon, it suggested the use of qualitative methods (Yin, 1994; Yin, 1981). As this research involved understanding the sequencing of events, the emergence of new information over time and the reaction of incumbents to such information, it was imperative to reconstruct the sequence of events in a reliable manner. Such research involves penetrating the specifics of a time and place so that findings are generalizable in an analytical rather than a statistical sense (Eisenhardt, 1989).

As a first step, this research cast a wide net over several industries to identify some of the innovations that incumbents could have perceived as profit-destroying innovations.

It must be noted that our search for innovations focused on potential innovations that appeared to be profit-destroying before they became successful. As a result, it was not important to verify how much profit was actually destroyed by the innovation. It was more critical that the innovation appeared to be profit-destroying.

This search led to a list of a dozen innovations. Furthermore, a quick research on these innovations was carried out to understand the nature of the data availability and to understand whether there were strong reasons to believe ex-ante that the innovation was perceived as profit-destroying.

The list of the dozen profit-destroying innovations included cultured pearls, custodial services, cultured diamonds, LED lights, wireless electricity, laser-based hair removal devices, consumer cameras, mutual funds, quartz watches, free software, software solutions for tax preparation, and music labels. From this list, three industries were chosen based on two criteria. First, the innovation should have occurred in the past and the reaction of the incumbents should have been documented. This ruled out emerging profit-destroying innovations such as LED, wireless electricity, software services, laser-based hair removal devices, tax preparation software and cultured diamonds. Second, extensive data should have been available on the industry and its incumbents. This ruled out cultured pearls and custodial services, as data on these two industries was sparse at best. The four industries that met the criteria were digital cameras, mutual funds, music labels and quartz wristwatches.

Digital cameras involved a major change in technology, whereas quartz wristwatches and music labels involved minor changes in technology, and index funds involved no change in technology. Since there was a redundancy between wristwatches and music labels (both involved minor changes in technology), we decided to include wristwatches instead of music labels because wristwatches also enabled us to study an international context of incumbent responses. This led to the final choice set of digital cameras, quartz wristwatches and index funds.

Data on CT scanner innovation was also collected to use as a control case where the innovation was profit-enhancing in nature. However, due to space constraints, data on CT scanners is not shared in this paper.

As the next step, a massive data gathering effort was undertaken for the digital camera industry. It involved iterative searches for terms including “digital camera”, “film camera”, and several other related terms in the lexis nexis academic universe database for the time period 1979 to 2005. Since the first digital camera was announced in the early 1980s, this time period would have captured all the events related to digital cameras. This yielded

over 3000 articles in publications from across the various searches. Based on a quick review of the article title and metadata, relevant articles were put aside for deeper review. Along with these articles, all available 10-K reports, industry reports, existing case studies and web based searches were used to better understand lesser understood terms and events for carefully reconstructing the history of the industry. At times, some data made it imperative to go back further than the initially selected dates. This data collection effort took place between 2006 and 2009; additional data was collected through interviews with several subjects later on.

The camera industry research demonstrated that data closer to the emergence of the innovation provided the most valuable sources and data temporally distant from the innovation was significantly less relevant. This insight was used to collect data on quartz wristwatches and the mutual fund industry where a similar method was used but where the dates for collecting information was reduced to 1 year prior to the innovation and 10 years after the innovation.

Moreover, while both the camera industry and CT scanner industry involved fewer than 50 firms that entered the industry and competed, the Swiss watch industry as well as the mutual fund industry involved thousands of firms.

Due to large variations in the number of firms in the industries, while the data for the digital camera and CT scanner industry encompassed all firms across the entire time period, the data for quartz watches and the mutual fund industries focused on a sample of incumbents along with aggregate industry data where available.

One author undertook the entire data collection effort. Since the data collection focused not just on quantitative data but also qualitative data, such as press releases and company official statements, the focus was on recreating a timeline.

Based on the various data sources, a detailed timeline of events was reconstructed for each industry. Since data was used from several sources, it ensured increased reliability and the validity of the findings. Furthermore, since the data was used to reconstruct the history so as to provide a contemporaneous feel for the events, it reduced the likelihood of retrospective bias. By preserving the chronological flow of the events, the detailed timeline provided a rich dataset that enabled a deeper understanding of the phenomenon and any other issues related to profit-destroying innovations. The narrative distilled from the dataset and the implications are presented in the next section.

5. Analysis of Incumbent Response in Three Industries

5.1 Incumbent Responses in the Photographic Equipment Industry

The photographic equipment industry refers to the group of firms that produce cameras, film, photofinishing services and accessories. Over the last 130 years, this industry has witnessed two major innovations. The first involved the invention of the film roll that led to a rapid expansion of the industry in the early twentieth century. The second involved the transition from film cameras to digital cameras in the early twenty first century. Prior to the film roll, the technology involved a cumbersome technique in which a coated glass plate was exposed to capture the image. Due to this cumbersome methodology, professional photographers were the core customers of the industry.

Kodak pioneered the film roll technology that replaced glass plate technology. Due to its technological and marketing efforts, Kodak had become a dominant player in the industry by the middle of the 20^{th} century. Its innovation efforts focused on making the camera easier to use and improvements to the picture quality. By the 1950s, it had eliminated virtually all competition from the industry and in the 1970s Kodak had a 90% market share in film and an 85% market share in cameras in the US market. Its photofinishing technology had

become the industry standard. Its position outside the United States was also strong but not as strong as at home. In 1976, it had $2bn of global sales compared with the $2.8 billion global sales of all other competitors. Not only did Kodak have a dominant position, but the business itself was very lucrative too. By many accounts, the gross margin of the business was upwards of 50% (Porter, 1983).

Polaroid was the other major player in the industry with complete dominance in the instant photography segment, a segment that it pioneered. Its technological lead and dominance in instant photography allowed it to grow at over 25% p.a. for 30 years from 1945 to 1975. Polaroid's innovation efforts aimed to improve the image quality and to reduce the time between capturing the image and obtaining the finished photo. Although Kodak entered this segment in the 1970s, it was driven away from the segment by Polaroid's lawsuits.

Canon, Nikon, Fuji Photo, and Agfa were other important players in the industry globally. Canon and Nikon made cameras while Fuji and Agfa also made film. Although Fuji entered the US market in the 1970s and slowly nibbled at Kodak's market share through its low cost offerings, reaching a 20% share by the end of the century, Kodak remained the dominant market leader.

Throughout the century, innovations emanating from the industry enabled firms to enhance their profits. Color photos, faster and better quality film, and superior photofinishing allowed firms to maintain or increase profits. At one point, DuPont, the chemicals major, tried to enter the industry in the film segment with a better quality film roll. At that time, Kodak moved swiftly to beat DuPont in the technological race initiated by DuPont. Each subsequent product launch showed Kodak's superiority over DuPont. DuPont left the industry shortly after. This episode showed the significant capabilities and market power of Kodak and was an example of an incumbent reacting to a profit-enhancing innovation in this industry.

