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Analysis of Photogrammetry, Additive Manufacturing, Programmable Logic, and Social Media as a Combined Threat to the Consumer Electronics Industry

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I. Abstract

In 2011, the total retail value of seizure of Intellectual Property (IP) infringing goods reached $67 million in Canada. Customers are increasingly exposed to counterfeit forcing manufacturers such as Canon, Yamaha, and Nikon to invest in anti-counterfeiting campaigns.

This paper reveals that the motivators leading to the growth in counterfeiting far exceed the economic and financial aspects of the market. Research conducted on music piracy has revealed that consumers have grown more tolerant to counterfeit, and even see them as a viable alternative.

To better understand this counterfeiting culture, this qualitative paper focuses on the consumer electronics industry, more specifically on portable media players, where the pressure to refresh the product line-up quarterly forces manufacturers to switch to programmable logic devices. These off-the-shelf components are difficult to protect, and make it easier for competitors, counterfeitors, and even do-it-yourselfers to extract the source code and copy every feature and benefit without a large investment in reverse engineering.

The timing of this research paper coincides with recent advances in the fields of photogrammetry (scanning objects in 3D) and additive manufacturing (printing objects in 3D). Prior to these two enablers, home-based counterfeitors would have been seen as prototypers, without the resources to make their copy a commercial threat. The widespread adoption of 3D printing and 3D scanning has changed all that, making the hobbyist’s clone virtually indistinguishable from the original. Based on the availability of these new tools, and the increased tolerance toward counterfeit, this research paper asks:

*Can the combination of photogrammetry, additive manufacturing, programmable logic, and social media into a unified product acquisition cycle, eliminate the barrier to entry and provide the tools needed by the end-users to take on the manufacturing themselves, and as such, create a viable threat against the established firms?*

In order to assess the research question, the analysis focuses on the motivators, skills needed, product features, and reliability to prove the magnitude of the new threat. As supporting data, the satellite hacking phenomenon will be used, where at least two million satellite receivers were modified (hacked) to acquire content without subscribing. End-users became counterfeitors by gathering the resources (tools and knowledge) from social media portals. The same do-it-yourself attitude is visible in the Hackintosh community, where consumers build their own fake Apple Macintosh look-a-likes.
Another universal platform making the research question relevant is the Raspberry Pi, a small computer that costs less than $40, and can take the form of a portable media player, mobile phone, tablet, etc. This computer, developed for high school students, exploded in popularity due to the do-it-yourself movement. In most of these cases, the leading motivation behind the act of building one's own is the psychological need for self-actualization.

Enforcement will be shown to be outdated, and unsuccessful. The focus on going after the traditional counterfeiters, who sell illegal files on physical media, leaves a regulation gap where millions of would-be home-based counterfeiters can download all the files needed to a clone product, at no cost, from the safety and privacy of their living room.

Based on the data results, and a thorough analysis of the economic, legal, brand, process, financial, human, and ethics aspects of counterfeiting, the threat is assessed to be real, and growing. To mitigate the risks, the traditional enforcement model should be put aside, and a new type of product line will be proposed, in the form of homebuilt kits. This recommendation targets the social need of do-it-yourselfers, while appealing to those who want the product, but feel that the premium brand is overpriced.
II. Introduction

A. Background

In 2013, “$145 million worth of counterfeit Consumer Electronics entered the US”. The same year, “over a quarter of people surveyed said they’re willing to buy counterfeit goods” (Appendix A, Canon.com, 2014). Figure 2.1A reveals a significant gap in response between two demographics: the baby boomers and the millennials; the millennials are said to be five times more likely to buy a fake product than the baby boomers. The younger generation’s social shift in attitude, combined with easier access to illegal goods, and an over-confidence in one’s ability to spot a fake could potentially erode the power of manufacturers.

The examples used in the Canon survey (Figure 2.2A) explain why the manufacturer claims that 18% of consumers “unknowingly bought fake consumer electronic”. Counterfeiters attempt to fool the customers by duplicating all of the product’s unique identifiers, such as brand logos, slogan, packaging, and disclaimers; this infringes on multiple copyright laws, even if the features and benefits, or the internal circuitry differ.
In the late seventies, when Porter proposed his *five competitive forces* framework (1979), nothing hinted that pirated copyrighted goods would be perceived as a substitute. Who could have foreseen that copies could reach a level of realism where the products are undistinguishable? The strategic concepts used over the last thirty years might be ill-equipped to define, and compete against the new manufacturing tools available to the counterfeiters. As such, one should ask if the consumer electronics industry is aware of, and ready for this new threat.

At this time, counterfeiting is an expensive process, accessible mostly to large-scale organizations. What if, instead, it came from a much broader network of smaller counterfeiters, who suddenly had access to the resources needed to clone their *Apple iPod®, Sony Walkman®,* or *Samsung Galaxy®*? This threat will materialize if consumers discover that recent advances in four technological fields, combined together, give them the resources needed to duplicate virtually any consumer electronics devices. These four technological pillars are:

- Programmable logic components;
- Photogrammetry;
- Additive manufacturing;
- Information access through social media.

**Programmable Logic**

The use of standardized circuit boards, populated with off-the-shelf programmable components has revolutionized the product development life cycle. The components’ topography can be changed by simply modifying their source code. That flexibility makes them more vulnerable to code stealing, which is why they were intended for R&D and prototyping stages mostly. The competitive pressure led to manufacturers making the strategic choice of gaining first-entrant advantage over preventing counterfeiting, or making it easier for competitors to imitate the same features and benefits.

Figure 2.3A shows a popular example of a widely available programmable logic device (PLD), used in the manufacturing of all types of consumer electronics products, from mobile phones to satellite receivers.

*Figure 2.3A. - An Example of a Popular PLD Components Available on the Market (Altera.com, 2014).*
Photogrammetry

According to Merriam-Webster (2014), photogrammetry is “the science of making reliable measurements by the use of photographs”. Driven and developed by the cartography and computer gaming industries, it is now used to scan any type of object. This new tool has reduced the barrier to entry and opened up 3D scanning to the small entrepreneurs and enthusiasts. Figure 2.4A shows an array of digital cameras used to capture three-dimensional objects, to be converted into computer files. These files can later be converted into lifelike products printed in additive manufacturing (Figure 2.5A).

![Figure 2.4A. - Photogrammetry Studio Example (Henry, 2014).](image)

![Figure 2.5A. - Realistic Rendering Made from Photogrammetry (Xinhua, 2013).](image)

Additive Manufacturing

Once the 3D file is compiled from the multiple cameras of the photogrammetry process, additive manufacturing (AM) turns that rendering into a physical product. Additive manufacturing uses inexpensive devices known as 3D printers to transform the
file into a three-dimensional object with the same shape, texture, and color as the original. Figure 2.6A shows how small and simple these printers have become. Hewlett-Packard is rumored to introduce a consumer model below $500 by 2015 (McGrath, 2014), which will bring manufacturing capabilities to any enthusiast.

![Figure 2.6A. - Example of a Desktop 3D Printer (Airwolf3d.com, 2014).](image)

**Social Media**

Social media is the enabler that makes it possible for an end-user to research, acquire, and share the resources needed to duplicate a genuine product and become a counterfeiter. Amongst the notable cases of this, we can see two examples: The Free To Air (FTA) community, sharing source code to modify their generic satellite receivers to give them access to unpaid content; and the 3D printer community which shares printable files of complex assemblies, such as handguns.

Social media also brings a human resources perspective to the issue: it promotes these activities, motivates future counterfeiters, and obscures the consequences of these illegal actions. Drawing a parallel with the music industry, we can see the weight that social media has, with 95% of all music downloaded via the Internet being pirated (Pfanner, 2010, p.1).
B. Research Question

Programmable logic devices, social media, photogrammetry, and additive manufacturing have traditionally been studied in isolation. What this paper proposes is to look at them as a combined cohesive product life cycle from design to disposal (Graph 2.1B). It will address the availability of low-cost tools, process improvement opportunities, return on investment, human motivation aspects, and environmental impact of shifting from the centralized, manufacturer-driven model, to a wide-spread home-based network of duplicators.

This paper will propose a set of strategic objectives for the consumer electronics industry to mitigate the risks, and compete with the speculated risk of decentralized counterfeiting. The qualitative research approach will be founded on the following research question:

Can the combination of photogrammetry, additive manufacturing, programmable logic, and social media into a unified product acquisition cycle, eliminate the barrier to entry and provide the tools needed by the end-users to take on the manufacturing themselves, and as such, create a viable threat against the established firms?
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C. Delimitations

Even though the research could apply to most types of consumer electronics products, it will be limited to portable media players, due to a well-defined control environment:

- Small form factor (will fit in low-cost consumer 3D printers and photogrammetry scanners);
- Low parts count (simple and inexpensive to experiment with);
- Standardized features and benefits (equivalent between models);
- Lack of proprietary or hard to reproduce components (such as imaging capture sensors);
- Exclude transmission or reception functions (isolates product from service);
- Well-defined timeframe (15 years historical data which coincide with the maturing of all four techniques: photogrammetry, social media, programmable logic, and additive manufacturing).

D. Limitations

It should be noted that the term fake can take many forms. A differentiation should be made between reverse engineering, grey market, counterfeits, and knock-offs.

According to Atuahene-Gima (2013, p.22), “Copying and imitation through reverse engineering has a long history of being an accepted innovation practice and is generally viewed as a best way to acquire know-how”. This makes reverse engineering a legally permissible action that is used by competitors to create their own unique version, which would be equal to or better than the original. This threat can be mitigated by keeping R&D strategies confidential, by being first to market, and by introducing new models faster than they can be analyzed by the competition.

Grey market is a parallel importation, where “the goods involved are lawfully placed on the market in their place of export, but the owners and licensees of the intellectual property rights associated with the goods in the place of import oppose the importation” (Belmore, Katyal, & Wilkinson, 2002, p.2). Grey market offers an alternative to the buyer, often at lower cost than in the local distribution channel.

Counterfeits and knock-offs, in contrast, are a clear infringement of the intellectual property rights. Counterfeits can be described as “any goods, including packaging, bearing without authorization a trademark which is identical to the trademark validly registered in respect of such goods, or which cannot be distinguished in its essential aspects from such a trademark, and which thereby infringes the rights of the owner of the trademark in question under the law of the country in which the procedures set forth” (WTO.org 2014). Knock-offs are “goods which do not bear the brand name of
the legitimate product but are in other respects copies or emulations of the brand name product” (Belmore, Katyal, & Wilkinson, 2002, p.3).

Reverse engineering and grey market will be excluded from this research paper as they are deemed legal approaches. The research question will therefore be limited to the threat imposed by knock-offs and counterfeit, regardless of how closely they imitate the genuine article.

E. Implications

The examples used in the Canon survey are of consumable parts and accessories. Most manufacturers obtain higher selling margins from these after-sales items than from the core product, luring counterfeiters to this type of product. It might not seem financially worthwhile to duplicate an entire product if the cost to benefit ratio is insufficient, but one could argue that the motivation driving some end-users would trump the traditional business sense. The Free to Air phenomenon discussed earlier is one such example, where the counterfeiter disregards the labor spent as it is considered personal satisfaction. Can companies such as Canon, Sony, Apple, Yamaha, and Nikon, really afford to lose market share for their flagship product on identical counterfeits?

What makes the situation more dangerous is the decentralized nature of the counterfeit market. In the current model, most offenders come from large organizations abroad; the physical location gives regulators a port of entry to monitor, while the decentralized model makes it impossible to track the global network of basement counterfeiters.

If the acceptance of counterfeit by younger customers leads to homemade copies, the electronic industry cannot afford to turn a blind eye to these new substitutes. Figure 2.1E shows the counterfeiting of one of the best-selling consumer media players: the Apple iPhone©.

*Figure 2.1E - Counterfeit and Genuine Apple iPhone Comparison (dailymail.co.uk, 2011)*.
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III. Research Purpose and Research Sub Problems

A. Statement of Sub Problems

1. How likely are hackers to share photogrammetric scans and source code freely on the web?
2. How likely are customers to use illegal files to clone branded products?
3. How successful would customers be in cloning devices?
4. How and why should manufacturers safeguard their intellectual property?

B. Management Domain

Strategic Management

Combining four technological processes gives this paper a wide reach, but at its core, it will always go back to the strategic management concept, and the effect the threat from end-users turned manufacturers will have on large-scale organizations. In order to assess the likelihood of the research question coming true, the human resources, operations, information technology and marketing management will be researched as enablers to the counterfeiting culture. Based on the potential of the threat, a set of recommendations will be presented to mitigate the risks, and prepare the consumer electronics industry to handle the new competitive landscape.

Human Resources Management

Understanding the learning process of implementing programmable logic and additive manufacturing at home, from a non-technical user perspective, will be transposed to a new venture attempting to recruit and train new staff. The research will also investigate the motivating factors behind intellectual property infringement.

Operations Management

The manufacturing process as it relates to processing times, materials handling, product procurement, and quality control will be applied to operations and process management.
C. Definitions of Terms

For the purpose of this paper, the definition of terms and acronyms will be aligned with the Anti-Counterfeiting Trade Agreement (ACTA), and the trade-related aspects of intellectual property rights (TRIPS), established under the umbrella of the World Trade Organization.

1. **ACTA** – “Anti-Counterfeiting Trade Agreement” (Foreign Affairs, Trade and Development Canada, 2013);
2. **Authorities** – “Judicial, administrative, or law enforcement authorities” (Foreign Affairs, Trade and Development Canada, 2013);
3. **Counterfeit** – “any goods, including packaging, bearing without authorization a trademark which is identical to the trademark validly registered in respect of such goods, or which cannot be distinguished in its essential aspects from such a trademark” (Foreign Affairs, Trade and Development Canada, 2013);
4. **Grey Market** – “Parallel Importation of goods. The goods involved are lawfully placed on the market in their place of export; and the owners and licensees of the intellectual property rights associated with the goods in the place of import oppose the importation” (Belmore, Katyal, & Wilkinson, 2002, p.2)
5. **Knock-Offs** – “Goods which do not bear the brand name of the legitimate product, but are in other respects copies or emulation of the brand name product” (Belmore, Katyal, & Wilkinson, 2002, p.3)
6. **Intellectual property (IP) rights** – “Rights given to people over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creations for a certain period of time” (wto.org, 2014);
7. **WTO** – World Trade Organization (Foreign Affairs, Trade and Development Canada, 2013);
8. **Pirated copyright goods** – “Any goods which are copies made without the consent of the right holder or person duly authorized by the right holder in the country of production and which are made directly or indirectly from an article where the making of that copy would have constituted an infringement of a copyright or a related right under the law of the country” (Foreign Affairs, Trade and Development Canada, 2013);
9. **Additive Manufacturing (AM)** – “Process by which digital 3D design data is used to build up a component in layers by depositing material” (ASTM, 2014);
10. **Programmable Logic Device (PLD)** – “Generic electronic devices that can be programmed to implement a wide variety of different types of digital circuits” (Waterloo University, 2012);
11. **Application Specific Integrated Circuit (ASIC)** – “are, as the name indicates, non-standard integrated circuits that have been designed for a specific use or application” (Radio-Electronics.com, 2014);
12. **Reverse Engineering** – “The process of extracting information about a product from the product itself” (Curtis, Harston & Mattson, 2011);
13. **Photogrammetry** - The science of making reliable measurements by the use of photographs (Meriam-Webster, 2014);  
14. **Social Media (SM)** – “Online environment in which content is created, consumed, promoted, distributed, discovered or shared for purposes that are primarily related to communities and social activities, rather than functional, task-oriented objectives” (Gartner, 2014);  
15. **Circuit topographies** – “Three-dimensional configurations of electronic circuits embodied in integrated circuit products or layout designs” (CIPO.IC.GC.CA. 2014);  
16. **CSR** – Corporate Social Responsibility (Sexty, 2011).
IV. Literature Review and Related Theory

The literature review presented in this chapter will be guided by the research subproblems introduced in Chapter III:

1. **How likely are hackers to share photogrammetric scans and source code freely on the web?**
2. **How likely are customers to use illegal files to clone branded products?**
3. **How successful would customers be in cloning devices?**
4. **How and why should manufacturers safeguard their intellectual property?**

The first section gathers information on the likelihood of product piracy. It will look into the motivation of hackers and end-users to infringe on intellectual property. The arguments presented by researches on a similar issue, electronic media piracy, will be transposed to the intent of copying PLD source code, and AM files.