In 1981, Sony, the consumer electronics major, introduced a digital camera called Mavica that required no film. It was a sophisticated piece of consumer electronics compared to the ordinary $50 film cameras then sold across the United States. Both Polaroid and Kodak began investing in developing a wide range of capabilities needed to compete in the digital camera domain. Kodak set up a laboratory in Japan to learn consumer electronic technologies and over the next 10 years invested over $5 billion in digital technology. Both Kodak and Polaroid set up digital technology teams that amassed capabilities in microelectronics, IC design, image processing and software design. Kodak launched the world's first image sensor in 1986 that became the industry standard. By 1989, Kodak had launched over 50 products related to digital image capture or conversion.

The reaction of Kodak and Polaroid to Sony's digital camera allowed the firms to build impressive digital capabilities within the next 10 years. There was absolutely no hesitation or feet dragging by these firms in developing new technological capabilities and producing digital products. Eventually the senior management realized that the innovation was a profit-destroying innovation as the launch date approached. Digital cameras decreased profitability by eliminating the film and photofinishing services on the one hand and by increasing competition from consumer electronic firms on the other hand. The margins were significantly lower in the digital world.

When the management of both Kodak and Polaroid realized that the digital camera was a profit-destroying innovation, they began to resist the commercialization efforts. Many news reports and other industry observers noted that managers were resisting the digital technologies. A senior manager at Polaroid said "Why 38%? I can get 70% in film. Why do I want to do this?" upon realizing that the innovation was profit-destroying (Tripsas & Gavetti, 2000).

Similarly, Kodak's managers also lamented the profit-destroying nature of the innovation. A senior vice president and director at Kodak said "We're moving into an information based company, but it's very hard to find anything [with profit margins] like color photography that is legal". Even the new CEO, George Fisher, found significant resistance from the traditional film business and had to merge the two divisions to end the war between the digital and film based businesses.

Feet dragging by Kodak and Polaroid had a significantly detrimental effect on their market positions. Kodak lost its dominant position in the industry. Polaroid, on the other hand, became a non-player. In 2001, it filed for chapter 11 bankruptcy and its assets were sold off to another company who continued the business under Polaroid's name. In 2007, it decided to exit the instant photography market. In the case of digital cameras, the innovation was a profit-destroying innovation as the firms expected it to be. Fuji's profits declined from 13% in 1990s to 7% in 2005 and Kodak's gross margins declined from 46% in 1998 to 32% in 2005.

Canon and Nikon, on the other hand have used the opportunity of digital cameras to promote digital single reflex cameras (DSLR), which is a more lucrative market segment. SLR cameras allow users to change the lens and provide significant flexibility in photo capture. Point and shoot (P&S) cameras replaced SLR cameras a long time back because of their ease of use. With the ability to get instant results from a digital camera, a user can see the result from the various features of a SLR camera instantly. As a result, the SLR segment began expanding due to the efforts by Canon and Nikon. Due to its SLR strategy, Canon, which was a peripheral player in the industry, became one of the major competitors in the digital arena.

The photographic equipment industry showed that the most dominant incumbents dragged their feet in the face of profit-destroying innovations while commercializing the innovation. However, when the same incumbents faced a profit-enhancing innovation, they aggressively defended their turf. Furthermore, peripheral players were better able to deal with the profit-destroying innovation than the dominant players. Finally, firms like Kodak and Polaroid that relied heavily on the industry for their profits had a more difficult time dealing with profit-destroying innovations than firms such as Canon who depended less on the industry for their profits.

5.2 Incumbent Responses in the Swiss Wristwatch Industry

Just as Kodak and Polaroid dominated the photographic equipment industry for the entire century, Swiss watchmakers dominated the global wristwatch industry up until the early 1970s. "Made in Switzerland" stood for excellence in wristwatch-making due to centuries of superior artisanship. Until 1957, all watches in the world were mechanical watches consisting of more than 100 small components and requiring fine artisanship to keep accurate time. Accuracy in time-keeping was the core benefit of watches and Swiss watches provided the highest accuracy.

Post World War II, Swiss watchmakers accounted for 80% of the world watch production and the industry employed 80,000 people across 2500 firms. Over 95% of Swiss watches were exported and these exports accounted for 10% of GNP. These watches were jewelry items sold at jewelers and provided watchmakers with over 50% gross margins. During the 1950s and 60s, cheaper watches of inferior quality from Japan and United States nibbled away some of the market share of the Swiss watch makers. Nevertheless, even by 1970, Swiss watch makers dominated the global industry with a 50% market share.

Quartz technology heralded a major change in the industry in 1970s. Quartz crystals could be used to keep time without the need for the more than 100 small components that a mechanical watch needed. Quartz watches were as accurate as the best Swiss watches, and were significantly

cheaper. Originally, the Swiss incumbents created the technology. This invention was the result of a research consortium set up by Swiss watchmakers in response to an electric watch that appeared in the industry in the 1950s. However, the firms decided not to commercialize the quartz technology. This was because moving to quartz would have eroded the 20% premium that Swiss watches commanded over other watches; although Swiss artisanship was difficult to copy, quartz technology was difficult to differentiate.

Japanese and American watchmakers led the way in commercializing the quartz watch category. During the 1970s, quartz watch sales increased throughout the decade and beyond. In 1975, only 3% of the watches sold worldwide were quartz watches but by 1979, this share of the quartz segment increased to 31% and by 1984, 75% of all watches sold globally were quartz watches. Since the Japanese and the American watchmakers led the way, they gained significant market share in the quartz watch segment. For example, Seiko, a major Japanese watchmaker, increased its production of quartz watches from 20% in 1975 to 72% in 1977. Timex, a major American watchmaker, introduced its first quartz watch in 1971 and priced it at 60% discount to the least expensive watch sold in the United States. The rapid expansion in the industry lured many companies to the watch industry. Over 50 companies entered the industry in the 1970s including Texas Instruments and National Semiconductors.

Since the technology required to produce quartz watches was significantly different from the technology required to produce mechanical watches, the innovation was a radical innovation. Furthermore, the key purchase criteria or benefit from a watch did not change. Consumers valued the accuracy of watches as the most important attribute to choose a watch, and they continued to value accuracy even in a quartz world. Since innovation classes are ex-ante descriptions, quartz innovation was a radical and sustaining innovation.

Quartz technology reduced barriers to entry in the industry, barriers that were earlier based on the superior artisanship of the Swiss watchmakers. Due to lower barriers to entry in the industry, the profitability of the incumbents was expected to drop as competition would lower prices. The Swiss firms saw the profit-destroying potential of quartz watches clearly. One industry observer noted, "Many doubted there was any profit to be made in selling inexpensive watches". Hayek, the man responsible for the eventual resurrection of the Swiss watch industry, said about the Swiss mindset "Why should we compete with Japan and Hong Kong? They make junk and then give it away. We have no margin there".

The most pervasive response of the Swiss firms was no response to the quartz watch competition. Instead, they ceded territory across the world in mid and low priced segments. By 1985, the global revenue share of Swiss watchmakers had declined to 30% and their volume share had declined to 10%. The total exports of mechanical watches had declined from 40 million units in 1973 to 3 million units in 1983. During this period, from 1970 to 1985, the total number of Swiss watchmakers declined from 2250 to a little over 750 and the number of employees in the industry declined from 65,000 to less than 30,000.