In order to address the research question, some enablers need to be present; they should meet the criteria of affordability, ease of use, and efficiency. The second section will cover various studies supporting the argument that the combination of PLD, AM and SM is possible today, and is not out of reach for the average customer.

Even with the intent to cheat, and the availability of cloning tools, one can argue that failing to meet, or exceed, the performance of the original would lessen the attraction for cloning. The literature selected in the third section will show some structural shortcomings of additive manufacturing in comparison to conventional manufacturing, raising concerns over the quality of the end product compared to the original.

The final section of this chapter addresses the financial impacts of product piracy. Past legal review will draw a parallel between the financial losses incurred by the satellite television industry and the risk of home-based counterfeiting to the mobile consumer electronics industry.
A. Motivation Leading to Intellectual Infringement


This survey is used as foundation to explain the tolerance of millennials toward counterfeit products, along with their perceived ability to identify counterfeits. The responses indicate that the counterfeits are perceived as cheaper, and as good as the genuine product.


The ACTA becomes the legal foundation for signatory countries to ratify within their legal system. It explains in point-form the nature of counterfeiting, the exceptions, and the expectations placed on parties to the treaty.


The authors’ Social Cognitive Theory (SCT) will be used to understand the motivation behind copyright infringement; hence, why would a customer choose to clone instead of purchasing a branded unit? It will also help to understand why some feel entitled to hack, and share confidential information with strangers.


Fishbein and Azjen’s theory of Reasoned Action (1975) and the application of the model by Christensen and Eining (1991) toward software piracy corroborate the findings of Sheehan, Tsao, & Pokrywczynski. If the perceived legal, performance, and social risks are low, the average customer can be enticed to partake in media piracy.

In Copyright Freakonomics, Newman challenges the status quo, proposing that copyrights are a disguised form of legal monopoly and arguing that the artistic creation process is a sunk cost. His argument could shed some light on what drives some end-users to develop a sense of entitlement to copyright-free content. What motivates them to download illegal movies could very well be transposed to 3D files or source code as well.


This Internet law magazine offers more questions than answers. One question raised is how to establish legal blame when BitTorrent technology subdivides the files in multiple sections? If a video file is divided in a thousand sections, will the law go after all holders of partial sections, or only after the ones that have all of it? The question of partial downloads can also be asked of partial product cloning: what are the legal implications of cloning a damaged replacement case for a product purchased legally? Even if the full combination of the four manufacturing pillars were proven unlikely, there could still exist a significant impact from the additive manufacturing threat alone. The replacement parts industry could be a worthwhile subject to study in that case.

Another question posed is the legal coverage of the subscription. One could ask if a legal subscriber of a specialty television channel (e.g. HBO) would be covered for content created by that same provider, even if it were downloaded from an illegal source. Would misunderstanding in the terms and conditions obscure the perceived weight of the terms and conditions of a contract?
B. Enablers to Infringement


Harris presents a set of supporting arguments for the growing use of additive manufacturing. These include:

- Reduction of tooling required;
- Support for multiple material types with a single unit;
- Material waste reduction;
- Elimination of parts shortage;
- Weight reduction;
- Improvement of modeling and simulation results in the early stages of the design;
- Manufacturing capabilities that were not previously possible (in space missions).

Even if one challenged the transition from conventional manufacturing to 3D printing, they would have to debunk Harris’s arguments. Ignoring the trend is not an option, at least not for a long-term strategy.

Donovan, J. (2006). Programmable SoCs. Configurable and reconfigurable SoCs are changing the ASIC landscape.

According to Donovan (2006, p.9), “You can go through three generations of a consumer electronics device in the time it takes you to design an ASIC for it”. In layman’s terms, programmable components let you build multiple models of a TV while manufacturers of dedicated chips struggle to catch up.

This fascinating article (for engineers at least) traces a roadmap of programmable logic taking over the ASIC market. The arguments point toward an increased trend of standardizing designs between product lines, and even between manufacturers, making it easier for end-users to reprogram product A to emulate the functionalities of product B.

This older article shows that programmable logic was already taking a stronghold more than eighteen years ago. Furthermore, it shows that even the defense industry was willing to shift to programmable logic, even if it came with higher risks of hacking and tampering.

C. Manufacturing Process and Quality Control


This article is not limited to intellectual property. As part of the background on additive manufacturing, it includes some process information, including the following statement: “Although a 3D-printed object may be visually indistinguishable from its manufactured counterpart, expertise is required to ensure that the object meets tolerances for key functional elements” (Kurfess & Cass, 2014, p.37). For example “stress concentration may appear at the junction of multiple printed layers” (Kurfess & Cass, 2014, p.37).


Data from Wohlers Associates (2013) estimate the market for 3D printers to be $2.2 billion in 2012, and expected to grow to $6 billion by 2017. 50,000 printers were sold in 2013, showing increased availability to the hackers. With increased demand comes increased competition, leading to more affordable prices, within reach of the average end-user.
Figure 4.1C shows the *Ur-Bee*, a Canadian automobile utilizing more than 50% additive manufacturing in its fabrication. The Ur-Bee, although not a clone, does show that the barrier to entry is lowered with additive manufacturing, and increases the competitive landscape, even in the expensive automotive industry. The article provides multiple links to other such examples which can be used to confirm the maturity of additive manufacturing.

*Browsing the electronics forums, we can find multiple examples of media players made from programmable logic boards. These designs made from hobbyists kits are often found protected inside 3D-printed cases (Figure 4.2C). The sharing of the source code and 3D printing file is a direct example of the hypothesis, and little is missing to turn these examples into a Sony or Apple look-a-likes.*
D. Impact on the Industry


This article establishes that piracy is present in the Canadian market, with the experience of two national satellite communication providers: ExpressVu and Star Choice. They report losses in the hundreds of millions, coming from grey markets where Canadian customers have cloned the source code of US receivers to get access to US-owned satellite services. The scale of the amount highlights the impact of this research finding a way to mitigate piracy.


Jackson (2003) confirms the magnitude of the piracy phenomenon with a report that millions of homeowners have opted for illegal alternatives, at an average loss of $90 per household.

What makes the article even more important is that it reports a counter-law suit against US satellite providers claiming unfair business practices, based on how one provider attacked illegal users. By using a mass campaign of intimidation letters sent to names retrieved in police raids, the lawyers for the class action claim that the satellite provider forced customers to pay, even if they had not committed illegal acts, or had already made arrangements to enroll into a legal subscription. If the legal counsel of an organization informed senior management of the risk of counter-lawsuits, ratio of lost claims, or risks of appeal, would senior management of a firm pursue illegal action with such fervor?


The supply chain question is raised in this paper, with the liability of an organization, if counterfeit parts make their way in a legal system. The chief risk officer (CRO) would have to evaluate the impact on the brand, the legal responsibilities, the financial costs, and lost productivity costs, or even ask if the risk is so high that the organization should exit that market.

An enlightening assumption made by Kurfess & Cass is that even if intellectual property is defendable in court, the number of cases to be handled might very well
exceed the capacity of a traditional legal structure. This argument alone would warrant a paper by itself.
V. Research Design and Data Collection

A. Research Methodology

This research study is designed as a conceptual paper. At no point shall primary data be collected, as the author of this paper intends to launch a venture in additive manufacturing, and as such, gathering information from members of this industry could be perceived as an unfair competitive advantage. Gathering secondary sources of data is sufficient to address the research question of this paper.

Data will be collected for a period of no more than fifteen years, which coincides with the growing sales of portable media players, the adoption of programmable logic devices, the proliferation of BitTorrent websites, the price erosion of 3D printers, and the maturing of photogrammetry.

In order to evaluate the research question of a user combining photogrammetry, PLD, AM and SM to reduce their reliance on consumer electronics manufacturers, the collected data will be gathered and analyzed based on the four fundamental sub problems presented in Chapter III.

B. Observed Trends in Product Piracy

Data Requirement

- Ratio of infringing versus legal content on the internet;
- Psychology papers showing motivation factors for counterfeiting;
- Number of seized counterfeits over the research timeframe.

Data Sources

- Survey (Canon);
- Blogs (BitTorrent);
- Psychology trade journals (Psychology Today);
- IT trade journals (CIO, Gartner Insight);
- Trade law journals (Vanderbilt Law Review, ITLaw);
- Ethics trade journals (Journal of Business Ethics).
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Treatment of Data

- Increased instances value of counterfeit seizures.

C. Availability of Resources Leading to Counterfeiting

Data Requirement

- Adoption ratio of PLD versus ASICS;
- Adoption of additive manufacturing;
- Growth in the 3D printer market.

Data Sources

- Electronic trade journals (IEEE, SMPTE, EEtimes);
- 3D file sharing websites (GrabCAD, 3dvia, freestlview,CNCzone);
- Blogs (BitTorrent);
- IT trade journals (CIO, Gartner Insight);
- Xilinx and Altera financial reports;
- 3D printers manufacturers’ websites.

Treatment of Data

- Lead manufacturers (Xilinx and Altera) financial reports (will be used to show the increased trend toward using PLD and creating generic circuits);
- Competitive landscape to establish a parallel between the use of off-the-shelf components and the reduction of the barrier to entry;
- Increase in the number of 3D printers sold and price point, as a supporting argument toward the ease of access to the technology.
D. Impact on the Industry

Data Requirement

- Financial losses incurred by the satellite industry from code counterfeiting;
- Financial losses incurred by the manufacturing industry from forgery;

Data Source

- FCC court documents (Public records);
- MPAA studies (Public records);
- Economics journals (Journal of International Trade & Economic Development).

Treatment of Data

- Number of suspected offenders in illegal use of satellite receivers, and the financial losses expected;
- Scope of illegal product reproductions and financial impact as a growth trend;
VI. Results

A. Research Sub Problem One

*How likely are hackers to share photogrammetric scans and source code freely on the web?*

According to the total value of seizure of intellectual property infringement from 2005 to 2012 (RCMP-GRC.gc.ca, 2013), we can see a clear trend that counterfeiting is on the rise in Canada.

*Graph 6.1A – Retail Value of Seizures of IP Infringing Goods (RCMP-GRC.gc.ca, 2013).*

Looking further in the report, we find that apparel and footwear are the leading type of counterfeit seized (45%), followed by copyrighted work (25%; media files included), and consumer electronics products in third place (10%) (Graph 6.2A).
If we take into consideration that one of the research paper’s sub problems addresses the likelihood of counterfeiters using illegal files to program, and physically manufacture a product, we can propose that the clone would fall within two categories: (copyrighted work, and consumer electronics products, making it almost as damaging as the counterfeit market of apparel and footwear (Graph 6.2A).

![Graph 6.2A- Type of Commodities Seized in 2012 (RCMP-GRC.gc.ca, 2013).](image)

In order to understand the likelihood of counterfeiters sharing illegal source code and 3D scans with the social media community, we can turn to a two-year research conducted by Sheehan, Tsao, and Pokrywcynski (2012), looking into what motivates college students to download and share illegal media. The three leading drivers (Sheehan, et al, 2012, p 311) were identified as:

- Economic utility (saving money);
- Collection utility (enhancing musical enjoyment by having a larger collection);
- Social utility (increasing social connectivity from sharing a wider array of songs).

![Graph 6.3A- Motivational Drivers to Electronic Piracy (Source: Author).](image)
Once the initial phase of the survey returned the leading motivations, the researchers were able to quantify these motivations using a regression analysis. Table 6.4A shows the results.

<table>
<thead>
<tr>
<th>Motivation</th>
<th>$B$</th>
<th>$\beta$</th>
<th>$\tau$</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>0.50</td>
<td>0.30</td>
<td>4.00</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Economic</td>
<td>0.25</td>
<td>0.15</td>
<td>2.04</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Social</td>
<td>0.54</td>
<td>0.32</td>
<td>4.33</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

$R=0.46$, $R$-Square= 0.22, $d.f.=141$, $F=12.97$, $p<0.001$

Table 6.4A – Multiple Regression Analysis of Motivation on Gratification of Digital Music Piracy (Sheehan, Tsao & Pokrywczynski, 2012, p.313).

The intercept parameter $B$ shows the value of the dependent variable of gratification if all of the independent variables are absent (value of 0). In layman’s terms, the regression analysis evaluated the impact of the economic, collection, and social utility as independent variables to understand their impact on the dependent variable of gratification. The outcome quantifies that the main reason college students download and share illegal content is to increase social connectivity ($B=0.54$), while collection is second ($B=0.50$). Saving money was the last reason why college students chose to download illegal files instead of legal ones ($B=0.25$).

This focus on the human aspect of counterfeiting will be analyzed further in the human resources section of the analysis (Chapter VII, section H).

**B. Research Sub Problem Two**

*How likely are customers to use illegal files to clone branded products?*

In 2011, the research firm Envisional was commissioned to assess the depth of piracy. The technical report outcome entitled *An Estimate of Infringing Use of the Internet* focused on peer-to-peer networks (BitTorrent), file hosting sites (Cyberlocker) and other web-based piracy venues (streaming). The survey reveals that “across all area of the global Internet, 23.76% of traffic was estimated to be infringing” (Envisional, 2011, p2).
Chart 6.1B shows that once pornography is excluded (76.23%), the sum of all other bandwidth is considered infringing material. Pornography is excluded as its "infringing status can be difficult to discern" (Envisional, 2011, p5).

We can further subdivide this 23.76% infringing content; of this number, BitTorrent was identified as the lead offender, with 11.39% of all the global bandwidth. Focusing on this protocol, Envisional researchers isolated the 10,000 most popular files exchanged. The breakdown in Chart 6.2B (Envisional, 2011, p5) revealed the following:

- “35.8% was pornography, the largest single category. The copyright status of this was more difficult to discern but the majority is believed to be copyrighted and most likely shared illegitimately”;
- “63.7% of content managed by Public BitTorrent was non-pornographic content that was copyrighted and shared illegitimately”;
- 0.48% (just 48 files out of 10,000) could not be identified.
The Threat of Home-Based Counterfeiting on the Electronics Industry

Of the 63.7% non-pornographic content (Envisional, 2011, p.5), the researchers identified that:

- 35.2% was film content – “all of which was copyrighted and shared illegitimately”;
- 14.5% was television content (television, sports, and anime) – “all of which was copyrighted and shared illegitimately”;
- 6.7% was PC or console games – “all of which was copyrighted and shared illegitimately”;
- 2.9% was music content – “all of which was copyrighted and shared illegitimately”;
- 4.2% was software – “all of which was copyrighted and shared illegitimately”;
- 0.2% was book (text or audio) or comic content – “all of which was copyrighted and shared illegitimately”.

![Chart 6.2B - Top 10,000 Torrents by Content Type, PublicBT, December 2010 (Envisional.com, 2011, p.10).](chart)

These results show the importance of BitTorrent as an enabler to counterfeiting. One should ask if the availability of illegal content further motivates the would-be counterfeiters.

This can be answered by looking at the interactions between the BitTorrent users. In the Torrent ecosystem, those who have the illegal files available for download
are called *Seeders*, and those who are looking for that content are referred to as *Leechers*. Keeping this in mind, what is important for this paper’s research sub problem two is that almost half of all torrents (1.32 million, or 48.5%) (Envisional, 2011, p.9) of the sample are initiated by *Leechers*, with no visible *Seeders* having the requested file. This proves that almost one out of two BitTorrent user makes the conscious decision to look for specific illegal content, not knowing if it is available or not. This phenomenon shows that the supply of illegal files is not driving the demand, but instead, that demand drives the supply in at least half of the cases.

*Raspberry Pi Sales Growth*

Figure 6.3B shows the Raspberry Pi, a $50 Compaq Computer designed and manufactured in England. With total sales of more than 3 million units to date, this open-source project offers customers a full solution to play audio or video files, and can even connect to the Internet and use standard computer peripherals such as touch screen, mouse, keyboard, and monitor.

*Figure 6.3B - Raspberry Pi Microcomputer Platform, Next to a Genuine iPhone (Hightower, 2014).*

The popularity of the Raspberry Pi is based not only on its attractive price, but also on its low power consumption (can be powered by batteries), strong computational power (uses the same type of microprocessor as computer tablets), wide range of applications, and free open-source software and tutorials. With this single model, millions of users have created various projects such as media players, cameras, video games, web servers etc.
Graph 6.4B shows the exponential sales of the product, which the designer had created to stimulate interest in programming. The 3+ million sales to date have far exceeded the 10,000 pieces that the founder dreamed of.

The availability of this microcomputer answers the electronics’ portion of the counterfeiting risks. Even if the electronic design differs from the iPod/walkman/Galaxy Tab, the features and benefits can be replicated on the screen to be virtually indistinguishable from the genuine product.
The Threat of Home-Based Counterfeiting on the Electronics Industry

3D Printer Sales Growth

The sales of 3D printers under $5,000 have exploded since 2007 as can be seen in Graph 6.5B.

![Graph 6.5B - 3D Printer Sales Trend (Raskin & Kolet, 2012).]

According to Raskin & Kolet (2012), “until recently 3D printing was limited to large companies that could afford the industrial machines; this change is similar to the supercomputers of the 1970s that were only affordable to the major corporations, and now we’re in a period analogous to the 1980s, where the personal computer came about; now we have personal printing”.

3D Scanner Sales Growth

A recent development in photogrammetry is the introduction of the Microsoft Kinect device. This inexpensive ($200) 3D scanner was developed for the Xbox One gaming console but is finding its way in various product scanning applications. Based on the interest from developers, Microsoft has even launched a 3D builder application and offers printing services to end-users.
**Shift to Programmable Logic Components**

Xilinx describes Programmable Logic Devices (PLD) as “off the shelf logic chips that the customer, rather than the chip manufacturer, programs to perform a specific function” (Xilinx.com, 2014, p.1). Graph 6.6B shows the growing sales of Xilinx for the 15 years covered by this research paper. With the exception of the early 2000 spike in sales (telecommunications’ golden age), followed by an abrupt drop (US terrorist attacks of 2001), the sales of programmable logic devices have grown steadily over the last 15 years. The transition from application specific ICs, built by the manufacturer, to general purpose components has reduced the R&D cycle, but has opened up the door to counterfeiting.

![Graph 6.6B – Xilinx Net Sales 1999-2014 (Xilinx.com, 2014).](image)

**How it all Connects**

Illegal file sharing is not a hypothesis, it is already a fact of life; 3D printers are no longer oddities, they are sold through popular store chains; the Raspberry Pi has far outsold the intended audience, and is now an intricate part of the home-brewed electronics community. All the enablers needed to become a counterfeiter are at the do-it-yourselfer’s fingertips.
C. Research Sub Problem Three

*How successful would customers be in cloning devices?*

To answer this question, three counterfeit products will be used as example, along with some insight on the additive manufacturing process:

- The Hackintosh versus Mackintosh;
- The Raspberry Pi versus iPod Touch;
- The clone satellite receiver versus the ExpressVu receiver.

**Hackintosh Versus Mackintosh**

Amongst the leading social media dedicated to counterfeiting, we can find the Hackintosh community. Building a Hackintosh consists of turning a personal computer (PC) into a Mackintosh equivalent. Since Apple uses standardized components, including a graphic card, motherboard, hard disk drive, and microprocessor, a user can build his own counterfeit from the same parts, and run the Apple Operating system on it. As can be seen in Figures 6.1C and 6.2C, the counterfeit can be built to take the same physical appearance as the original.

![Figure 6.1C - Hackintosh Example (Horsey, 2014).](image)

![Figure 6.2C - Hackintosh Example (Horsey, 2014).](image)

![Figure 6.3C – A Genuine Mac Pro Computer (Apple.com, 2014).](image)
The research sub problem can be answered in this case with the following questions:

- Does it look the same?
- Does it perform the same tasks?
- Are performances equivalent?

In the examples shown (Figures 6.1C and 6.2C), the designer used a trash can and other recycled parts to build the enclosure. Even if the results look similar, one could expect that the use of a 3D printer would have created a much closer resemblance, with the same material thickness and curvatures. It should be noted that most inexpensive 3D printers use plastic filament, but some commercial models can print with a metal filament, which would be needed to achieve a closer copy of the aluminum case used by Apple. Would customers be satisfied by a counterfeit that looks identical to the original, even if the material used to duplicate it was different? That is a question that will be analyzed later in the human resources aspect of the Analysis section (Chapter VII, Section H).

The second question is the easiest to answer as both machines use the same operating system; hence no differentiation factor exists between the counterfeit and the original.

To the performance question, this is where the counterfeit and the genuine unit differ. The benchmark presented in Graph 6.4C show that the counterfeit (Hackintosh) outperforms the genuine computer on many tests. The tests were performed using Xbench Benchmarking tool; higher scores indicate better performances.

Graph 6.4C- Hackintosh Versus Mac Pro Versus MacBook Pro Benchmarks (Pash, 2007).
The results shown in Graph 6.4C are misleading as both computers have different processors, graphic cards, memory and other components. It would be easy to assemble the Hackintosh from the same components as the genuine model, but it is unlikely that a counterfeiter would use the same parts for the following reasons:

- The cost difference between both units would become insignificant (The genuine unit might even be less expensive as Apple has the economy of scale that the counterfeiter has not);
- When both units are identical, but the counterfeit requires assembly, the genuine model gives a faster satisfaction.

**The Raspberry Pi Versus iPod Touch**

The same questions of appearance, features, and performance, can be applied to the portable media player as well, especially the Raspberry Pi programmable board (Figure 6.5C) versus the iPod Touch (Figure 6.6C).

![Figure 6.5C - Raspberry Pi](Raspberry Pi, 2014)

![Figure 6.6C - Apple iPod](IHS, 2012)

Both units might appear different in design, but they both support digital audio playback in CD quality, and full HD video playback.

**The Clone Satellite Receiver Versus the ExpressVu Receiver**

Well before the Raspberry Pi existed, the free to Air (FTA) movement revealed a flaw with using programmable logic in consumer electronics products. In 2009, Wong reported that “there are at least two million illegal satellite television households in the U.S. and Canada, out of a universe of about 15 million legal households” (Wong, 2009).
Even more problematic, the lack of enforcement contributed to building a false sense of confidence in the hacker community. In rare cases, ring leaders were prosecuted, such as an American hacker who was suspected of selling 6,000 illegal piracy devices from his home (Sullivan, 2013). The loss to the subscription television industry was evaluated at $14,864,960 from this single home-based hacker.

This was possible because receivers from telecommunication companies were built on a standardized set of programmable components, to give flexibility to the service provider to upgrade as needed. The receivers used in Europe and North-America shared the same components, which led to years of product counterfeiting. Chinese and Korean manufacturers would make universal integrated receiver decoders (IRD), which end-users would reprogram to access signals from Canadian provider Bell ExpressVu, and American provider Dish Network.

Even though the graphic user interface (GUI) was different between the counterfeit and the genuine unit, the picture quality was similar. One could even say that the counterfeit exceeded the features and benefits of the genuine, as it gave access to all channels on the satellite, at no cost.

From a performance perspective, the units were increasingly unstable. Once the hacking grew in number, the service providers had to increase the speed at which they updated the encryption code, leading to more frequent loss of signal, and an increase lead time before the key was decrypted and provided through social media.

The FTA phenomenon is significant in this research paper as it was the first wide adoption of two of the enablers proposed in the research question: social media and programmable logic. The hackers used social media portals (forums) to get training on how to hack their receiver, get a list of suppliers for the different tools needed to hack, and get the firmware source code, or encryption key.

The illegal receivers did not look like the genuine model as there was no inexpensive technology available to duplicate the physical chassis of the receiver (Figure 6.7C). This is different today, with the maturing of additive manufacturing. One can speculate that if hackers spent significant amount of time breaking the code, and sharing their success online, they would have used these new tools to also replicate the physical appearance of the IRD.

**Figure 6.7C – Counterfeit Satellite Receiver (diytrade.com, 2009).**
Additive Manufacturing in General

Figures 6.8C shows two examples of 3D printed objects. These lifelike figurines demonstrate how realistic the 3D printing process has become.

![3D Printed Examples](image)

*Figure 6.8C – 3D Printed Examples (Collis, 2013).*

This level of realism comes at a cost. Additive manufacturing, in contrast to the subtractive process used by genuine manufacturers, uses a series of thin layers of molten plastic to build up a part. Because of this layer arrangement, it is common to use a filler material inside the object, which will be dissolved once the part is printed. The hollow shape is lighter than the original, but it is also more fragile.

When creating a counterfeit, if the same rigidity is required, the thickness of the part needs to be redesigned to make up for the lower structural strength. The counterfeiter is left with the choice of redesigning the part, or if the outside case is only required for appearance, simply accept the structural weakness.

Does Quality Matter?

What should be assessed is the importance that appearance holds over reliability. When it comes to counterfeiting, the fashion industry has been hit with many counterfeits of lower quality, but the counterfeiting trend continues to grow (Section A). It tells us that customers are willing to accept a lower build quality (for equivalent functional features), if the cost savings are significant enough. This is also true if the motivation is the satisfaction of assembling the unit themselves.
D. Research Sub Problem Four

_How and why should manufacturers safeguard their intellectual property?_

Sub problem four addresses the corporate strategic plan that a firm should adopt against the threat of home-based counterfeiting. Following a thorough analysis of the core management domains, the risks will be assessed, and a set of recommendations will be provided in Chapter IX to answer this last sub problem.

E. Relationship to Literature

As discussed in the literature review section (Chapter IV), the increased availability of enablers is visible, in the form of source code, 3D files, and printers. These enablers act as independent variables to the number of cases of counterfeiting (dependent variable, Graph 6.1E). An increase in the availability of enablers is expected to lead to an increase in the instances of counterfeiting. Motivation will act as a moderating variable, either promoting counterfeiting, or reducing the interest of making your own duplication.

Graph 6.1E. - Dependent, Independent, and Moderating Variables (Source: Author).
F. Relationship to Theory

Based on academic principles, one could expect Maslow’s hierarchy of needs (1998) to explain what drives a consumer to voluntarily purchase a fake, or participate in the counterfeiting process. If the motivation for end-users to manufacture their own counterfeit product is deemed real, Barney’s VRIO (2007) and Porter’s five forces framework (2008) will be used to assess these actions as a passing trend or as quantifiable risks toward established brands (Chapters VIII and IX).

G. Relationship to Practice

When it comes to the law, the practical implementation can vastly differ from the academic concepts. The Anti-Counterfeiting Trade Agreement was signed by eleven parties, but like most multilateral agreements, it is not enforced until the participating country ratifies the agreement, in whole or in part, in its constitution. The presence of regulation has limited weight if not enforced. According to Foreign Affairs, Trade and development Canada, “A Party may exclude from the application of this Section small quantities of goods of a non-commercial nature contained in travelers’ personal luggage” (2013). This statement causes concern: targeting large-scale organizations potentially leaves a gap that protects millions of would-be home-based counterfeiters.
VII. Analysis

A. Approach

The results presented in Chapter VI will be approached through individual analysis of the pertinent management domains. Following stakeholder identification, the subjects of economics, legal, brand valuation, process, finance, human resources, and ethics will attempt to explain the drivers behind the results presented, and the likelihood of customers turning to social media, photogrammetry, additive manufacturing, and programmable logic, to create their own counterfeit media player.

B. Stakeholder Identification

In order to assess the impact of counterfeiting on the organization, one must first establish who the stakeholders are, and what relationship they share with the organization. Freeman’s stakeholder management capability framework (1984) proposes to:

- Identify the organization’s stakeholders and their perceived stakes according to the rational perspective;
- Determine the organizational process used to manage the relationship with stakeholders;
- Understand the set of transactions or bargains between the organization and a stakeholder.
Graph 7.1B is the identification process, where all stakeholders who have an interest in the counterfeiting culture are listed. In the center of the graph, the three leading manufacturers of portable media players act as anchor for Freeman's framework. The surrounding stakeholders are those who stand to profit, or lose from counterfeiting.

![Graph 7.1B – Home-Based Counterfeiting Stakeholders Map (Source: Author).](image)

The impact of counterfeiting is used to appreciate what organizational process should be applied to manage these stakeholders, and understand the bargaining power of each:
The Threat of Home-Based Counterfeiting on the Electronics Industry

**Creditors/Shareholders**

- Loss of revenues to the counterfeiters;
- Brand devaluation as the product is easily copied;
- Price erosion due to the counterfeit alternatives;
- Lost dividends from financial decline;
- Stock value becomes less attractive to shareholders.

**Employees**

- Downsizing from reduced demand for the genuine product;
- Increased workload to the remaining workforce (from downsizing);
- Uncertainty and negative atmosphere felt by employees and management;
- Increased pressure to speed-up the development cycle of new products (faster release of new products to capitalize on sales before counterfeits are introduced).

**Competitors**

- Can covertly use the information from hackers instead of reverse engineering their competitors’ products;
- Can promote counterfeiting as a ploy to weaken their opponent’s sales.

**Government and Regulators**

- Lost revenues from taxes charged to genuine manufacturers;
- Increased financial burden from unemployment;
- Limited control over what is produced illegally;
- Added costs of enforcement;
- Product liability cannot be traced back to counterfeiter;
- Product disposal becomes the burden of the government.
**Business Organizations**

- Financial losses slow down CSR initiatives, including school funding to train future employees;
- Damages caused by counterfeits are tainting the work of professional engineering associations;
- Less willingness from manufacturers to copyright their designs as it publically documents their inner workings;
- Lost credibility of professional certifications (if anyone can program and print his own design, why do we need engineers?).

**Media**

- The repeated instances of counterfeiting become less newsworthy;
- Unscrupulous reporters could create their own counterfeit to document the process, which would bring more attention to it, and increase its popularity.

**Social Media**

- Availability of counterfeit files increases traffic (and advertising sales) to the site;
- Loss of premium advertising from established brands, who do not want to be associated with illegal content shared on these sites.

**Senior Management**

- Corporate strategy is formulated in reaction to the counterfeiters’ threat, leading to short-term objectives instead of a long-term, sustainable plan;
- Increased pressure by the shareholders to perform against the counterfeiters;
- Unstable employment for managers, linked to their ability to compete against counterfeiters;
- Potential lawsuits against the firm’s officers if a counterfeit causes damages, and the product is mistaken for a genuine unit.
Counterfeiters (Originators)

- Source of financing for criminal and terrorist organizations;
- Can hide from prosecution behind multiple layers of internet servers;
- Enforcement is weak. Once raided by the police, retailers often reopen within days.

Counterfeiters (Followers)

- Perceived low risk of prosecution from the wide-spread download of illegal files;
- Feel that social media shields them from traceability to the originators of the counterfeit files;
- Are under the impression that the product manufactured in their basement is invisible to the regulators.

Customers of the Genuine Product

- Their products’ value is tainted by the multitudes of counterfeit;
- Expect a higher level of service, and some form of added benefits for being loyal to the genuine product.
Stakeholder Typology

Now that the stakeholders and their perceived stakes are established, they must be categorized for salience, or what Mitchell, Agle, & Wood (1997) describe as the “degree to which managers give priority to competing stakeholder claims”.

In the center of the graph (7.2B), we can see the most important stakeholders, those who have the three attributes of the stakeholders’ map. They are the only ones who share the executive power to make immediate and legitimate decisions. They include the government, senior management, and the shareholders (or creditors). One
could argue that the government has less power than the shareholders, but in most countries, the federal government can take control of an organization if it feels that the organization threatens the security of its nationals.

Following closely, we get to the dangerous stakeholders: social media; counterfeiters originators; and counterfeiters followers. They might not have a legitimate claim on the firm, but they have the power to influence decisions, and have enough weight to impose urgency on the firm's decision makers.

The employees are dependent stakeholders, with little to no power over the decisions of the firm, but can influence the urgency by their freedom to leave work, and have legitimate claim on the future of the organization, and the decisions made in that respect.

All other groups have only one attribute, which makes them less prone to influence the decision makers. This is traditional of the normal competitive landscape when the threat is from new entrants and established competitors, instead of counterfeit and illegal file sharing.