Swiss firms had the technology to introduce quartz watches but did not commercialize the technology. They watched a slow motion train wreck and did nothing for over a decade and a half. These firms behaved just as a deer does in car headlights – they froze without a response. This provides further evidence to support the findings from the digital camera industry that incumbents behaved in line with behavior decision theory predictions and not in line with rationality view predictions.

The Swiss watch industry also gives an example of a firm which successfully dealt with a profit-destroying innovation. Instead of following the Japanese in mak-

ing watches an everyday item, Swatch repositioned the wristwatch from being a jewelry item to being a fashion accessory. It used its Swiss origins to demand a premium and used its design skills to create watches for different moods, clothes, occasions and events. This provides more evidence that, irrespective of whether the innovation is eventually profit-destroying or not, the incumbents behave as a deer in headlights when they perceive the innovation to be profit-destroying. Moreover, it shows that some incumbent firms can respond to profit-destroying innovations effectively.

5.3 Incumbent Responses in the Mutual Fund Industry in the United States

The common theme between digital camera innovation and quartz innovation was that they both involved a radical technology needing significantly new knowledge. However, the innovations in the mutual fund industry involved no new technology and thus the mutual fund industry is a welcome addition to the data set used for this research.

The mutual fund industry is a part of the broader financial services industry and plays an important role in providing investment products with different risk profiles and liquidity. The three major categories of mutual funds are equities, bonds, and money market funds. A mutual fund takes money from investors and uses it to buy and sell financial instruments to generate returns in line with the fund's objectives. The fund company makes money by charging for investment management and sometimes takes a percentage of the profits. The key drivers of profitability in the industry are the size of the assets under management and the management fee.

Until 1976, all mutual funds were actively managed funds. Managers of such funds buy and sell instruments, such as equities, to beat a benchmark index, such as the S&P 500 index. Fund managers of active funds use research staff, and incur enormous expenditure when buying and selling financial instruments. Such funds charge close to 1.5-2% of the assets under management as a management fee from the investors. History shows that more than 50% of all funds underperform their benchmark index.

In 1976, Vanguard introduced the first index fund, called the Vanguard Trust 500. Unlike actively traded funds, such a fund is a passive fund that replicates the benchmark index and undertakes no buying and selling except when the index composition changes or to honor fund redemptions. However, it guarantees index performance that is at least as good as the universe of all actively managed funds. Such a fund also charges a significantly lower management fee compared to actively managed funds; Vanguard's fees were estimated to be almost a sixth of the fee charged by equivalent active funds.

Index funds were a profit-destroying innovation for the mutual fund incumbents because it reduced the management fee significantly. In fact, if all assets were moved to index funds, the overall management fee charged by all funds would reduce by over 80%. Irrespective of how profitable the index fund business could be, with an 80% reduction in revenue, the incumbents would see a reduction in profits. As a result, mutual fund houses quickly realized that this innovation could destroy profits. However, the industry participants believed that such an innovation would not succeed as no one would want to achieve such a mediocre performance. Vanguard was even criticized for being un-American by providing mediocre returns. However, the innovation succeeded. By 1990, 2% of the assets under management in equity funds belonged to the index category and by 1998 it had increased to 7.3%. By 1998, 33% of funds flowing into equity mutual funds went into the index fund category.

Fidelity, the market leader, did not respond to this threat for over 15 years during which time Vanguard played in a largely uncontested field. Moreover, even when Fidelity and Dreyfus launched their own index funds they did not promote

these funds in a meaningful manner. As a result, more funds continued to flow to Vanguard index funds than to Fidelity and Dreyfus. Due to this delayed reaction by the incumbents, Vanguard's market share of the mutual fund industry had increased to 5.5% by 1992. From 1987 to 1992, while Fidelity's share of direct marketing assets declined from 30.5% to 28%, and Dreyfus's share of this asset class fell from 13.9% to 10.6%, Vanguard's share increased from 15% to 20.7%. By 2007, Vanguard had become the clear leader of the index fund category with 46% market share, a remarkable achievement in a fragmented industry.

The mutual fund industry did not need new technology to launch index funds. In fact, any fund house could have launched such a fund in a very short period because they had all the knowledge required to do so. Nevertheless, the incumbents did not respond, even when large amounts of new assets were flowing to Vanguard.

A key difference between the outcomes for mutual fund incumbents and incumbents in the industries covered earlier was that in this industry, Fidelity was not displaced by Vanguard. In fact, Fidelity's overall market share did not decline in a meaningful manner due to the rise of Vanguard. So why did Fidelity not lose its leading position, even when it demonstrated a weak and indecisive response to the threat? The answer lies in the fact that mutual fund incumbents had significantly stickier client relationships than incumbents in the camera or watch industry had. In the pension plans category, employers often administer the plan wherein they choose a menu of funds to be provided to employees for investment of their retirement savings. These plans tend not to change very often. Similarly, for self-directed IRAs, investors had to open new account relationships with a fund family, which is a switching barrier. Moreover, financial advisors who advise clients on which funds to add to their portfolio are often paid by active funds whereas they do not get sales commission on index funds. Finally, selling and buying in taxable accounts has a tax implication that may make such moves expensive. Overall, these barriers in the mutual fund industry made it harder for assets to be switched from actively managed funds to index funds but did not prevent new funds from flowing to index funds.

In 1993, the mutual fund industry witnessed a second profit-destroying innovation that competed directly with the index funds. The American stock exchange launched the first exchange-traded fund (ETF), which is similar to an index fund but costs even less and provides several advantages over index funds. The lower cost of such funds is a result of less administrative work required to run such funds. As a result, an ETF is an index fund with lower costs because of the elimination of some of the value activities. Barclays, a non-player in the mutual fund industry, provided a major commercialization impetus to this product category. From the year 2000 onwards, the total flow of assets to ETFs surpassed the share of funds flowing to non-ETF index funds and the ETF category had increased to over $422 billion by 2006. The rise of ETFs was akin to the rise of index funds.

While other players in the mutual fund industry, including Merrill Lynch and State Street, moved into ETFs, Vanguard, the leader in index funds showed the same behavior as Fidelity demonstrated in response to index funds. In fact, when the Vanguard managing director Gus Sauter proposed that Vanguard should launch ETFs, the chief executive of Vanguard, Jack Brennan, responded, "I think that's the worst idea you have ever had". Vanguard had become a deer in the headlights in response to a profit-destroying innovation. It finally responded in 2001 with its first ETFs but did not advertise those ETFs to any great extent. In this sense, its response was no different from Polaroid's commercialization efforts of its digital cameras. Just as Vanguard rose to prominence with a

profit-destroying innovation, so Barclays also succeeded with ETFs. By November 2007, Barclay's had a 57% share of the ETF segment; State Street had a 21% share, while Vanguard had a mere 7% share.

The fact that financial service firms that could have quickly imitated any new product took 15 years to respond to a profit-destroying innovation provides further evidence that, in the face of profit-destroying innovation, incumbents tend to behave as deer do in the headlights of a car. This finding is similar to the findings in the previous two industries.

6. Synthesis of Findings from this Research

A common theme emerging across all profit-destroying innovations described above is that the incumbents behaved as deer in headlights do when faced with a profit-destroying innovation. They continued with this avoidance response even in the presence of significant evidence that the innovation would succeed. The evidence suggests that the mechanism proposed by behavioral decision theory research was working rather than the mechanism proposed by rationality theory. On the other hand, in the case of a profit-enhancing innovation, incumbents were spurred into action, as was shown by the response of Kodak to DuPont.

The incumbents in the digital camera industry did not hesitate to invest aggressively in the radically new technology but did not demonstrate the same force when commercializing the innovation. Similarly, the Swiss watch incumbents and the mutual funds incumbents continued to avoid the innovations in the face of mounting evidence that the innovations were succeeding.

Figure 2 summarizes the results across the three industries studied in this paper.

Figure 2: Summary of results from the analysis of four industries

Industry / Innovation	Common Incumbent response	Impact on Incumbents
Mutual Funds /Index Funds	Delayed and indecisive reaction	Rise of Vanguard / No incumbent displacement
Mutual Funds / Exchange Traded Funds	Delayed and indecisive reaction	Rise of ETF players / insignificant displacement
Camera / Digital Camera	Spurred into action when investing in technology. Dragged feet when commercializing	Significant market share loss and exit of dominant incumbents. Peripheral players rose to dominance.
Wristwatches /Quartz Watches	Ceded territory to quartz players/ delayed action on quartz	Loss of profits/ market share, exit of many players
Camera / Film roll innovations (faster, color)	Spurred into action when faced with better film innovation	Improved position / profits. Drove out challenger

7. Discussion and Lessons for Managers

When we asked senior managers how they would respond if they were faced with a profit-destroying innovation, we were told that they would rather survive with lower profits than exit while trying to maintain profits in a losing scenario. However, this research shows that even very successful firms fail to make this choice. The incumbents in this study behaved as deer in headlights do when faced with profit-destroying innovations. These incumbents did not miss the innovation facing them and they did not refuse to invest in the technology. However, when it came to commercializing the innovation, they just dragged their feet, did not commer-

cialize the product fast enough, did it tentatively, or behaved in a self-destructive manner. On the other hand, when the innovation was profit-enhancing, the incumbents were spurred into action.

The rational approach of incumbents would have been to assess the probability of success of the innovation and then make an investment decision based on the risk-adjusted net present value of the investment. Although the uncertainty associated with an innovation is very high early on (Mitchell, 1991), it is still possible for firms to take a real option approach (McGrath, 1999). While wristwatch makers and camera manufacturers did this because the technology was radical, mutual fund incumbents did not have to take a real option approach to the technology as it was not new.

The literature mentions several factors that contribute to incumbents reacting to innovation at a slower pace than required. However, none of those traditional factors were at work here. First, the speed at which innovation displaced mainstream technology was not an issue (Christensen, 1997). In all three industries, the innovations took between 15 to 25 years to displace the mainstream products. As a result, lack of time is not a reasonable explanation for an incumbent's response. Second, a lack of cash flow and resources also do not explain this anomaly because the incumbents had significant resources at their disposal (Tripsas, 1997). Third, the degree of technological change does not explain the behavior because the photographic equipment incumbents spent enormous amounts of money and the Swiss watchmakers had all systems ready to go to produce and commercialize the innovation (Anderson & Tushman, 1990; Tushman & Anderson, 1986). In fact, the three innovations across three industries had different degrees of technological change (low, medium and high) and there was no difference in the incumbents' responses in spite of differences in technological change. Fourth, the blind spot argument that the incumbents did not see it coming also does not work because of the long time periods over which the incumbents witnessed a displacement of their position (Christensen, 1997).

Tripsas and Gavetti (2000) have examined Polaroid and suggested that Polaroid suffered from the inertia of dominant logic due to the fact that the firm did not aggressively commercialize its capabilities. Although dominant logic (Bettis & Prahalad, 1995; Prahalad & Bettis, 1986) clearly played a role in Polaroid's failure, this was not the case in the other examples because for mutual funds and wristwatches the business model didn't change much. Furthermore, within the photographic equipment industry itself, other incumbents behaved somewhat differently from Polaroid, as we saw earlier.

This research provided evidence that the mechanisms proposed by behavioral decision theory rather than rationality theory were at work when incumbents were faced with profit-destroying innovations. Not only did the incumbents behave as deer in the headlights, the more central incumbents behaved more in this way. Kodak and Polaroid continued to drag their feet in commercializing the technology but a peripheral player, such as Canon, aggressively moved in with SLR technology to claim a larger market share. It stands to reason that the deer in the headlight response would be strongest for the most dominant players in the industry because the leaders of such firms would have the most to lose. It appears that the stronger the market position of an incumbent facing a profit-destroying innovation, the more such a firm would stand to lose by embracing the innovation. On the same lines, when Vanguard dragged its feet in embracing ETFs, smaller index fund players moved aggressively towards the ETF market. Similarly, Japanese and American watchmakers, peripheral players in the global watch industry, embraced the innovation aggressively while Swiss watchmakers ceded territory to these firms.

This research also suggests that the more a firm depends on the industry facing a profit-destroying innovation, the more it behaves as a deer in headlights. Firms such as Canon had revenue sources from several industries whereas Kodak and Polaroid were completely dependent on the camera and film industry. Vanguard was dependent on the index fund market for its revenue whereas Fidelity and others had several actively managed products. Again, this shows that firms tend towards a more rational approach when they are less dependent on an industry for profits and revenues. Such firms can cover their decreasing performance in one industry with an enhanced performance in another industry. On the other hand, a firm entirely dependent on one industry may find it risky and difficult to create new sources of revenues in other industries. In short, not only did the incumbents behave as deer in headlights do, the most dominant incumbents and those most dependent on the industry behaved even more so. As a result, they lost position or had to exit the industry.

This research provides some key lessons to managers dealing with innovation decisions

1. *Some innovations can destroy profits instead of enhancing profits*: A key lesson for managers is not to view all innovations as good. Managers are urged to examine their own innovation pipeline and assess if some of these innovations may potentially be profit-destroying innovations. At the same time, it shows how peripheral firms can use the opportunity of a profit-destroying innovation in the way Vanguard did.

2. *Watch out for decision-making biases in innovation decisions:* Decision-making for innovation takes the decision makers into the realm of high uncertainty and sometimes into loss domains, as shown in this paper. The fact that decision makers assess uncertainty and probability differently when in a gain domain than in a loss domain is a key reason why they sometimes fall into certain decision traps. Not being aware of this cognitive bias may lead decision makers to make the same mistakes that managers facing profit-destroying innovations make. Although an awareness of decision-making biases would help decision makers in many situations, Vanguard's response to ETFs showed that mere experience may not be sufficient for decision makers to avoid cognitive biases.