What makes this typology different is the power shift to the customers, who are now able to clone their own product. They are no longer traditional customers, but instead, they take on multiple roles in the typology map, becoming part competitors, part new entrants, and part substitutes. Unless the firm's leaders are careful, they could be blindsided by the power, urgency, and legitimacy of these home-based counterfeiters, leading decision makers to formulate plans that are hasty and reactive, instead of assessing their long-term impact on the growth of the firm.

C. Economic Analysis

Even though sales data are not publically available for the iPod/Walkman/Galaxy Tab, versus their counterfeit versions, the use of a regression model as proposed by Thomas & Maurice (2011, p. 40) offers a visual roadmap to understand what factors drive the demand for the genuine media players, and how important each one is. Table 7.1C describes the empirical demand function used in the regression.

<table>
<thead>
<tr>
<th>Empirical Demand Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Q = a + bT + cP + dM + eN + fA + gP_r )</td>
</tr>
</tbody>
</table>

*Table 7.1C- Generic Empirical Demand Function (Thomas & Maurice, 2011, p. 40).*
**Quantity of Legitimate Products Sold (Q)**

The variable Q expresses the quantity of genuine products sold as a dependent variable. All variables to the right of the expression (Table 7.2C) will be considered economic drivers (independent variables) impacting the demand for the genuine products. These include the customers' taste, the price of the product, the average after-tax household income, the size of the purchaser population, the advertising expenditure, and the price of a related product.

<table>
<thead>
<tr>
<th>Empirical Demand Function Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>Q</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>T</td>
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<tr>
<td>P</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>N</td>
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<tr>
<td>A</td>
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<td>Pr</td>
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</tbody>
</table>

*Table 7.2C - Empirical Demand Function Variables (Thomas & Maurice, 2011, p. 40).*

Based on the stakeholders’ typology map of Section B, we can draw a parallel between the economic drivers listed above and their respective group of stakeholders:

<table>
<thead>
<tr>
<th>Stakeholder / Economic Drivers Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stakeholder (Variables)</strong></td>
</tr>
<tr>
<td>Shareholders/Creditors</td>
</tr>
<tr>
<td>Employees</td>
</tr>
<tr>
<td>Competitors</td>
</tr>
<tr>
<td>Government and Regulators</td>
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<tr>
<td>Business Organizations</td>
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<tr>
<td>Media</td>
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<tr>
<td>Social Media</td>
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<tr>
<td>Senior Management</td>
</tr>
<tr>
<td>Counterfeiters (Originators)</td>
</tr>
<tr>
<td>Counterfeiters (Followers)</td>
</tr>
</tbody>
</table>

*Table 7.3C - Stakeholder / Economic Driver Relationship (Source: Author).*
Now that the relationship between the stakeholders and the economic drivers is established, the following sections will develop the logic behind each of these factors, and how they impact demand.

**Intercept Parameter (a)**

In the demand function, the intercept ‘a’ represents the value of Q (demand for the genuine products), if all the other economic drivers were set to 0 (no increase or decrease on any of them). From a qualitative analysis, it has limited value, but it is still mentioned, as a follow-up quantitative research would need to take it into consideration.

**Taste of the Customers for the Genuine Product (T)**

The taste for the product, more specifically the desire for the genuine brand, is linked to the motivation aspects of the research question. Why would a customer choose to purchase a genuine product when a lower-cost clone is available? The report from Philips (2005) reveals indeed that many customers are satisfied with having a product that looks and feels like the original. The taste for the product, or the desire to be seen with it, supersedes the need to have the original.

It is noted by Phillips that even when the taste for the genuine product is established, a supply shortage changes the customer’s attitude toward counterfeit. One such example is how legal purchasers of the Hermes *Birkin* bag elect to buy a second unit that is counterfeited because they want to have more than one color and are not willing to go back on the wait list.

**Price of the Genuine Product (P)**

As the price of the genuine product increases, the demand would typically decrease, or shift to a lower-cost alternative such as a counterfeit. There are two exceptions to this rule:

- *The price elasticity is higher*: In this case, the customer desires, or needs the product to the point where he/she is willing to pay more for it. The elasticity indicates up to what point that customer is willing to open up their wallet, before deciding that they do not need a genuine product at that price;
- *The luxury nature of the product*: When the product is considered a luxury item, a price decrease will make it less of a social status symbol, which would decrease the demand for the genuine product. An iPod at $49 raises suspicion that it will
be of lower quality, and would negatively impact the brand value. At which point, the counterfeit and the genuine have low differentiation factors.

**Average After-Tax Household Income (M)**

The customer income should have a direct impact on the demand for the mobile electronics product. We could expect that a rise in the population’s income would increase the demand for products, but what is even more important for this research question is that as the population’s income becomes disposable, the customer sees the purchase of the 3D printer, scanner, and programmable board as an affordable hobby. As will be shown in the financial analysis (Section G), the initial investment can be below $1000, which many already spend on entertainment and hobbies.

**Size of the Purchaser Population (N)**

The size of the population usually implies that if more people live in a country, sales of the product are likely to increase. In our case, the Canadian demographic becomes secondary, as globalization opens up the market demand to the world. With the advent of low-cost portable printers, development boards, and scanners, one can duplicate a product almost anywhere, as long as the electrical supply, internet access, and shipping of raw material are available. Having 50% of the Canadian population’s demand (34 million, statcan.gc.ca, 2014) is insignificant against 1% of the global population (7.3 billion, populationinstitute.org, 2014). Amazon, and TaoBao, ranking in the top ten most visited websites in the world, redefine the concept of how many customers are looking at the products available from genuine manufacturers, and counterfeiters.

**Advertising Expenditure (A)**

Advertising expenditure in the context of the formula would be based on how much the genuine manufacturer invests in promoting its product. The outcome would be to familiarize the customer with the existence of the product and to show its advantages over the competition.

This research paper proposes that advertising expenditure should be allocated to an anti-counterfeiting campaign, such as the one launched by Canon, and including the survey described earlier in this paper. The added advertisement would make the customer aware of the risks and implications of purchasing a counterfeit over a genuine article.
Price of a Related Product (Pr)

In this research paper, the counterfeit is viewed as a substitute to the genuine product. As the price of the substitute decreases (for equivalent features and benefits), the demand should shift from the genuine product to the home-based counterfeit. Of course, a subpar copy would have less impact on the demand for the original, but in the context of a portable media player, it is difficult to establish a clear differentiation between the sound quality produced by one product over the other.

A Quantitative Approach?

Since this research paper is qualitative in nature, the empirical demand function was not measured under hard numbers. In the event where a follow-up study would attempt to change the research question into a hypothesis, the author of this paper recommends quantifying the independent variables from a reference product. Using the Apple iPod as an example, the researcher could use the following data collection approach:

<table>
<thead>
<tr>
<th>Qualitative to Quantitative Data Collection Approach</th>
<th>Description</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q</strong> Quantity of legitimate iPods sold</td>
<td>From Apple’s financial statement, divide the net sales of iPods by the average selling price of the product</td>
<td></td>
</tr>
<tr>
<td><strong>a</strong> Intercept parameter</td>
<td>Calculated mathematically</td>
<td></td>
</tr>
<tr>
<td><strong>T</strong> Taste of the customers for the genuine product</td>
<td>Attribute a ratio based on the sales of Apple versus Sony, Samsung, and the additional 26 vendors identified in the Best Buy online retailer’s list</td>
<td></td>
</tr>
<tr>
<td><strong>P</strong> Price of the genuine product</td>
<td>Track the product price through historical web search of Best Buy online</td>
<td></td>
</tr>
<tr>
<td><strong>M</strong> Average after-tax household income</td>
<td>Statistics Canada historical demographic reports</td>
<td></td>
</tr>
<tr>
<td><strong>N</strong> Size of the purchaser population</td>
<td>Statistics Canada historical demographic reports</td>
<td></td>
</tr>
<tr>
<td><strong>A</strong> Advertising expenditure</td>
<td>Extract sales, general, and administrative (SG&amp;A) costs from the financial statement, and speculate on the sales/administrative/marketing ratio</td>
<td></td>
</tr>
<tr>
<td><strong>Pr</strong> Price of the related product (counterfeit alternative, or competitor’s product)</td>
<td>Compare with the price of the second leading product for the period, whether it is Samsung or Sony.</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.4C - Qualitative to Quantitative Data Collection Approach (Source: Author).
D. Legal Analysis

Sale of Goods Legislation

In Canada, the "Sale of Goods legislation" implies specific conditions into most contracts of sale (Borden, Ladner, Gervais, 2013 p.4). The specific conditions which the seller must meet are:

- The goods are fit for a specific purpose;
- The goods are of merchantable quality;
- A warranty covers the product after its sale.

"If a product is sold that does not meet these conditions, the seller will be held liable without the plaintiff having to prove fault or negligence." (Borden, Ladner, Gervais, 2013, p.4).

The issue with homemade counterfeiting is that no such contract of sale exists. The home-based counterfeiter is the sole person responsible for the functionality, quality, and reliability of the counterfeit. This is even the case if the counterfeiter purchases the source code from a retailer, the 3D file from another and the documentation from a third vendor. None of these suppliers will guarantee the proper working of their subassembly as each section is incomplete and cannot function by itself.

When asking how successful would the counterfeiter be in cloning a product, we should stress that if he/she fails in the process, no financial recovery is possible. When looking at this research sub problem, manufacturers should assess how valuable the warranty is to the end-user; and if it is not, one should expect the customer to look for illegal alternatives.

Legal Separation

eBay is perhaps the perfect example of legal separation. It describes itself as “one of the world’s largest online marketplace” (eBay.com, 2014). You will not see eBay brand itself as an auction house because, from a legal perspective, "a traditional auction house has the product in its possession when it is sold and therefore sees the item and can spot a counterfeit" (Phillips, 2005, p.89). eBay operates as a marketplace where sellers and buyers meet, separating the brand from the actions of its members.

Even if eBay was to become more proactive in regulating the transactions of counterfeit products on its marketplace, the issue is further complicated by the
distribution of counterfeit in sub-assemblies, as the research paper suggests. If a customer purchases a 3D design file of a product from one retailer, and the source code from another, each one of these, even combined, do not constitute a counterfeit media player, but rather the tools needed to potentially create such a counterfeit. eBay, or the regulators, would be left with the burden to prove that the combined tools were in fact used to create a counterfeit. The challenge to monitor the progress made from the buyer after the transaction is complete is arguably not within the legal rights of eBay.

One could argue that these files can be used for reasons other than counterfeiting; these could include:

- Using 3D photogrammetry files to design and manufacture third-party accessories;
- Using source code to troubleshoot a media file compatibility issue;
- Using source code to develop after-market applications (“apps”) to run on the device;
- Using 3D files in conceptual academic papers.

In all these cases, the reasons to purchase source files from social media would probably not be seen as illegal, or would not warrant taking legal actions. In any case, establishing the relationship between the social media or online retailer, and the counterfeiter, would be challenging at best.

**Standards Compliance**

Standards are those that manufacturers must follow to ensure that their products do not harm end-users in their application. The Canadian Engineering Standards Association (CESA/CSA) is one global organization providing quality assurance (QA) and inspection programs on products imported in Canada. Products inspected by the CSA group are less likely to cause damages as they have been benchmarked against historical engineering best practices.

The existence of counterfeit is often unknown to the regulators as they are imported illegally in the country. The research question pushes the argument further, where the counterfeiter would create the device at home, eliminating the ability to monitor the port of entry.
With no incentive for counterfeiters to submit their designs for testing, the likelihood of a clone causing damages is increased, as can be seen in some past examples:

- “Some knockoff Bic lighters, left on dashboards, exploded when they got hot.” (Phillips, 2005 p.22);
- “In 2003, Nokia admitted that three exploding handsets – were due to counterfeit batteries” (Phillips 2005 p. 23).

Enforcement is further complicated by the availability of third-party accessories such as chargers and batteries, which often escape compliance testing as they fall below the power consumption benchmark set by regulators. The chances are that standards compliance testing would have prevented these incidents.

**Enforcement**

Before contemplating enforcement against home-based counterfeiters, we need to understand what processes are in place to stop traditional counterfeiting, where the product is clearly an illegal copy, bearing the same logo. According to Phillips (2005, p. 9), “France is the only country in the world with a strict no-tolerance policy towards private citizens who buy knockoff luxury goods”. The Canadian situation is opposite, where the purchaser of a counterfeit is not a priority for the regulators. According to the Royal Canadian Mounted Police (RCMP), which regulates intellectual property crimes in Canada “the investigational priority will be commercial infringement at the manufacturing, importation and commercial wholesale distribution level, working toward dismantling the entire criminal organization involved in the illicit activities” (RCMP-GRC.gc.ca, 2013). Unless the RCMP adopts the French no-tolerance strategy, their approach completely ignores the threat from a vast network of home-based counterfeiters manufacturing small quantities for themselves.
Even with an eye toward large counterfeiting networks, the Canadian regulators are slow to react. The Canadian Anti-Counterfeiting Network (CACN) has questioned the lack of enforcement by the RCMP. In its *Report on counterfeiting and piracy in Canada* (2011), the CACN highlights shortcomings in the regulation and enforcement, explaining the growth of counterfeiting in Canada:

- Counterfeit “retailers” are not prosecuted (CACN.ca, 2011, p.6);
- Online, direct sales to consumers (and domestic retailers) are becoming the norm (CACN.ca, 2011, p.6);
- Proceeds of crime legislation exclude copyright piracy (CACN.ca, 2011, p.6);
- Outdated and ineffective IP crime legislation (CACN.ca, 2011, p.6);
- Lack of effective anti-counterfeiting civil remedies (CACN.ca, 2011, p.8);
- Disempowerment of customs officials (CACN.ca, 2011, p.8);
- Troubling ethics (CACN.ca, 2011, p.10);
- Product safety legislation excludes counterfeits (CACN.ca, 2011, p.11);
- World Intellectual Property Organization (WIPO) internet treaties and Anti-Counterfeiting Trade Agreement (ACTA) are not implemented (CACN.ca, 2011, p.11).

Assuming that enforcement is successful, and a retail location selling counterfeit is closed, “the counterfeiters often lose one day of production at worst; they reopen the next day” (Phillips, 2005, p.159). The availability of counterfeit is so widespread that the retailer can replenish its shelves faster than the regulators can seize it. For this reason, some experts propose that the regulators should have the right to monitor the supply of raw material, to trace it back to counterfeiters. Monitoring the use of polycarbonate to find illegal CD/DVD duplication factories could be transposed to monitoring the demand of plastic extrusion used in additive manufacturing. By following the raw material trace, the likelihood of stopping the counterfeiting phenomenon is higher than by targeting the retail stores who have a choice of suppliers.

Regardless of the investigative approach, until the Canadian regulators change their strategy, and recognize the combined threat of thousands of home-based counterfeiters over a few single large counterfeit manufacturers, the likelihood of clones appearing everywhere will grow. Let’s not forget that this already happened when the counterfeited music and movies sales shifted from purchasing illegal CD/DVD in a retail location, to downloading them free of charge at home. The regulators have yet to adapt to this new reality, which will repeat itself when counterfeit media players are no longer sold in stores or online, but printed at home by the end-users themselves.
E. Brand Valuation Analysis

“It is not the strongest or the most intelligent who will survive but those who can best manage change” (Darwin, 1882). Organizations that have recognized that brand value has evolved, and adapted to it, are those who can see it materialize in their financial reports. According to Interbrand (bestglobalbrands.com, 2014) the concept of brand value has moved from a safety factor, to a human-centric experience, through four phases:

- **Age of Identity** - "Branding began as a mark of ownership, trust, and quality, and evolved into a more sophisticated symbol of differentiation and identification” (bestglobalbrands.com, 2014);
- **Age of Value** - “Valuable business assets that contribute significantly to financial performance-driving choice, securing loyalty, and affording the owner a premium” (bestglobalbrands.com, 2014);
- **Age of Experience** - “Interactions are seamless, contextually relevant, and increasingly based around creating an ecosystem of integrated products, services, information, and entertainment: both physical and digital” (bestglobalbrands.com, 2014);
- **Age of You** - “Recognize the human in the data, uncover genuine insights, and create a truly personalized and curated experience” (bestglobalbrands.com, 2014).