3. *Don't envision the future through the rosy lens of current capabilities*: A key mistake that firms often make when facing such innovations is that they view the future through the rosy lens of their current capabilities and consumer understanding. Kodak believed that the future of photography was a convergence between chemical science and microelectronics. As a result, it created dozens of products that would help customers in the converged end state. These products involved expensive photo CD players (priced at $500) and Kodak CDs to convert film to digital pictures. Polaroid, on the other hand, believed that the future of photography involved the need for small printers on the top of digital cameras. As a result, it spent an enormous amount of resources developing such a printer and camera combination. Similarly, Swiss watch firms believed that consumers would loathe cheap watches that didn't include fine Swiss artisanship. They perhaps thought the market for cheap watches would remain separate from the market for fine watches and didn't imagine that the segment boundaries would blur. All these firms were deluding themselves to a great extent. They were creating a future through the rosy lens of their current capabilities and thus missed out on the greatest threat to their ex-

istence. To some extent, one can understand why firms can get into the trap of believing that what made them successful will continue to make them successful. One way to overcome this challenge is to deliberately avoid envisioning the future through the lens of current capabilities. This would force managers to envision challenging future end states and the ways to deal with them.

4. *Don't miss out on major and minor trends in the industry and its adjacent spaces*: In hindsight, one can question why these firms didn't do several obvious things. Why did Kodak not notice the significant penetration of personal computers and the rise of the Internet? Why did camera incumbents not attempt to dominate image manipulation software, online picture manipulation and sharing, social networking around images and online printing? Why did Swiss watch firms not come up with the idea of a watch as a fashion accessory before most of the firms exited? Why did mutual fund firms not come up with active ETFs as a way of dealing with Vanguard's plain vanilla index funds? This line of questioning highlights the fact that firms can miss the key trends since they do not look out for them. Firms can create several opportunities if they focus on these minor and major trends.
5. *Create an option C*: All the firms that succeeded in dealing with profit-destroying innovations did so by getting out of the false dichotomy of embracing or avoiding the innovation. Swatch transformed the watch into a fashion product to create an option C. Canon brought back the idea of the SLR camera and rapidly created a prosumer segment for the SLR camera. Unfortunately, some of the firms that failed also attempted to create option C. Kodak thought that convergence products would create an option C. Firms such as mutual fund incumbents tried to create an option C by repositioning the index fund category as a low payoff category. This was not very different from how diamond incumbent De Beers has been dealing with the threat of cultured diamonds. So far, De Beers has been successful in creating an image that cultured diamonds are inferior to natural diamonds. This brings out the key challenge of a profit-destroying innovation, i.e. not all option C's will be successful. As a result, firms need to have a portfolio of option Cs to deal with profit-destroying innovations.

This research took an important first step in understanding a class of innovation that is not only counterintuitive and challenging for firms, but also one that innovation literature has underemphasized. Since this is the first step in uncovering the details of such innovations, this research used a qualitative method. Scholars have proposed that when examining a relatively less understood and less studied phenomenon, qualitative methods are very powerful (Eisenhardt, 1989). This research paves the way for quantitative research in the future.

Although this is a small step in a greater understanding of this phenomenon, it shows there is a rich set of possibilities for research in this direction. Therefore, this paper is also a call to scholars to investigate profit-destroying innovations in more detail.

This research not only fills a gap in the literature but also helps practitioners deal with such innovations. As many industries are facing such innovations today, or will soon face them, this research would greatly benefit mangers. Microsoft has been facing such an innovation from Google in the office productive software market. Similarly, the music industry has faced a profit-destroying innovation from the new format called MP3 format and newspapers are facing the problems pre-

sented by blogs and other informational sources on the Internet. In the near future, it is likely that the shaving industry and the chemical-based hair removal industry will face this innovation in the form of laser-based hair removal technology. Similarly, the alkaline battery industry will probably face this type of innovation in the form of wireless electricity. Practitioners can learn from the examples raised by this study and not only become aware of the challenges ahead but also use this learning to handle such innovations better. Thus, this research would not only advance the literature but also help practitioners in a meaningful manner.

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Retailers Innovate Differently - The Need for a Retail Research Laboratory

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Abstract

There is a strong need for innovation within the retailing sector (RS), but at the same time, retail sector innovation is not yet fully understood. This paper aims to investigate retail innovation and identify its specific characteristics as being both process- and product innovators, as well as presenting a case whereby the University could act as an innovative hub. Retailers are open innovators - they engage in both technological and non-technological innovation and they innovate incrementally, focusing on business model innovations. We elaborate upon the different contributions that a retail research laboratory could give to retailers as well as to the academic community. We also discuss the potential of such a laboratory in a practice approach focusing on the advantages to researchers, consumers and retailers, and the potential in linking research on business models with a practice-oriented approach.

Keywords: Retail, open-innovation lab, business model innovators, incremental innovation, practice-oriented approach

1. Introduction

Historically, retailers have played a role in society by making it possible for consumers to purchase goods and by providing services (Berry et al., 2010). However, in order to continue with prosperous growth, retailers need to face challenges and global competition within the retail sector and become more efficient, more flexible and better able to innovate. At the same time, there is also a need for retailers to understand how they actually contribute to innovation, and provide a means whereby they can be inspired to continue their work.

The ongoing structural retail changes we are seeing in terms of new channels and new actors in the market means that traditional retail business models are being challenged and new business concepts are being established. The need for innovation in ongoing multichannel behavior and multimedia retailing environments is obvious (Dholakia et al., 2010); however, how to accomplish this is unclear. In addition, the growth of e-commerce may affect many small retailers who are not able to maintain the same price levels or the assortment of goods that the big players can, which means they will disappear from the market. For some retailers, one of the priority challenges is how to react to the 'threat' posed by e-commerce instead of treating online sales as a possibility for innovation (Brown & Dant, 2014).

In order to become more connected with the multichannel consumer and to learn from their behavior, a number of private actors in Europe are forming innovation labs to develop technology that optimizes the retail experience. Some examples are Unibail-Rodamco within the commercial real estate sector, and digital

agents such as R/GA. However, there is a high probability that these retail labs will be designed without concern for the special characteristics of how the retail sector actually innovates, and will be based on the idiomatic belief that e-commerce is threatening the brick-and-mortar store, thus pushing innovations that focus on the environment and fixed store design. On the other hand, technological actors risk becoming stuck on high tech solutions which leave consumer value aside. Our distinct belief is that a combination of both e-commerce and fixed store development within the retail sector will boost innovation, and as such, needs to be developed in an open and neutral research environment: the Academy.

The above-mentioned changes towards a digitalized retail landscape and the need for innovation within the retail sector serve as the argument for the aim of this paper: to scope retail innovation and pinpoint a case regarding an open innovation laboratory in the academic environment. In this paper we describe the sector-specific characteristics for innovation and how these insights led to the design and start-up of an open innovation environment: a retail research laboratory. We further show how the research done in the retail research laboratory furthers our knowledge and theories on consumer decision-making processes and consumer value. Management implications in this paper are given on a retail level.

2. The Nature of Retail Sector Innovation

Consumer use of emerging technologies, such as mobile Internet and the phenomenon of the Internet of Things, has contributed to the enhancement of the digitized retail landscape. The transition to a digital society where individuals are constantly connected to the Internet is one of our greatest social changes, and in some cases also challenges, and as such it affects competition, business models, business growth, global development and innovation. Whether a firm succeeds or not depends on consumer value delivered and retail firms must strive to better align themselves to consumers' evolving needs. As a result, the ability to innovate successfully and create customer-centric differentiation is critical to the overall success of the retail sector. However, the retail sector is a poor innovator, at least compared with other sectors of the economy, such as pharmaceuticals, healthcare, energy and engineering. One reason why the retail sector is weak in innovation is that innovation is measured in a conventional way, based on product innovation, number of patents and share of turnover (Katila & Mang, 2003; Katila & Shane, 2005; Hervas-Oliver, Sempere-Ripoll & Boronat-Moll, 2014). The retail sector is significantly under-represented in terms of both patents and trademarks, which are traditional markers of innovation intensity (Sundström & Reynolds, 2014). And yet, retailing created added value of EUR 432 billion in 2009. It was the largest private employer within the EU27 in terms of the number of persons employed (18.6 million). These are all facts pointing to the sector's need to be dynamic as well as competitive.

2.1 The Origin of Process Innovation

The nature of retail sector innovation comes down to the question of how the sector can be both dynamic and competitive, but at the same time be poor at innovation. This paradox arises in part because retailers innovate differently compared to traditional industry, and their innovative performance is mainly derived from process innovation strategies. Process innovation characterizes the service sector (Metka & Galouj, 2012), however, retailers are or have also become, hybrid innovators and the retailing sector shares a distinctive approach and mix of characteristics in relation to innovation (Oxford Institute of Retail Management, 2007). Retail businesses can be both product and process innovators as well as engaging successfully with both technological and non-technological innovation. Innovation

in retail can thus be described as being neither product nor process, but a combination of both. However, retail innovation tends to focus on adopting and re-organizing business operations using a cost reduction perspective or the improvement of flexibility in production (Herves-Oliver, Sempere-Ripoll & Boronat-Moll, 2014). Many larger retail firms are also open innovators, as they seek to co-ordinate both product and process innovation across the value chain, and at the same time, take market demands and the company's vision into account (Gassmann & Enkel, 2004). However, a major problem to open innovations within the sector is the general lack of long-time funding, and the ability to document innovation processes. Also, the nature of competitive retail markets means that retail firms often exhibit more incremental than radical innovation practices. We explain some of these distinctive characteristics below, based on the work from the Expert Group on Retail Sector Innovation (2014). As some large retail firms merge horizontally with suppliers, multinational retail chains and large-scale retail formats have developed with more significant market shares (Reynolds et al., 2007). This in turn leads to competition between channels rather than between enterprises, and implies that cooperation and partnerships among firms have to increase.

2.2 From Producer Push to Consumer Pull

Today, the consumer is an integral part of the marketing channel and superior firms have sought to develop more dedicated and efficient distribution systems and integrated supply chain capabilities in the search for operational efficiency and to better meet customers' needs. This means that retailers use external as well as internal ideas and both internal and external paths to market as they look to advance their technology or innovate with partners by sharing the risks and the rewards (Chesbrough, 2003).

The development and application of scanning systems and the associated technology has provided the necessary information for many retail supply chains to be reversed from a 'producer push' to a 'consumer pull' approach, placing some retailers (those that are closer to the consumer than others in the value chain) in a position where it is easier for them to discern opportunities through more effective insights into consumer behavior. Such retailers then have the capability of becoming 'innovation hubs', coordinating and broadening innovation across a range of supply chain members. Retailers can co-create value with supplier firms, or with consumers, downstream. Ultimately, some retailers have become vertically integrated, exhibiting a 'manufacturing' approach to product innovation. While significant, sector-wide investments in innovative technology systems (such as self-scanning, loyalty marketing systems, mobile web platforms or new payment methods) continue to transform the customer's experience and the efficiency of retail businesses, non-technological innovation in the store or online experience has perhaps had an even greater influence on consumer behavior in the long run. McGrath (2011), together with Teece (2010), argues that product innovation in general no longer offers sufficient competitive advantage, as in a global world it has been too easy to copy innovation, and harder to handle shorter product life cycles. This leads to a different way of rearranging value creation activities; hence, companies today consider business model innovation as an opportunity to build advantages (Osterwalder & Pigneur, 2005; Matzler et al., 2013). There is strong support for the fact that business model innovators have higher and more sustained returns than product innovators (Lindgardt et al., 2009, Matzler et al., 2013).

New business models are a particularly effective way for retailers to differentiate their value proposition for their customers. Successful leading adopters of new formats can see their efforts generate sec-

tor-wide transformation. For instance, the growth of generic formats, such as hypermarkets, convenience stores and deep category specialists, all have their origins in the innovative practice of individual firms, and are good contemporary illustrations of the ways in which specific organizational innovations can become sectorial norms. Sometimes, apparently small innovations can deliver significant outcomes for retail firms. The development of shelf-ready packaging, the movement of a barcode or continuous strategies to reduce waste can have substantial effects over time. Retailing also trades in markets characterized by their 'low appropriability'. That is, many business practices and processes are more open to emulation by competitors, in part because of their very transparency. This can often cause innovating retailers to work differently, perhaps by starting small or working incrementally, before rapidly scaling up their activities. The risks of easy emulation may also discourage retailers from sharing innovative ideas with others at an early stage, particularly when many of the kinds of innovations in which firms engage are unable to be fully protected in terms of IP legislation or patent law because of their lack of formality. Starting small also minimizes risks and other costs. Unlike in manufacturing, however, retailers can experience a reverse innovation cycle, where financial and organizational costs attached to innovation are low at the beginning and high at the end, such as when a successful innovation must be rolled out across an extended network of stores. Our analysis shows that retailers are both product and process innovators. They are also open innovators, engaging in both technological and non-technological innovation, and they innovate incrementally and focus on business model innovations. This clearly shows that the retail sector innovates differently from other sectors, and it is, therefore, hardly surprising that statistical surveys and analyses simply aimed at quantifying levels of innovation from the point of view of patents or licensing are generally poorly equipped to effectively represent the sector's performance in this respect. Therefore, we further stress the need for a different type of approach to research with regard to innovation within the retail sector.

2.3 Creativity and the Process of Retail Innovation

An increasingly customer-centric approach will satisfy a market that is expecting value, convenience and seamless omni-channel service, transparency and honesty. The customer-centric nature of retail innovation demands that the process is not just about improving efficiency in the sector but is also concerned with achieving greater effectiveness in the customer's experience of the retail offer. The important task for innovative retail leadership is to find new ways to generate added value for customers and monetize any surplus value (Matzler et al., 2013). As a result, the 'science' of retail innovation has to be complemented by the 'art' practiced within the innovation process itself, not least by those who lead that process. Retail innovation is as much an exercise of creativity within the retail job as it is of scientific management. At its heart, retail innovation will only be successful if it can substantially increase customers' quality of life throughout the shopping experience (including pre- and post-purchase experiences), and find ways of getting paid for that service. While much innovation within the sector is focused on increasing efficiency, boosting productivity and the speeding up of administrative processes, the most effective kind of retail innovation occurs when there is a re-engineering of the shopping process. That is, firms need to understand the buying process, identify barriers and moments during that process when the individual might appreciate support, and develop services that create value. The creative process requires clear empathy for the lifestyles and expectations of a firm's customers.