Apple will be used to perform the brand analysis as it holds the top spot of the brand valuation survey (Table 7.1E). The manufacturer uses a systematic marketing approach where it fulfill the Age of You experience (life improvement tools), the Age of Identity (quality of the product), the Age of Value (loyalty and premium price), and the Age of Experience (iTune ecosystem). The success strategy yields a $118 billion brand valuation.

![Table 7.1E- Top 20 Global Brands](bestglobalbrands.com, 2014)
The question that remains is:

*Can the brand value outweigh the lower acquisition cost of the counterfeit, or the personal satisfaction that comes with making your own product?*

This section will present arguments for and against the brand value, to understand how the desire of owning a genuine product factors in the purchasing decision.

**Impact of Increased Supply of Counterfeit**

In Table 7.1E, we can see that Apple is followed closely by Samsung (ranked 7, with a $45 billion value). Both brands have products that are physically different and have their own features and benefits, giving Apple the opportunity to differentiate its brand and products.

What is not shown in the survey is the impact that a larger number of counterfeits would have on the brand. An increase in the availability of clones could lead to the same situation as the Swiss watch industry, where “Each year some 40 million fake Swiss watches go on sale, which is more than the 30 million authentic Swiss-made watches produced each year” (Simonet, 2014). Gioconda (2005, p51) even warns that “if counterfeiters steal enough of the brand, the value of the brand goes away”.

**After-Sales Support**

As part of their brand value, manufacturers like Apple can promote their after-sales services over those of the counterfeit product. What is noteworthy is the customer’s perceived expectations from the genuine brand. John Larsen, President of New Balance Shoes explains that “If the product fails and the consumer thinks it’s our product and we say no, we’re not going to do anything, then we get the blame: first of all for having a product that failed, secondly for not dealing with it. And thirdly we’ve lost whatever the profits are on the sale of that product originally, and fourthly we’ve lost a customer and any kind of lifetime profits that would result.” (Phillips, 2005, p 61)

**Quality Control**

As the Canon survey warns, the manufacturing quality of components used in counterfeit products is not at par with the genuine item. The end-user might be fooled into thinking that the product is as good, but the marketing campaign from Canon is designed to educate the customers and make them realize that the brand is not only about the product logo, but also the build quality. Quality control is part of the Apple,
Sony and Samsung brands; “fighting against counterfeiting isn’t just about controlling counterfeit products. It’s about letting people see you are in control of quality” (Phillips, 2005, p.161).

**The Brand Should not Work in Lieu of the Product**

Matveyev (2005, p.161) warns that Microsoft should earn “honest money, not easy money”. His statement is based on the poor technical support provided by Microsoft in Russia. His argument is that if the support for the genuine product is inadequate, why would a customer choose to pay more for the original? The brand alone is not enough to sell the product; the product needs to hold its own.

**Copying is the Sincerest Form of Flattery**

Using a universal development board such as the Raspberry Pi, and printing a counterfeit case of the genuine product will most likely cost the same regardless of the product copied. As such the leading brand is more likely to be counterfeited than its competitors. This places companies like Apple in an unfair disadvantage in regards to counterfeiting but opens up the door to a new strategy where they could benefit from counterfeiting by adopting a licensing system. Instead of fighting against counterfeiting, the manufacturer could offer the design under license to end-users, who would opt for this alternative as it gives them the peace of mind of a legal license, and some form of after-sales support. For the genuine manufacturer, the licensing option would generate a lower selling price, but the margins would be offset as the customers handle all the costs of the manufacturing on their side.

**F. Process Analysis**

Process planning is where counterfeiters and genuine manufacturers part ways. Measuring and managing process performances are so critical to a firm’s competitive advantage that it has led to multiple schools of thought, the likes of LEAN, Six Sigma, and Kaizen. Counterfeiters, in contrast, have limited incentive to improve their operational process as they have no fixed deadline, no liability on the product, limited expectations on the product quality, and no distribution channels waiting for a product.

Some Japanese manufacturers use target costing when developing their strategic plan. In this approach, the selling price is known (based on marketing analysis of what the market is willing to pay for a product), and the expected profit is decided in advance. Using such an approach, the manufacturer has an expectation on what the costs should be to meet its target. This is where measuring and planning processes
have the most impact. Any improvement, no matter how small, brings a direct saving that is multiplied by the large production capacity of the genuine manufacturers. Slack, Chambers and Johnston (2010, p 89) propose a set of five strategic performance objectives to extract any potential improvement from the processes. The attributes of quality, speed, dependability, flexibility, and costs are explained below.

**Quality**

- “Quality reduces costs” (Slack, Chambers, and Johnston, 2010, p. 39);
- “Quality increases dependability” (Slack, Chambers, and Johnston, 2010, p. 39).

Higher planning, design and manufacturing quality leads to a product that meets the customer’s expectations, and reduces manufacturing errors. The cost of quality reduces or eliminates the financial and reputational losses of reworks or recalls. For major manufacturers, this has a significant impact that the counterfeiter, producing for himself, does not have to worry about.

Forecast accuracy is one of the leading strengths that genuine manufacturers have over counterfeiters. Their sell-in and sell-through are predictable, and even seasonality is factored in to guarantee that the supply always meets the demand. Having too much inventory comes at a cost, so does missing opportunities because the shelves are empty.

**Speed**

- “Speed reduces Inventory” (Slack, Chambers, and Johnston, 2010, p. 43);
- “Speed reduces risks” (Slack, Chambers, and Johnston, 2010, p. 43).

The ability that genuine manufacturers have to produce a device quickly gives them the opportunity to use a just-in-time process. Knowing the exact production time, and armed with an accurate forecast, the genuine manufacturer does not need to order raw material in advance, which reduces inventory costs. That same production speed ensures that products can be manufactured and shipped as needed, instead of forecasting well in advance, and falling victim to market shifts, where the product is waiting on the shelf while a more appealing alternative renders it unwanted.

The home counterfeiter has no accurate forecasting ability, nor does he need one. When deciding to build a counterfeit media player, he has limited pressure to meet a timeline, other than the anticipation to use it. Additive manufacturing can
easily take hours to print a simple design, which would make it uneconomical to the
genuine manufacturer, but is not a barrier to the home counterfeiter.

**Dependability**

- “Dependability saves time” (Slack, Chambers, and Johnston, 2010, p. 45);
- “Dependability saves money” (Slack, Chambers, and Johnston, 2010, p. 45);
- “Dependability gives stability” (Slack, Chambers, and Johnston, 2010, p. 45).

When using additive manufacturing, the term prototyping is appropriate. Most
beginners are shocked by the time needed to set-up the printing process, in comparison
to the actual fabrication. The time spent on properly preparing the printing process is
because each new part is a prototype, and the information gathered from that specific
print process cannot be applied as is on a part of different dimensions. For example,
running out of plastic filament or filler material in the middle of a fifteen-hour print would
jeopardize the part’s viability. Stopping the printing in progress causes structural
weaknesses, leading to expensive rework. Genuine manufacturers test the process at
length prior to launching the production run, to eliminate these risks. Establishing a full-
proof process before going into production yields the following competitive advantages:

- Precise amount of raw material is known;
- Precise manufacturing time is known;
- Impact of environmental factors on the final part is known;
- Failure rate of the manufacturing tools can be anticipated.

Being able to quantify these attributes gives the genuine manufacturer the ability
to reduce set-up time and costs, and manufacture just-in-time, reducing the inventory
costs and ensuring production capacity standards.

The home-based counterfeiter does not have the luxury of learning from the
manufacturing mistakes as he/she will produce only a single part of a specific model.
The added issue of long printing time compared to injection molding used by genuine
manufacturers is that the counterfeiter will need to monitor the work for the entire
printing process to ensure that it completes without incident.

**Flexibility**

- “Flexibility speeds up response” (Slack, Chambers, and Johnston, 2010, p. 48);
- “Flexibility saves time” (Slack, Chambers, and Johnston, 2010, p. 48);
- “Flexibility maintains dependability” (Slack, Chambers, and Johnston, 2010, p. 48).
Product, mix, volume and delivery flexibility is where the home counterfeiter might have the outmost advantage over the large firms. Indeed, the counterfeiter can make changes to the design at any time, without having to worry about the lost revenues from stopping a production line or the likelihood that the change will impact the demand. Larger organizations are slower to react to change as any process change comes with added costs and risks.

**Costs**

Costs will be discussed further in the financial analysis section, but needless to say that each performance objective listed above is intended to keep costs low, and increases profitability.

**Measuring and Managing Process Performance**

The home-based counterfeiter could, if they chose to, monitor the same operational benchmarks as the genuine manufacturer, but this research paper proposes a situation where the home-based counterfeiter produces a single quantity for himself. In the case of large-scale organizations, the economy of scale means that the marginal level of improvement is proportional to the marginal rate of production, reducing costs over the number of units, when a home-based counterfeiter would probably not notice a 1% time saving on a 15-hour print process.

**G. Financial Analysis**

In the first and second sub problems of this paper, we ask:

- How likely are hackers to share photogrammetric scans and source code freely on the web?
- How likely are customers to use illegal files to clone branded products?

Looking at the BitTorrent phenomenon, no evidence exists to support that the Seeders or the Leechers benefit financially from exchanging illegal files, other than to eliminate their movie rental or movie going costs. Based on this premise, the financial analysis of this section will approach the incentives of creating counterfeit and sharing the information with others, from the point of view that no profit is added in the mix, but instead, the counterfeiter acts as a cost center.
Classifying Costs

In order to understand the cost center approach, the review of the various costs involved in the product lifecycle is presented below:

<table>
<thead>
<tr>
<th>Product Life Cycle Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Costs</strong></td>
</tr>
<tr>
<td>Sunk</td>
</tr>
<tr>
<td>Fixed</td>
</tr>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Planning</td>
</tr>
<tr>
<td>R&amp;D</td>
</tr>
<tr>
<td>Marketing/Sales</td>
</tr>
<tr>
<td>After-Sales Support</td>
</tr>
<tr>
<td>Disposal</td>
</tr>
</tbody>
</table>

Table 7.1G- Product Total-Life-Cycle Costs (Atkinson, Kaplan, Matsumura & Young, 2012, p.302).

Sunk Costs

“Sunk costs are costs that have previously been paid and cannot be recovered” (Thomas & Maurice, 2010 p.99). Table 7.2G shows the initial investment in the counterfeiting tooling which should be seen as a sunk cost.

<table>
<thead>
<tr>
<th>Initial Investment on the Counterfeiter Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Price</td>
</tr>
<tr>
<td>Model Name</td>
</tr>
<tr>
<td>Retailer</td>
</tr>
</tbody>
</table>

Table 7.2G - Counterfeiting Tools Initial Investment (Source: Author).
It may seem odd to invest $800 (Table 7.2G) in tooling to replicate a $219 iPod Touch (Apple.com, 2014), but many hobbyists don’t see the investment as a one-project investment, but rather as a tool that will give them many years of production, to be used on a series of projects.

**Fixed Costs**

According to Thomas and Maurice (2010 p. 99), “Fixed costs are costs that are constant and must be paid no matter what level of activity is chosen”. From the home counterfeiter’s point of view, the fixed costs of counterfeiting are irrelevant, when realizing that the power consumption of a Stratasys Mojo 3D printer is six amperes. Even operating for twenty-four hours at the peak utility charge, this still represents a mere two cents per day (Ontario-hydro.com, 2014). For the internet, most customers who are using portable media players already require speed and capacity for audio and video file download that far exceeds the requirement of 3D files or programmable logic components source code.

**Variable Costs**

Thomas & Maurice (2010 p. 99) warn that the only relevant decision variable in making business decisions is marginal costs and marginal revenues. As explained earlier, the utility costs are insignificant, and must be paid no matter what. The initial investment in the 3D printer and programmable board would not be done if it was only to reproduce one unit as it would be a poor return on investment. We must therefore assume that the initial investment in equipment is a sunk cost regardless of whether or not the media player is built. Therefore, the only relevant cost is the raw material cost. Since the project is based on free source code, the only expense is on the raw plastic filament and filler material used in the 3D printer. Figure 7.3G shows that a 350-meter filament can be purchased for less than $50. This quantity is sufficient to make multiple iPod/Walkman/Galaxy Tab copies.

![Figure 7.3G - Plastic Filament for 3D Printer (Amazon.ca, 2014).](image-url)
Product Planning Costs

Product planning is a cost that the counterfeiter takes away illegally from the genuine manufacturer. The planning includes extensive marketing research to understand the market potential, customer's expectations, manufacturing costs, etc. When the customer elects to counterfeit a genuine product, one can assume that he selected this target model because it is a popular model, which undermines the work that was accomplished by the product planners and marketing strategists.

Research & Development Costs

Looking at the top 20 R&D spenders of 2013 (Table 7.4G, strategyand.com, 2013) the R&D spending of genuine manufacturers is significant: $10.4 billion at Samsung, and $5.7 billion at Sony.

Table 7.4G - Top 20 R&D Spenders (strategyand.pwc.com, 2013).
Apple did not make it to the top 20, but they invested $4.5 billion in R&D for 2013 (Graph 7.5G, Heisler, 2014).

![Graph 7.5G - Apple Annual R&D Spending 1995-2013 (Heisler, 2014).]

According to Kitts, “companies may be reluctant to spend millions of dollars on research when the risk is that all of that investment will be threatened by the work of the counterfeiters.” (Kitts, 2005 p.25). If this happens, the customers investing on the genuine product will suffer, seeing their product stagnant, with long periods before a new model is introduced.

**Sales and Marketing Costs**

When Apple, Sony, or Samsung adopt their pricing strategy, it includes assigning indirect costs such as sales, general, and administrative (SG&A) to each product. This is known as activity-based costing (Atkinson, Kaplan, Matsumura, and Young, p172). The assumption made in this paper is that the home-based counterfeiter will not sell his creation to a customer, but rather, use it himself. The SG&A costs are therefore nil, making it appear less expensive to those who contemplate counterfeiting.

**After-Sales Support Costs**

When a product is sold, part of the selling price includes a provision to support this product for a fixed period, known as the warranty term. The accrued amount
depends on the type of product, its price, complexity to repair, environmental use of the product etc. For example, the warranty costs to support an automobile should be expected to be higher than those of a portable media player: parts are more expensive, the unit needs to be repaired locally, and the chassis is subject to environmental damages.

When it comes to portable media players, due to their price point, many manufacturers find it less expensive to replace the unit than to repair it. The home-based manufacturer does not have to calculate after-sales support costs as he takes on the risk that the product will not last for the time expected, let alone work at all.

The after-sales support costs that counterfeiters save could also become a strategic advantage. Since genuine manufacturers often chose to replace the unit instead of repairing it, those who have issues out of warranty are left with no repair parts, or service center to help; as such, the ability to print your own replacement case, or substitute a defective board for another universal one gives them more flexibility and a longer product life than for the genuine product.

**Disposal Costs**

Disposal costs are imposed on genuine manufacturers. At Sony for example, the environmental initiative includes disposing safely of any product made under its brand, and the manufacturer also accepts products from other vendors. As consumer electronics products become less expensive, the choice to replace them instead of repairing them forces the electronics industry to reevaluate how it can dispose of cell phones, media players, televisions etc. The cost on the industry is taken on by the leading manufacturers, which will most likely refuse to dispose of counterfeit.

The research question presented in this paper does focus on the use of a universal programmable board at the center of the counterfeit. This implies that the Raspberry Pi board used in a media player could be used tomorrow to make a computer, or next week to control a microwave. The flexibility of this component raises a question about re-purposing components. For manufacturers, the use of an identical board would reduce sales of new models, but for the consumer, it would reduce the acquisition costs, and could still be upgraded as new features become available. This question is beyond the scope of this paper, but it is worth asking:

**Will the demand for universal consumer electronics products, with manufacturer-specific source code, force manufacturers to standardize hardware?**
This is already seen in the computer industry, where the IBM clones were built by multiple vendors, around standard electronic boards; the selling price and physical appearance were the only obvious differentiators between manufacturers.

*Is the Cost Worth it?*

As will be shown in the next section, the leading motivation to purchase, or make counterfeit is a social one. If financial reward is secondary, it could be said that the counterfeiter can accept financial losses on the counterfeit venture, as long as his main income is sufficient to cover the expenses of the tools needed to counterfeit. If that is the case, using poor return on investment as an argument to convince counterfeiters to purchase the genuine product would bear little weight.