Firms must also be able to draw upon a wide range of technologies and novel

disciplinary approaches, as well as being able to document their methods for future knowledge transfer. Some applied technology can fundamentally affect competition and is capable of disrupting business models, labor markets, consumer behavior, consumer privacy, and global development. However, in order to understand consumer decision-making and, from that insight, draw conclusions on additional applied technologies, there is a need to co-operate with scientific researchers. The sector has already witnessed the increasing role of the mobile Internet and how it creates opportunities for continuous shopping, and enhances competitive pressures between retail firms. But do we really know *why* consumers find the mobile Internet valuable? New technology systems have also played a major role with respect to inter-firm retail functions, and many "intelligent technologies" (e.g., RFID, NFC, 3D-printers, mobile payments, etc.) have emerged during the past few years supporting a number of retail functions. However, we know less about the value these systems might bring to the consumer decision-making process. In light of this, the need to work together with academic researchers is very clear.

The broader organizational environment within which retailers operate naturally includes networks, partnerships and supplier relationships that might serve as an 'innovation pool.' Therefore co-operation is important to joint forces, and, in the future, will probably be even more important and often a necessity. Retailers can learn new skills and competencies both from and with their partners, including suppliers, service providers, and consumers. Collaboration with suppliers and partners from different sectors can lead to the instigation of new innovations too, for example, in IT, telecommunication firms and market research companies (Reynolds & Hristov, 2009). However, retailers also need to be closer to academic researchers in order to be more systematic in their operations and to learn from trial and structured testing, something that could minimize the often, ad-hoc methods of in-house research within retail companies.

To summarize, the pivotal characteristics of managing retail innovations are: 1. Applying a customer centric approach focusing on the customer experience and the ability to develop support and services that create value. 2. An ability to draw upon technology, and an understanding of contemporary consumers and the retail context. 3. A familiarity with the network of actors engaged in retailing. 4. An incentive to participate in academic research.

3. A Retail Research Laboratory

So far, our description of retail innovation investigates a sector that acts and works differently from others with regard to innovation. As retail firms act as both incremental and open innovators, they need to be better at documenting knowledge in a scientific manner, while at the same time being dependent on creativity in their processes. The challenge to create and sustain a research environment for the sector is huge, and needs to be based on the pivotal mechanism mentioned above. Such an assignment was given to the Swedish Institute for Innovative Retailing (SIIR) by the board of the University of Borås in 2013. Inspired by our earlier work at the University of Borås on value innovation and Living Labs (Ericsson & Sundström, 2012; Cronholm et al., 2013; Goldkuhl & Cronholm, 2010), we wanted to build an environment that focused on consumer insight, thus integrating user-centered research with multi-disciplinary research on IT and business design (Martin, 2009). We also reflected upon the purpose of taking a stronger stance toward the role that an innovation laboratory could have in an academic setting by providing well documented research methods. With respect to the knowledge that the retail sector innovates differently from others, and the strong need for engagement by retail management, employees, and creativity, we drafted an environment based on the vision

of "contributing to innovative and sustainable retail". This vision was formulated and put together by members of a strategy group in order to represent researchers, senior managers and entrepreneurs within the retail sector.

3.1 Building an Arena

We proceeded by planning an environment involving important actors within the network of retailing, adding researchers, solution providers and consumers. The arena was placed inside the University and designed as a fixed store. We also based the laboratory on applied retailing research on consumer behavior and the decision-making process, which engaged multi-disciplinary researchers from marketing and IT. However, before starting, we undertook a major study on the kinds of problems and challenges retailers were facing. Following this analysis, the environment could be planned in more detail.

The original goals of the retail laboratory were to use and develop modern technologies that could help retailers in a transforming landscape of digitization. Applying a customer-centric approach helped us with our ambition to develop IT-pilots designed for a context where e-commerce and fixed store settings might melt down to an omni-channel environment, bringing value to both consumers and retailers. Students and academic employees were used as respondents in early tests of the IT-pilots and service development in order to pre-test perceived value. The main competencies of the researchers engaged in the project were marketing, informatics and IT. Ideas for new customer value-driven services came from both retailers, consumers, solution providers and researchers, and were evaluated, screened and developed with system developers employed at the SIIR research program.

In the built-up environment, we currently offer the development of decision support prototyping, testing, demonstrating, eye-tracking, validation and market replication, which have direct relevance for innovation in the retail sector. Each test performed in the laboratory is designed with a documented method. In the following table, we present a selection of the experiments and tests that have been carried out in the retail laboratory the past six months, including what questions where researched, which methods were used and what kind of outcome each study gave. These ten cases are selected to show the variety of methods used in the laboratory and also the different types of questions that are researched.

Table 1: Description of Experiments Carried Out in the RL

	Questions researched	Method	Outcome
1.	Do consumers use QR codes in-store, intend to use QR codes in-store, or have knowledge of QR codes?	Observations and questionnaires carried out in the retail laboratory (RL) and in fixed stores	Two popular scientific reports. One scientific conference paper. One scientific manuscript. Numerous presentations at conferences aimed at retailers.
2.	Could there be different segments of consumers thinking alike when it comes to buying home interiors (textiles), and what characterizes these segments?	Questionnaires and focus groups carried out in the RL	One popular scientific report. From that report, one retail chain chose to re-build one of their stores in order to become a complete omni-channel store, offering their customers the opportunity to shop from digital screens in store. Input to retail firms on

Questions researched	Method	Outcome
		how to develop new services.
3. What are the behavior and attitudes toward web store check-in and check-out?	Eye-tracking and questionnaires carried out in the RL	One popular scientific report. One report aimed directly at a specific retailer, which, in turn, led to revisions of their check-out functions.
4. Is it possible to stimulate consumers' perception of the value of an advert with the help of specific words?	Eye-tracking and questionnaires carried out in the RL	One scientific conference paper. Another financed research project on data mining within the retail setting. A software programme to suit the grocery industry that can handle big data and work with promotions within the store.
5. Spending habits online and in physical stores related to home interiors and textiles.	Focus groups, questionnaires, and eye-tracking carried out in the RL	One master thesis.
6. Does a store experience involve physical arousal when engaging in new technology?	Experiments with pulse watches RFID tests, questionnaires, carried out in the RL and the virtual fitting room	One bachelor thesis.
7. Facilitating a demonstration that offers the consumer a general solution of how to return products bought online, with the help of a mobile application.	Programming and testing	A start-up company.
8. How do customers perceive service and to what degree are they more or less satisfied depending on the encounter with people or machines?	Observations and questionnaires	One bachelor thesis, awarded twice: Best thesis in Sweden regarding retailing research. Practical output for numerous retailers working with service development and service education.
9. Does the level of personal service or interactive computer service in a pop-up store affect customer satisfaction?	Observations and questionnaires RFID tests	Two bachelor theses. Input to retail firms regarding how to work with service added value.
10. Do consumers concerned with environmental issues value environmental information about shirts? Does this information affect their choices and could the information be monetized in terms of a commercial service?	Observations and questionnaires Eye-tracking carried out in the RL	Support for an index presenting a product's environmental effects. Support for a new business model on information and transparency regarding product information.