**H. Human Resources Analysis**

According to Pfanner (2010), “95 percent of all music downloaded via the Internet, worldwide, is pirated”. Of special interest, “two-thirds of college students who download music do not care whether the music is copyrighted” (Intellectual Property Institute, 2006). This corroborates the Canon survey that shows that millennials are most likely to purchase a fake. Using illegal content is not an isolated event, and understanding why people are driven to copy illegal content falls under this human resources analysis section.

**Theory of Needs**

Chapter VI has shown, through the regression analysis of Sheehan, Tsao, & Pokrywcynski (2012, p 310), that college students share illegal content first and foremost for social reasons. When transposing these results on Maslow’s hierarchy of needs (1998) (Graph 7.1H), we realize that counterfeiting fills the needs of belongingness, esteem, and self-actualization that Maslow qualified as psychological, and self-fulfillment needs. Since counterfeiting fulfills the needs of the highest three echelons of the pyramid, we can see how much weight the human factors have in regard to this paper’s first sub problems:

- How likely are hackers to share photogrammetric scans and source code freely on the web?
- How likely are customers to use illegal files to clone branded products?
When sharing illegal content with peers, the counterfeiter feels a sense of belonging. The collection utility described by Sheehan, Tsao, & Pokrywcynski, (2012, p. 310) as the gratification from having a larger media collection (latest music, films, games, software or even source code) fills the esteem need that comes with having the largest database.

As for self-actualization, it explains why someone would go through the trouble of hacking a genuine mobile media player to extract the code. The gratification of knowing that it can be done, and that he himself was the one to crack the code, is in direct relation with the growing trend of hobbies, and why self-help tutorials are ever growing on YouTube. End-users might not need to renovate their home themselves, create their own Hackintosh (a counterfeit version of an Apple Macintosh), or change their car brakes, but they choose to do so because of the self-actualization that comes with knowing that it can be done.

**Graph 7.1H - Maslow’s Hierarchy of Needs Pyramid (Maslow, 1998).**

- **Physiological Needs:** Food, Water, Warmth, Rest
- **Safety Needs:** Security, Safety
- **Belongingness and Love Needs:** Intimate Relationships, Friends
- **Esteem needs:** Prestige and Feeling of Accomplishment
- **Self-Actualization:** Achieving one’s full Potential,
The satellite hacking phenomenon discussed in Chapter VI (Section C) is evidence of this need for self-actualization. Many went through the expensive and painstaking process of learning how to source the tools needed to hack (satellite receiver, and source code) but even more important, these hackers had to learn how to solder, and risk destroying a new programmable receiver, in large part to prove that they could do it. The satellite hacking phenomenon is important in regard to the research paper question as it was the first wide-spread situation where customers mixed off-the-shelf programmable logic boards, social media, and illegal file sharing, to make a counterfeit that had the same features and benefits as the genuine receiver. The only missing link to this paper’s question is the additive manufacturing, to replicate the receiver’s form factor and appearance. 3D printing was not readily available in the glory days of satellite hacking, which might explain why creating a clone of the receiver’s chassis was overlooked by counterfeiters.

Peer Pressure

Peer pressure, or the impression that making your own iPod, Walkman, or Galaxy Tab is the cool thing to do should not be overlooked when analyzing the likelihood of home-based counterfeiting becoming a trend. James (2012) proposes that “college students' risky behavior is reinforced by the feeling that others are taking similar risks or by the perception that the risks are socially desirable”.

Deterrent

If social motivation is the reason why a counterfeiter feels the need to share illegal content, what would prevent him from doing so? The traditional approach used by regulators is to focus on arguments that would scare the counterfeiters away. These include:

- Risks of getting arrested;
- Risks of getting fined;
- Risks of being denounced publically;
- Risks of infecting your computer with viruses;
- Risks of being turned down for future employment.
In the third phase of their anti-counterfeiting study, Sheehan, Tsao & Pokrywczynski (2012) evaluated these risks, and identified that the leading two successful marketing messages to counteract illegal file sharing were:

- The risk of infecting the download computer with malware, spyware, and/or viruses;
- The risk that illegal downloading could jeopardize your hiring chances.

The marketing ads used for the field study are shown below (Figures 7.2H and 7.3H):

![Marketing Ad 1](image1.png)

**Figure 7.2H - Anti-Piracy Campaign Sheehan, Tsao & Pokrywczynski (2012, p.320).**

![Marketing Ad 2](image2.png)

**Figure 7.3H - Anti-Piracy Campaign Sheehan, Tsao & Pokrywczynski (2012, p.321).**

Of course, countless Hollywood movies have been made on the premise that the most astute hackers are hired by security firms to put their unique skills to good use. This would go against the theory that hacking could prevent an applicant from employment, but the real cases of hackers turned security experts are exceptional, and do not seem to influence the results.

What is even more significant is that even if these two campaigns were successful, the most active downloaders still did not respond to them. According to the social cognitive theory (SCT), “behavior having a positive outcome is likely to be repeated. Likewise, negative outcomes lead to reduction or elimination of the behavior. Importantly, SCT suggests that positive or negative outcomes can be socially observed" (Bandura, 1971).
The Social Cognitive Theory shows us that unless the hacker falls victim to the threat, or sees someone else succumb to it, he is likely to continue sharing illegal content with others. This is why the risks of a virus or of threatening employment are more successful; viruses are widely expected, making the threat real, while the loss of employment is difficult to disprove as an illegal downloader would most likely not document that he was turned down for a job because he/she acted illegally. The threat from arrest, fine, or public outing is low, as the Canadian regulators, led by the RCMP, focus their limited resources on the larger organizations rather than on the home-based counterfeiters.

**Education/Training**

The Canon anti-counterfeiting survey (Canon.com, 2014) indicates that “almost 1 in 4 (millennials) unknowingly buys one (counterfeit)” (Figure 7.4H).

![Figure 7.4H. - Millennial Versus Baby Boomer Survey Results (Canon.com, 2014).](image)

When it gets to education, one could expect that the knowledge available from the internet would increase the level of awareness about what is genuine versus counterfeit, but the survey shows that this increased knowledge also brings a false sense of confidence. The instances of internet scam, known as the *Spanish prisoner* scam (Giddens, 2014, CBC.ca) are on the rise, proving that more information does not directly lead to more protection.

One humorous situation depicting that a large pool of customers can be fooled into thinking that a counterfeit is genuine happened in Russia, during the Soviet era. According to Phillips (2005, p160), “families for many years got the chance to watch Disney’s Snow White and the Seven Dwarfs, which State TV had acquired from a poor-quality pirated tape filmed in the West. A generation of Russians grew up believing that the time code in the top corner, a series of numbers showing how much of the film had elapsed, was part of the authentic Disney experience. When a genuine copy was shown on Russian TV for the first time, scores of viewers complained that it couldn’t be real because they couldn’t see the little numbers".
When looking at the counterfeit market growth, from the stance that customers are unknowingly purchasing a fake, training does offer a better return on investment than trying to police the distribution channels. The same training approach can be duplicated regardless of the product, whether it is a fake Canon battery, or a pirated Disney copy.

Financial Incentive

When looking at the financial incentive (economic utility), we can certainly include the perceived notion that a counterfeit is less expensive than the genuine product. It is interesting to note that based on the study of distinction, “human beings tend to over-estimate the value of something that can be quantified, whilst under-stating the value of something that cannot.”(Bhattachary, Francas, Kyriakopoulos, Patel, & Puri, 2013, p.12).

In Chapter VI (section C) of this paper, the Hackintosh phenomenon was used as an example of counterfeit. When looking at the motivation behind making a Hackintosh instead of purchasing a genuine Macintosh, most online reviewers claim a significant cost saving.

<table>
<thead>
<tr>
<th>Hackintosh</th>
<th>Mac Pro</th>
</tr>
</thead>
<tbody>
<tr>
<td>$64.99</td>
<td>$293.99</td>
</tr>
<tr>
<td>Intel i5 4670K 1150 3.40GHz Quad-Core</td>
<td>Intel Xeon E5 3.70GHz Quad-Core</td>
</tr>
<tr>
<td>$18.99</td>
<td>$118.99</td>
</tr>
<tr>
<td>Gigabyte H87M-WIFI</td>
<td>Proprietary Apple MB</td>
</tr>
<tr>
<td>$154.99</td>
<td>$154.99</td>
</tr>
<tr>
<td>Viper 16GB DDR3 Dual Kit</td>
<td>32GB DDR3, 1866MHz</td>
</tr>
<tr>
<td>$144.99</td>
<td>$144.99</td>
</tr>
<tr>
<td>ADATA 256GB SSD</td>
<td>356BG Flash Storage</td>
</tr>
<tr>
<td>$259.99</td>
<td>$259.99</td>
</tr>
<tr>
<td>Gigabyte GeForce GTX 760 WindForce</td>
<td>Dual AMD FirePro D300 graphics processor</td>
</tr>
<tr>
<td>$69.99</td>
<td>$114.99</td>
</tr>
<tr>
<td>Antec Kuhler H20 650</td>
<td>CPU Air Cooler</td>
</tr>
<tr>
<td>$89.99</td>
<td>$299.09</td>
</tr>
<tr>
<td>EA-550 Platinum</td>
<td>450 Watts PSU</td>
</tr>
<tr>
<td>$1,143.92</td>
<td>$2,099</td>
</tr>
</tbody>
</table>

*Table 7.5H – Hackintosh Versus Mac Pro Comparative Table (Kahney, 2014).*

The numbers presented can be misleading. Most reviews compare units with different types of hardware (Table 7.5H). Even if the end-user experience when
operating the software appears similar, the performances and features of the counterfeit unit are different from the genuine product. When comparing a Hackintosh using the same configuration as the genuine Apple model, reviewers admit that the cost saving is negligible. The economy of scale that Apple possesses gives them negotiating power with their suppliers, that counterfeiters simply do not have.

The Hackintosh cost comparison presented also does not take into consideration the labour cost of building, troubleshooting, and perfecting the clone. If a counterfeiter loses one day of work to build his own counterfeit, the lost salary should be factored in the overall cost of acquisition; this is called opportunity cost.

Moving to illegal file download, it should be noted that little evidence exists to prove that Seeders contributing data on BitTorrent receive any form of financial compensation. This is a significant point as the arrival of high-speed internet and inexpensive storage is shifting the counterfeiting from large organizations (selling illegal copies on CD/DVD), to a series of independent users, downloading pirated files, at no cost, from home.

Back when physical media were used to carry counterfeit files, it was easier for people to profit from the sales. It was oftentimes associated with terrorist organizations using it as a source of funding. In his book *Knockoff the deadly trade in counterfeit goods*, Phillips (2005) provides many examples, one of which is from a Tchechen sympathizer, who financed the acquisition of weapons from his $500,000-$700,000 monthly sales of pirated CDs.
The Threat of Home-Based Counterfeiting on the Electronics Industry

I. Ethics Analysis

The stigma of organized crime and terrorism is not what first comes to mind when thinking of a college student downloading illegal music on his/her laptop. Perhaps the shift from buying pirated media in a parking lot, to downloading illegal content in a living room, gives the users a false sense of legitimacy. Assuming that the counterfeiter is no longer the terrorist group, but instead a college student, it seems fit to evaluate if human nature, and ethics have adapted to the new perpetrator.

Ethical Dilemmas

Of particular importance when looking at the ethical dilemmas of purchasing counterfeit, is the number of jobs lost in the movie industry, as reported by the Institute of Policy Innovation (IPI, 2007):

- More than 70,000 jobs in the recording industry and the loss of associated wages (Sheehan, Tsao, & Pokrywcynski, 2012 p. 309);
- Loss of more than 26,000 jobs that would have been added in the recording industry (or downstream retail industries) (Sheehan, Tsao, & Pokrywcynski, 2012 p. 309);
- Loss of 40,000 plus related jobs that a digital-piracy-free music business would have added to other U.S. industries (Sheehan, Tsao, & Pokrywcynski, 2012 p. 309);

To this list, we can add other ethical implications on the businesses which would impact the various stakeholders identified in Chapter VII (Section B):

- Financial losses from the media players sales lost to counterfeit;
- Loss of jobs to offset decreased sales;
- Forced plant closure (financial and social impact on the local community);
- Reduced incentive to invest in R&D, leading to exodus of engineers from the field;
- Surplus of engineers - academic program termination;
- Forced focus on short-term survival plans rather than on long-term sustainability of the firm;
- Less financial revenues to allocate to CSR.
Ethical Responsibility

The question of responsibility is murky at best when the counterfeiter is also the end-user, and owner of the firm. In a traditional corporation, the governance is well established, and the senior executives can be held liable for the action of their subordinates. As such, they must spearhead the corporate ethical program of the firm to eliminate any use of illegal content.

The most well-known form of liability on the senior executives is probably the Sarbanes-Oxley act (2002), which “requires that the CEO and CFO of a publically owned company certify the accuracy of the financial statements” (Fraser & Ormiston, 2010, p.16). The financial aspect of the firm is not the only area where the senior executives can be held liable, other regulations are in place to prevent the use of unlicensed software as well.

Media, software, source codes, circuit topography, are all types of works which can be protected under the copyrights law established under the Berne act of 1886 (updated in 1998). “Copyright laws protect the copyright holder, leaving the organization responsible for proving compliance” (IAITAM, 2012, p.34). Most large organizations have dedicated certified software asset managers (CSAM), whose responsibilities include proving compliance, but when it gets to the home-based counterfeiter, the ethical responsibility rests on the shoulders of a single individual. Even if that individual wanted to assess the end-user license agreement, should we expect him to understand the copyrights intricacies that CSAMs take years to master?

Environmental Impact

The environmental impact of established genuine manufacturing is well known. One could argue that the environmental claims of large firms are simply a ploy to appeal to shareholders through a form of corporate social responsibility (CSR), but reducing the environmental footprint comes at a higher cost, proving that they are willing to back-up their promises by investing the funds necessary to do so.
When looking at the environmental messages posted on the corporate websites of the three leading manufacturers of mobile electronics media players, we can see that their focus extends well beyond reducing the emissions caused by the manufacturing process (Figures 7.1I to 7.3I).

Figure 7.1I - Apple – Environmental Responsibility Message (Apple.com, 2014).

Figure 7.2I - Sony – Environmental Sustainability Message (Sony.net, 2014).

Figure 7.3I - Samsung Corporate Citizenship (Samsung.com, 2014).
The environmental claims (Figures 7.1I to 7.3I) show that these established manufacturers take a proactive role in reducing the environmental impact at each step of the product life-cycle, including disposal. The home-based counterfeit industry, in contrast, has no incentive to invest on the environmental sustainability. The counterfeiter himself is the shareholder and customer, making him the sole driver of that ethical responsibility.

Even though we could suspect that most counterfeiters would pay little attention to the environment, the simple fact that the manufacturing is done in close proximity to the customer has a different set of environmental impacts than the centralized model. Table 7.4I shows that some unexpected advantages mitigate the lack of incentive to make a sustainable product.

<table>
<thead>
<tr>
<th>Environmental Impacts of Home-Based Counterfeiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
</tr>
<tr>
<td>• Less shipping footprint</td>
</tr>
<tr>
<td>• Less packaging to dispose of</td>
</tr>
<tr>
<td>• Some of the electronic assemblies can</td>
</tr>
<tr>
<td>be repurposed in future designs</td>
</tr>
<tr>
<td>• Plastic can be melted and repurposed</td>
</tr>
</tbody>
</table>

*Table 7.4I - Environmental Impact of Counterfeiting (Source: Author).*
VIII. Discussion

A. Corporate Strategy

Now that the individual analysis of the economic, legal, brand, process, financial, human, and ethical aspects has been presented, we can move on to the last subproblem of this research paper:

*How and why should manufacturers safeguard their intellectual property?*

As part of this question, the senior executives of the firm first need to decide in what industry and market it should compete. Sometimes exiting a market is a better strategic decision than competing where the number of competitors is growing, product differentiation is unclear, and profit margins are eroding.

Atkinson, Kaplan, Matsumura, and Young (2012, p26) propose that senior executives make these strategic decisions based on the well defined balanced scorecard framework, which rests on four fundamental pillars:

- Financial perspective;
- Customer perspective;
- Process perspective;
- Learning and growth perspective.

In 2005, “there were 870 million illegal music files” (Phillips, 2005 p 112); this statistics reveals the global scope of the problem. With close to a billion illegal music and video files moving on the web, it would be naïve to assume that photogrammetry files, or programmable logic devices source code would not suffer the same fate. These files are smaller than a regular-length movie, and can be opened on software that is already available on the same social media portals as the latest music track, or feature film.

This form of threat might be new to some organizations, but thankfully, the strategic management frameworks that have been used for years to formulate a competitive strategy can be adapted to the new threat from home-based counterfeiting.
B. Porter’s Five Competitive Forces

The first step in formulating a strategic plan is for the genuine electronics manufacturer to understand where the threat is coming from. Porter’s five competitive forces framework (2008) will position these threats in regards to Apple, Sony, and Samsung.

Graph 8.1B – Porter’s Five Competitive Forces Framework (Porter, 2008, p.80).
Rivalry Amongst Existing Competitors

When looking at rivalry amongst existing competitors, Apple is at the top of most Internet searches with Samsung and Sony far behind. These three companies have been rivals for many years but their product offering can easily be differentiated in its form factor, features and benefits.

Threat from New Entrants

Figure 8.2B is taken from the leading consumer electronics retailer BestBuy. When searching for portable media player, an impressive twenty-six brands are found, highlighting the fact that the competitive landscape has changed from the traditional Japanese and Korean offering. Of these new entrants, chances are that most readers will only recognize one third.

The shift to using off-the-shelf programmable logic components has eliminated the barrier to entry. New entrants can re-use source code that is publically available to create a competitive offering, with limited investment in research and development.
Threat from Substitutes

The most common substitute of the portable media player is undeniably the mobile phone. Even if these phones can be used as stand-alone media players, this research paper excluded them from the analysis as their normal operation requires access to a wireless network. The requirement to breach an encrypted network to prove the research question is beyond the scope of this paper, but it might also provide some form of deterrent against counterfeiting. By offering value added content on wireless networks, providers such as Rogers, Bell, and Telus, can lock the customer into a complete solution, eliminating the risk of counterfeiting. In many cases, the telecommunication provider subsidizes the cost of the phone, in exchange for the customer’s loyalty (long-term contract). This corporate strategy focuses on the service ecosystem, where the customer sees value in the content, over the device used to reach this content.

Online audio streaming is also threatening the consumer electronics industry. The days of bringing a Walkman at the office are long gone, when most employees can use their office computer to stream their favorite music while they work.

Bargaining Power of Suppliers

By switching their design to off-the-shelf programmable logic devices, manufacturers make a choice to forgo their own production facility to a component that is used by most manufacturers and new entrants. Xilinx and Altera are the two leading vendors of these programmable devices (Chart 8.3B).

![Chart 8.3B - PLD Market Segment Share (Xilinx, 2013).](chart)
Since most components manufactured by Xilinx and Altera use similar architecture (with various degrees of processing power) even if a product shortage was to be encountered, the electronics manufacturer would have the option of changing supplier or component model within that supplier’s model mix.

A risk exist that Xilinx and Altera, as lead contenders, would artificially keep the price up through an illegal practice known as price-fixing. It is important for consumer electronics manufacturers to lobby the regulators for continuous audits preventing this.

From a physical assembly perspective, the genuine manufacturers use a process known as injection molding. In this process, the plastic used arrives in its raw form and can be obtained from many suppliers. In the case of counterfeiters, the use of additive manufacturing forces them to purchase already extruded plastic filament, supplied by a limited number of vendors, most of which cater to the hobby market. The bargaining power of suppliers toward the home-based counterfeiter is obvious when we see the purchase price difference: “A mass manufacturer using plastic injection molding might buy ABS in bulk for about $2 a kilo, but filament for 3D printing can cost as much as $80 a kilo” (economist.com, 2013).
**Bargaining Power of Buyers**

The top twenty-five most visited websites in the world are search engines, social media portals, and online sales (Alexa.com, 2014). Amazon.com and Taobao.com share the seventh and eight positions respectively (Table 8.4B) while Apple is the only manufacturer to make it in the top one hundred (35th position).

<table>
<thead>
<tr>
<th>Rank</th>
<th>URL</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Google.com</td>
<td>Search Engine</td>
</tr>
<tr>
<td>2</td>
<td>Facebook.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>3</td>
<td>Youtube.com</td>
<td>Video Sharing Portal</td>
</tr>
<tr>
<td>4</td>
<td>Yahoo.com</td>
<td>Social Networking, and Search Engine</td>
</tr>
<tr>
<td>5</td>
<td>Baidu.com</td>
<td>Search Engine</td>
</tr>
<tr>
<td>6</td>
<td>Amazon.com</td>
<td>Online Sales</td>
</tr>
<tr>
<td>7</td>
<td>Wikipedia.org</td>
<td>Online Encyclopedia</td>
</tr>
<tr>
<td>8</td>
<td>Taobao.com</td>
<td>Online Sales</td>
</tr>
<tr>
<td>9</td>
<td>Twitter.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>10</td>
<td>Qq.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>11</td>
<td>Google.co.in</td>
<td>Search Engine</td>
</tr>
<tr>
<td>12</td>
<td>Live.com</td>
<td>Search Engine</td>
</tr>
<tr>
<td>13</td>
<td>Linkedin.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>14</td>
<td>Sina.com.cn</td>
<td>Social Networking, and Search Engine</td>
</tr>
<tr>
<td>15</td>
<td>Tmall.com</td>
<td>Online sales</td>
</tr>
<tr>
<td>16</td>
<td>Weibo.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>17</td>
<td>Yahoo.co.jp</td>
<td>Search Engine</td>
</tr>
<tr>
<td>18</td>
<td>Blogspot.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>19</td>
<td>Ebay.com</td>
<td>Online sales</td>
</tr>
<tr>
<td>20</td>
<td>Hao123.com</td>
<td>Social Networking, and Search Engine</td>
</tr>
<tr>
<td>21</td>
<td>Yandex.ru</td>
<td>Search Engine</td>
</tr>
<tr>
<td>22</td>
<td>Vk.com</td>
<td>Social Networking</td>
</tr>
<tr>
<td>23</td>
<td>Google.de</td>
<td>Search Engine</td>
</tr>
<tr>
<td>24</td>
<td>Bing.com</td>
<td>Search Engine</td>
</tr>
<tr>
<td>25</td>
<td>Adcash.com</td>
<td>Online Advertising</td>
</tr>
</tbody>
</table>

*Table 8.4B – Top 25 Most Visited Websites in the world (Alexa.com, 2014).*

Looking at the statistics, it becomes clear that customers are more likely to choose a product on Amazon or TaoBao than to go to the manufacturer’s website. By reaching a website that has all the competitive products, including counterfeit, the customer is exposed early in the decision process to a wide range of products and prices. This visibility to alternatives shifts the bargaining power from the vendor to the customer.
While Amazon and TaoBao specialize in finished goods, BitTorrent is the marketplace offering the end-users all the resources to make their own clone. By publically offering 3D photogrammetry files and source code, BitTorrent gives an alternative to end-users, who no longer feel compelled to pay for the genuine article. What makes matters worse is that the end-user is presented with an incomplete portrait of the product cost, based solely on assembly parts. Without factoring the entire product life cycle cost, the customer underestimates the product’s real value, and will insist to get a lower price.

C. External Environment (DEPEST)

Studying the macroenvironment helps understand the firm’s external environment, more specifically how external stakeholders can threaten the genuine manufacturer, or offer opportunities to compete. The use of the DEPEST framework (Wood, 2011, p.28) goes through a methodological scan of the demography, economy, politic, environment, society, and technology.

Demographic

- Younger generation more accepting of counterfeit (Canon, 2014);
- Baby boomers are more careful about the source of the product (Canon, 2014);
- Younger customers are faster to embrace new technologies (photogrammetry and additive manufacturing);
- Younger customers are well-versed in the use of social media.

Economic

- After-tax income is increasing, generating more demand for portable media players;
- Financial comfort brings disposable income to spend on hobbies (such as 3D printers and programmable development boards);
- Price decrease of counterfeiting tools makes them affordable to a wider range of customers.
The Threat of Home-Based Counterfeiting on the Electronics Industry

**Political - Legal**

- Regulators unprepared to control the web;
- Elected officials will not sacrifice vote over regulation of what people do on the net;
- Whom do we go after? The big players or the millions of counterfeiters?
- Court system is not set to handle the volume of cases if individuals are prosecuted.

**Ecologic – Environmental**

- Lower shipping and packaging environmental footprint from home-based counterfeiting;
- Less material waste from home-based additive manufacturing over traditional methods;
- Increased spread of unregulated and unmonitored gas emissions from home-based additive manufacturing;
- Increased risks of dangerous material disposal (filler material residues from home-based counterfeiting);
- Genuine manufacturers will object to dispose of products that are not theirs, even if the government mandates it;
- Reduced electronic board disposal as it can be reprogrammed, and repurposed in the next counterfeit model.

**Social - Cultural**

- Attitude shift toward counterfeit;
- Social media is everywhere;
- False sense of privacy;
- Sense that if everyone is doing it, it is fine;
- Sense that the government cannot arrest everyone;
- Customer expects a new design every couple of months (not enough time for the manufacturer to recoup costs);
- Shareholders want profit at all costs.
The Threat of Home-Based Counterfeiting on the Electronics Industry

Technological

- Increased access to enablers (printer, scanner, source code, and PLD);
- Social media becomes a vehicle for file, resources, and knowledge access;
- Online ordering system (PayPal) isolates the seller and buyer, safeguarding the anonymity of the stakeholders.

D. SWOT Analysis

Now that the genuine manufacturer's internal and external environments have been established through multiple frameworks and management domains, it is time to compile the arguments into a comprehensive table, using the strengths, weaknesses, opportunities, and threats (SWOT) framework (Porter, 2008, p. 80).

<table>
<thead>
<tr>
<th>SWOT Analysis</th>
<th>Counterfeiters</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths</td>
<td>Small, Flexible, Invisible, Not subject to regulation, No license to pay, No copyright to pay, Immune from tax, No brand valuation risk, Can modify the design to meet specific features and benefits of a single user, Use less raw material (additive manufacturing)</td>
<td>Economy of scale (raw pellets), Brand value (customer wants the product), Offers a full in-store purchasing experience (Walking out of the Apple store with a bag…), Large human resources, Large financial resources, Large capital (tooling) resources, Established distribution channels, Experience with patent copyrights, Have the law on their side, Already have copyrights, Have established CSR initiatives</td>
</tr>
</tbody>
</table>
### Weaknesses

<table>
<thead>
<tr>
<th>Counterfeiters</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Limited human resources</td>
<td>• Slow to react</td>
</tr>
<tr>
<td>• Limited capital resources</td>
<td>• Tied to the legal court system (slow, expensive, negative impact on brand valuation)</td>
</tr>
<tr>
<td>• Limited financial resources</td>
<td>• Design based on compromise, to reach the expectations of the widest market</td>
</tr>
<tr>
<td>• Need to operate without attracting attention</td>
<td>• Additional cost linked to the product disposal</td>
</tr>
<tr>
<td>• Asking for help on forums attracts attention</td>
<td>• Use more raw material (subtractive manufacturing)</td>
</tr>
<tr>
<td>• No legal support</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Private assets linked to liability (they could lose their house)</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• No distribution channel</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Pay much more for raw material</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

### Opportunities

<table>
<thead>
<tr>
<th>Counterfeiters</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Access to all enablers</td>
<td>• Extra revenues through licensing scheme</td>
</tr>
<tr>
<td>• Can experiment until it works (no market pressure)</td>
<td>• Counterfeiters used to survey the customer’s opinions (Manufacturer can invest on R&amp;D based on the improvements made by counterfeiters on their copies)</td>
</tr>
<tr>
<td>• Lower price point generates sales</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Counterfeit perceived as good enough</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Counterfeit perceived as better deal</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Social bias against large firms</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Demand for customized versions of branded products</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

### Threats

<table>
<thead>
<tr>
<th>Counterfeiters</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased power of data mining (activity on forums and keywords can be tracked)</td>
<td>• Availability of 3D printer, 3D files, and source code on social media</td>
</tr>
<tr>
<td>• Collaboration between Internet service provider and the authorities</td>
<td>• Availability of tutorials</td>
</tr>
<tr>
<td>• Denunciation by the public</td>
<td>• Brand impact (if customers build the same for less money, is the big guy greedy?)</td>
</tr>
<tr>
<td>• Social pressure to have the “real” product</td>
<td>• Stock price valuation (if it is easily imitable, is the company at risk?)</td>
</tr>
<tr>
<td>• Plateau in the development of 3D printers</td>
<td>• Counterfeit market leads to new commercial entrants</td>
</tr>
<tr>
<td>• Cost escalation of raw material</td>
<td>• Some manufacturer could covertly leak a competitor’s designs to increase counterfeit against them and impair their sales</td>
</tr>
<tr>
<td>• Government audit of tax receipt</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Government audit of gas emission</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Government audit of power consumption</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

*Table 8.1D - Strengths, Weaknesses, Opportunities and Threats Analysis (Porter, 2008, p.80).*
IX. Recommendations

A. Overview

This research paper asked the question:

*Can the combination of photogrammetry, additive manufacturing, programmable logic, and social media into a unified product acquisition cycle, eliminate the barrier to entry and provide the tools needed by the end-users to take on the manufacturing themselves, and as such, create a viable threat against the established firms?*

From this, four sub problems were presented:

1. *How likely are hackers to share photogrammetric scans and source code freely on the web?*
2. *How likely are customers to use illegal files to clone branded products?*
3. *How successful would customers be in cloning devices?*
4. *How and why should manufacturers safeguard their intellectual property?*

The Results section (Chapter VI) has confirmed that the resources needed to counterfeit a product at home are available. It is no longer a question of likelihood; it is already done, and documented through the Hackintosh and Raspberry Pi examples.

The counterfeit might not be identical in every aspect, but having the same appearance or offering the same graphic user interface appears to fulfill the desires of customers.

In the Analysis section (Chapter VII), the motivation factors were reviewed to understand why a customer would choose to manufacture his/her own counterfeit instead of purchasing a genuine product. The results gathered show that the social motivation trumps the economic value. Maslow’s theory of needs confirms that the desire for self-fulfillment outweighs the high cost of purchasing the equipment, the high risk of failure, and the lack of support.

The Discussion section (Chapter VIII) focused on assessing the impacts of this counterfeit threat on the established manufacturers. The SWOT analysis (Table 8.1D) gave a wide view of the factors influencing the firm’s internal strengths and weaknesses, in relationship to the external environment threats and opportunities. This
visual roadmap becomes the chart needed by senior management to steer the organization's corporate strategy away from the risks, and navigate toward a long-term successful strategy.

Based on the results, this research paper proposes four management strategies to build competitive advantage against the new reality:

I. Prevent counterfeiting (stop it from happening by focusing on enforcement);
II. Use a differentiation strategy to position the genuine product as superior to the counterfeit;
III. Adopt a different pricing strategy, making it less appealing for counterfeiters to spend time and resources on a counterfeit that costs close to the genuine article;
IV. Accept the counterfeiting, but regulate it by offering a chargeable home-builder alternative to those who want to create their own unit out of self-actualization.

B. Prevent Counterfeiting

The first recommendation is to keep the status quo. The current approach is to investigate, and seize counterfeits. In France, single users can be prosecuted, based on their zero-tolerance policy, but in Canada, the RCMP elects to assign its limited resources to the top of the organization. This excludes the model where large organizations no longer control the counterfeit industry, but instead, there is no true leader, as the counterfeiting is becoming a wide-spread cultural phenomenon. In this option, the following actionable items are proposed:

- Give more legal power to the regulators (CACN.ca, 2011 p. 3);
- Provide more training to the enforcers (CACN.ca, 2011 p. 3);
- Give more financial resources to the regulators by allocating the profit seized from the crime back to them (CACN.ca, 2011 p.4);
- Make the intellectual property law clear and in layman’s terms (CACN.ca, 2011 p.3);
- Track raw material usage to find where the counterfeit locations are;
- Increase advertizing effort in anti-counterfeiting campaigns, focusing on the risks from being contaminated by viruses, or of being turned down for employment, as proposed by Sheehan, Tsao, & Pokrywczynski (2012).
C. Product/Service Differentiation

The product/service differentiation strategy adopts a more proactive view, where it sees the counterfeiter in the same way as another competitor. In this approach, the focus is to provide a genuine article that offers more value to the customer than the counterfeit. Some of the recommendations include:

- Move from product sales to solution (the service provider offers content that is only available to its subscribers, as long as they use the bundled phone, or media player);
- Process improvement (reducing manufacturing costs to where the counterfeit is simply no longer competitive);
- Accelerate the research and development cycle (customers will prefer to purchase the new unit than to wait for the new source code to be posted);
- Channel strategy (offering the product in additional distribution channels, making it more convenient than sourcing raw material);
- Marketing communication and influence strategy (develop loyalty to the brand, and pride of owning the genuine product).