3.2 Practical Cases and Outcomes

To further illustrate the cases listed in the table, we will take two cases and describe them closer. The first is case number nine. This case aimed to investigate whether the level of personal service or interactive computer service in a pop-up store affected customer satisfaction. The results indicate that it requires a high level of personal service to achieve higher customer satisfaction, and the combination of high levels of personal service together with interactive computer support in the decision-making process deliver the highest customer satisfaction.

The second example is case number ten that stemmed from wanting to know whether consumers concerned with environmental issues valued environmental information about the shirts, whether this information affected their choices, and if the information could also be monetized in terms of a commercial service. Preliminary results show that environmentally-concerned consumers used the information service delivered via RFID techniques and described the service as valuable in the decision-making process. They were also more inclined to pay for the product information service.

3.3 Designing the Research Cases

The experiment process applied to all cases follows the logic of a problem that is given from a company perspective or from a research standpoint. The experiment is then designed to match the setting of the laboratory and its resources, i.e., will this be an eye-tracking test, a magic mirror setting, etc. If the design demands programming or different software this is specified and ordered before executing the experiment. If the experiment will be performed in a special retail setting, visual merchandizers are contracted to help with building the right atmosphere. The next step is the selection and invitation of respondents to participate as experimental consumers. Then, the test is conducted in the laboratory and documented according to specifications from the researchers. The actual data collection in the laboratory is performed, sometimes by master students, giving respondents instructions and documenting their behavior and/or interviewing them after the experiment. The material is then analyzed by the researchers responsible for the case and conclusions are drawn. In the cases where a company is directly involved, a report and presentation is also given to them. Regarding consumer insight on a general level, researchers can choose to analyze many different experiments and aggregate them into a macro-level, thus providing opportunities for producing different kinds of research reports. The retailers are encouraged to use the insights from the experiments and apply the results to their own operations.

4. Contributions from an Innovation Laboratory for the Retail Sector

After evaluating the experiments and tests performed in the retail laboratory and obtaining feedback from the participating retailers, the analysis makes it abundantly clear that one of the greatest contributions of the laboratory is insight. The laboratory can provide valuable insights regarding the need for more structural processes on how to use consumer preferences to boost innovation. Our partners also talk about the importance of starting innovations in a small way and then, after a while, increasing the pace. This is particularly the case when testing RFID-technology to inform consumers about products. Advanced information is perceived by consumers as giving high value. However, the technology also risks pushing consumers away. Self-checkout operations could be a valuable service in the future, but they need to be complemented with strong personal services.

Other valuable insights gained from the retail laboratory include the knowledge that consumers find it hard work being a consumer, and that the job of choosing might not be seen as a pleasurable activity. This knowledge has inspired retailers to

develop commercial service concepts focusing on the shopping experience as a process and identifying points in the process where the consumer really needs help. A direct example comes from case number two (Table 1) and service development, helping consumers decide on what curtains to choose, giving them information on how to hang the curtains, how to measure the window, how to re-arrange curtain settings and so on. Some of the attendant retailers also joined together on other projects, taking advantage of each other's skills and developing commercial innovations, such as new store formats. For example, one e-commerce actor decided to introduce physical concept stores, designed as mobile boxes, thus entering the traditional physical retailing market but in a new and different way.

Results from eye-tracking studies in some cases provided management with proof and supported earlier hypotheses. However, some analyzed results surprised all actors and resulted in new and innovative designs, for example, how to check-out from a web store, how to communicate prices and how to give product information. However, perhaps the most valuable insights reported from retailers engaged in different experiments in the retail laboratory were organizational insights, new ideas on how to change existing business models and how to strengthen business goals and operations. An example of this was a retailer that gained an insight into the fact that in order to expand online sales, there was a need to change the mindset of store managers, and at the same time, offer other triggers in terms of individual store bonuses. If a store manager would like to engage in driving offline, in-store customers to become online customers, there needs to be incentives for those activities, motivating the employees to drive sales and earn their bonuses.

5. Theoretical Implications

From a research perspective, and as previously underlined, an innovation is not necessarily a physical object and an innovation within the retail sector differs from those of other sectors. An innovation can be a new thought, a new service or a new way to proceed. The key word is "new" and concept innovation means renewal. We have found that retail innovation may be boosted in an open-innovation environment led by researchers, joined by many actors, and with the main perspective of studying the practices of consumers. A practice relates to the unconscious dimension of consumer decision-making and focuses on what people say and do (Rindell et al., 2011) and, in our case, what retail customers do when shopping or making decisions at the point-of-purchase. The theoretical foundation regarding practice theory stems from the work of philosophers such as Wittgenstein, social theorists like Bourdieu and Giddens, and theorists of science, and technology, such as Latour and Pickering (Schatzki et al., 2001). In this sense, the scientific work in the retail laboratory has contributed to the development of a practice approach to the study of retail innovation by combining different approaches based on the empirical knowledge generated in different experiments and projects performed in the retail laboratory. Ongoing scientific production from studies in the retail laboratory focuses on, and contributes to, the rapidly emerging literature on business models (e.g., Coombes & Nicholson, 2013; Mahadevan, 2000). The discussion on business models has expanded in conjunction with the growth of the Internet and e-commerce (e.g., Amit & Zott, 2001; Zott et al., 2011) and is closely related to digitization and retail innovation. Business models demonstrate their respective companies' specific logic when combining value creation and maximizing value appropriation (e.g., Mizik & Jacobson, 2003). Although the academic literature on business models is extensive, the concept is considerably underdeveloped theoretically (Zott, 2011). Within innovation and retail-oriented research, many conceptually-oriented contributions have been pub-

lished (e.g., Sorescu et al., 2011), and there is, therefore, a strong need to link research on business models with practice-oriented approaches using open-innovation laboratories as a setting for development and practical experiments.

Given this practice-oriented approach and the use of open-innovation laboratories, this paper contributes not only to the deepening of our theoretical knowledge on the concept of retailing but shows width and diversity in how to boost retail and innovation. By showing the effects of, and the need for, a retail research laboratory, naturally we do not yet have all the answers on how the retail sector can become more innovative in the future. This is not the grand solution but a step in the right direction, a starting point, if you will, where the knowledge and insights gained from the use of the retail research laboratory adds, primarily, to our knowledge of a consumer's decision-making processes and a retailer's business model innovation. It contributes to the knowledge on consumer decision-making processes and adds more dimensions regarding consumer's use of digital aids and perceived customer value in the use of these.

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