D. Pricing Strategy

The pricing strategy is a dangerous alternative. It is oftentimes the last resort used by a manufacturer to regain market share. The risks are that, once the product is offered at a lower price, customers will come to expect it to be the new value of the product. It can reduce the perceived value of a luxury product, and force the competition to offer even lower pricing.

If a limited number of competitors exist, one could hope to maintain the low-price strategy long enough for the other players to exit the market, but with twenty-six brands of media players (BestBuy, 2014), this will not happen. The traditional pricing strategy includes:

- Lower the selling price of the product;
- Increase sales performance incentive funds (SPIFs) to entice dealers to carry inventory, and force them to sell it (loading the dealer market to show sales to shareholders);
- Remove the after-sales support (warranty) to lower the price (similar to the counterfeit which has no warranty);
- Eliminate the dealer network and sell directly to reduce SG&A costs.
E. Regulate Counterfeiting

This last approach is as unusual as the home-based counterfeiting reviewed in this research paper. Instead of policing the counterfeiters, the strategy proposes to adopt a licensing model. The genuine manufacturer would offer a homebuilder’s kit that counterfeiters could use to create a genuine unit. This would provide end-users with a less expensive alternative than the store-bought unit, and fulfill the social needs of homebuilders to create their own.

The kit price would be positioned lower than the assembled unit, as the homebuilder takes on the labour and capital (tools) needed to duplicate the unit. The price would include some form of homebuilder’s support, which would be the added value to justify the purchase cost. Restrictions would be placed on the license to ensure that it is used for home/personal use only.

The general aviation industry has adopted this model, where many manufacturers of turn-key aircrafts also offer plans, materials kits, basic kits, and prebuilt kits. This has proved quite popular with those who cannot afford to spend a lump sum on an airplane. The satisfaction to build the product by oneself fulfils the self-actualization need that Maslow proposed at the top of his pyramid, and that Sheehan, Tsao & Pokrywczynski (2012) confirmed in their study.

F. Leading Recommendation

Cutting-edge problems deserve out-of-the-box solutions. This is the case of the research question presented in this paper. Keeping the status quo and policing the counterfeit is not proving successful, as the trend of counterfeiting is on the rise. The pricing strategy is not a viable option either, as it is a last attempt to generate short-term gains.

This leaves us with the product/service differentiation, and the counterfeiting regulation model (licensing). One does not prevent the other. Creating a new product and services in the form of a kit is a novel idea which offers product differentiation. It can be marketed as an alternative solution to expand the value proposition. It shows that the manufacturer understands the “Age of You” brand revolution (Interbrand, 2014). Recognizing that customers are excited at the idea of learning new things, assembling their own product, and understanding what goes into making what they use is a long-term strategic plan.
This homebuilt licensing model might be unheard of in the consumer electronics industry, but it has caught up in other well-known fields:

- Home remodeling (with specialty channels such as Home and Garden Television, and self-help seminars in home improvement stores, the do-it-yourself trend is growing);
- Cooking (from the Food Network to YouTube tutorials, many feel that they can become great chefs);
- Programming (Microsoft offers its Visual Studio programming environment free of charge as it recognizes the interest of would-be programmers to develop their own programs and apps);
- Auto mechanics (multiple TV shows and YouTube tutorials, show that doing basic maintenance on your car is possible).

The product/service differentiation would be further leveraged if these homebuilders were targeted directly in an advertisement campaign. A special product logo could even be offered to them, to show that they are brand experts, giving them the pride of being seen with the limited edition status symbol.

G. Benchmarking the Recommendation

Proposing a recommendation is not enough to guarantee its worth. In order to offer a sustainable long-term competitive advantage to the firm, a good strategic plan must meet the attributes of value, rarity, imitability, and organizational advantages as proposed by Barney’s VRIO framework (2007). The homebuilt licensing model will therefore be benchmarked against these attributes:

Value

- Targets a new customer segment (the homebuilders);
- Shows the organization as being open-minded, which would appeal to the millennials;
- Gathers continued feedback from homebuilders who would modify the design to improve features and benefits;
- Feeds the self-worth of the homebuilder who provides feedback by giving recognition for his/her contribution in the new and improved models;
- Prevents the lost sales to counterfeit.
Rarity

The recommendation does not meet the attribute of rarity. According to Barney (2007, p.149) “if a particular resource or capability is controlled by numerous competing firms, then that resource is unlikely to be a source of competitive advantage for any of them”. Offering a homebuilt kit is a model that most manufacturers will adopt if proven successful by the first entrant. Senior management should recognize this risk, and evaluate its impact.

Imitability

The homebuilt model demand is driven by the genuine product’s success. Homebuilding a top-selling model would most likely consume the same efforts as a lesser known brand; as such the likelihood of homebuilders choosing the popular iPod is higher than for the other competitors.

The first-entrant advantage will also reduce imitability as securing orders from the early adopters locks them in a design and initial investment. Once the code and the photogrammetry files are purchased, it is less likely that the customer will look at other brands, instead of perfecting what he/she has already started.

The novelty and adaptability of the first organization to offer homebuilt kits cannot be repeated by any follower. Even if a competitor launched the same manufacturing model, they would always be seen as followers, because only one brand can be seen as the innovator.

Organization

With its network of “Genius Bar”, Apple is well organized to take full advantage of the homebuilt licensing model. The product specialists (labeled Geniuses by Apple) have the product know-how, and are physical located in key market areas. These organizational strengths are unique to Apple, giving them a higher potential for success in this new model.

It could be argued that Sony also has a network of well-trained product specialists, some of them located in Sony Stores spread across the same metropolitan areas as Apple’s. Where Sony failed is to market these specialists as such. In contrast, the aura created by Apple around its geniuses, gives the customers a perceived notion that only Apple can provide them with a homebuilding support structure, for which they would be willing to pay premium.
This paper asked the research question:

*Can the combination of photogrammetry, additive manufacturing, programmable logic, and social media into a unified product acquisition cycle, eliminate the barrier to entry and provide the tools needed by the end-users to take on the manufacturing themselves, and as such, create a viable threat against the established firms?*

The fact that some manufacturers like Canon, Nikon, and Yamaha feel the need to educate customers on identifying counterfeit is a sign that the subject is no longer an academic question. The Canon survey revealed that millennials, who have a better grasp of social media and technology, are more likely than baby boomers to be fooled into purchasing a counterfeit; even when they know it’s a fake, they are more tolerant, and willing to invest in these illegal alternatives.

What is most significant about this research question is that the easy access to the four enablers (photogrammetry, additive manufacturing, social media, and programmable logic) is not the leading reason why home-based counterfeiters are motivated in building their own. Who would have predicted that Maslow’s theory of needs, first introduced more than fifty years ago (1954), could explain why customers would choose self-actualization over economics, when it comes to purchasing a portable media player?

It is true that the advance in technology has moved photogrammetry and additive manufacturing in the hobbyist’s hands, but manufacturers should have expected that even without them, the shift from application specific ICs (ASICs) to off-the-shelf programmable logic devices (PLD) made the risk of counterfeiting inevitable.

With this growing trend toward self-actualization, the consumer electronics industry needs to adapt and catch up to the shift that the home renovation, culinary world, and auto mechanics have already taken. Enforcement has proven unsuccessful, and as such, it is necessary to appeal to a new market segment of would-be counterfeiters, who simply want to reap the prestige of being manufacturers themselves.

Phillips (2005) described counterfeiting as the world’s fastest-growing crime wave”. Ignoring this threat is a high risk, one that most organizations cannot afford to take. At present, no manufacturer has shown intent to offer a homebuilt kit alternative to those looking at counterfeit. The first to embrace the recommendation will reap the first-entrant competitive advantage, which might be enough to give this firm the long-term market leadership that every shareholder dreams of.
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Matveyev, A. (2005). Citation from Alexander Matveyev. From the book Knockoff: the Deadly Trade in Counterfeit Goods (Phillips, 2006). Retrieved December 1, 2014 from: http://books.google.ca/books?id=90ugkKjBu6IC&pg=PA51&lpg=PA51&dq=if+counterfeiters+steal+enough+of+the+brand,+the+value+of+the+brand+goes+away&source=bl&ots=ASrSgLLMq0&sig=KQGbcKdgbM5tjaar07VEcv1464&hl=en&sa=X&ei=DbiEVLCDZCZyQTEplKgDg&ved=0CB0Q6AEwAA#v=onepage&q=gioc onda&f=false


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XII. Appendix A - Canon Survey

EDUCATION IS KEY TO AVOIDING COUNTERFEITS

PERCEPTIONS OF COUNTERFEITING IN AMERICA

Three out of every four consumers are concerned about counterfeit electronics, but only about 1 in 2 believe they can accurately identify counterfeit electronics. This lack of awareness leads to the "Confidence Trap."

CONFIDENCE TRAP

More than a quarter of respondents say they're likely to buy counterfeit goods.

In 2013, 16% unknowingly bought fake electronics.

Of the 16% who unknowingly bought fake electronics, 67% believed they were able to identify them.

GENERATIONAL GAP

BABY-BOOMERS**

PERCEIVED ABILITY TO DETECT COUNTERFEIT ELECTRONICS

KNOWINGLY PURCHASE COUNTERFEITS

17% 22%

UNKNOWNLY PURCHASE COUNTERFEITS

17% 22%

THE CONFIDENCE TRAP IS HIGHEST AMONG MILLENNIALS, WHO BELIEVE THEY CAN DETECT COUNTERFEIT ELECTRONICS.

MILLENNIALS**

PERCENTAGE OF BABY BOOMERS AND MILLENNIALS WHO ARE 6X MORE LIKELY THAN BABY BOOMERS TO KNOWINGLY BUY A FAKE.

AND ALMOST 1 IN 4 UNKNOWINGLY BUYS ONE.

THE GOOD NEWS? MOST MILLENNIALS TRY TO EDUCATE THEMSELVES ON AUTHENTIC PRODUCTS.

79% are willing to pay a premium for electronics.

54% of millennial electronic purchasers go to an outside source for advice before they buy.
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**Gender Gap**

<table>
<thead>
<tr>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED ABILITY TO DETECT COUNTERFEIT ELECTRONICS</td>
<td></td>
</tr>
<tr>
<td>56%</td>
<td>28%</td>
</tr>
<tr>
<td>KNOWNLY PURCHASE COUNTERFEITS</td>
<td></td>
</tr>
<tr>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>UNKNOWINGLY PURCHASE COUNTERFEITS</td>
<td></td>
</tr>
<tr>
<td>21%</td>
<td>16%</td>
</tr>
</tbody>
</table>

**Education is Key to Stopping Counterfeiting:**

After learning the safety risks of counterfeits and the fact that they are illegal, 71% said they were less likely to buy them. That includes 40% who had knowingly bought fakes in the past.

**What Canon is Doing**

- Partnering with industry and government authorities
- Training relevant stakeholders on prevention tactics
- Working together with law enforcement and counterfeit experts
- Conducting regular internal reviews
- Assisting local authorities during follow-up enforcement action

**Help Protect Yourself and Your Equipment with Genuine Canon Accessories**

**Join the Fight Against Counterfeiting**

As in the past, the letters are coming in from around the globe, as does the problem of counterfeit products. Canon has taken action to prevent counterfeit products from entering the market. Counterfeiting costs billions of dollars annually and poses a serious threat to consumers. The use of counterfeit products can damage the Canon product or cause increased service problems, voiding Canon product warranties.

**Why Buy Genuine Canon Accessories?**

To help ensure the safety, reliability, and performance of your Canon equipment, you should avoid using counterfeit “Canon” accessories. Canon has invested millions of dollars in research and development to ensure that Canon accessories are designed and manufactured to meet the highest standards of quality, reliability, and performance. Unauthorized accessories may reduce the life of your Canon equipment, void your warranty, and invalidate your Canon product warranty. Genuine Canon accessories are designed and manufactured to meet the stringent quality and performance standards set by Canon. Unauthorized accessories may not meet these standards and could cause damage to your Canon equipment.

**Identifying and Avoiding Counterfeits**

Although counterfeiters are always working to make their products look as authentic as possible, there are a few things you can do to identify and avoid buying counterfeit Canon accessories. These include:

- Checking for genuine Canon accessories online at www.usa.canon.com
- Looking for the Canon product warranty information
- Inspecting the packaging for any unauthorized labels or markings
- Asking for a receipt
- Reviewing the packaging for damage or defects

If you are in doubt, Canon can help you determine if your Canon accessory is genuine or counterfeit. Just contact Canon at 1-855-4U-CANON.
XIII. Appendix B- Sheehan et Al. (2012) Study Results

This section shows some of the results found by Sheehan, Tsao, Pokrywczynski, when conducting their survey about the motivations leading to digital music piracy (2012, p. 312).

- RQ1: What are specific motivations for digital music piracy among college students?
- H1: There is a statistical relationship between specific reinforcements and motivations for digital music piracy.
- H2: There is a statistical relationship between specific perceived costs and motivations for digital music piracy.
- H3: Different motivations to download music illegally could predict the extent to which the gratifications are reached.

**TABLE 1**
Motivations for Digital Music Piracy

<table>
<thead>
<tr>
<th>F1: Economic Utility (Alpha = 0.85; Mean = 4.06)</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illegally downloading music saves money</td>
<td>0.72</td>
<td>0.33</td>
</tr>
<tr>
<td>I am not making enough money to buy music</td>
<td>0.88</td>
<td>0.17</td>
</tr>
<tr>
<td>Paying for music is too expensive</td>
<td>0.91</td>
<td>0.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F2: Collection Utility (Alpha = 0.70; Mean = 3.64)</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can find any song and download it online</td>
<td>0.14</td>
<td>0.83</td>
<td>0.13</td>
</tr>
<tr>
<td>I download music with an illegal program because I feel like everything I want is right at my fingertips.</td>
<td>0.13</td>
<td>0.82</td>
<td>0.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F3: Social Utility (Alpha = 0.64; Mean = 3.53)</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downloading is all about sharing songs with friends.</td>
<td>0.00</td>
<td>0.21</td>
<td>0.77</td>
</tr>
<tr>
<td>It is enjoyable to see what other people have in their collection.</td>
<td>0.06</td>
<td>0.00</td>
<td>0.87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eigenvalues</th>
<th>3.49</th>
<th>1.42</th>
<th>1.14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance explained (%)</td>
<td>38.82</td>
<td>15.79</td>
<td>12.66</td>
</tr>
</tbody>
</table>
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### TABLE 2
Multiple Regression Analysis of Reinforcements on Motivations of Digital Music Piracy

<table>
<thead>
<tr>
<th>Reinforcements</th>
<th>$B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moral conscience</td>
<td>-0.47</td>
<td>-0.27</td>
<td>-3.63</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anti musicians</td>
<td>0.52</td>
<td>0.30</td>
<td>3.99</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Social acceptance</td>
<td>0.42</td>
<td>0.24</td>
<td>3.26</td>
<td>0.001</td>
</tr>
<tr>
<td>Optimistic bias</td>
<td>0.32</td>
<td>0.19</td>
<td>2.47</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

$R = 0.51$, $R^2 = 0.26$, $d.f. = 4$, $F = 11.58$, $p < 0.001$

### TABLE 3
Multiple Regression Analysis of Perceived Costs on Motivations of Digital Music Piracy

<table>
<thead>
<tr>
<th>Perceived Costs</th>
<th>$B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search cost</td>
<td>0.28</td>
<td>0.18</td>
<td>2.11</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Legal cost</td>
<td>-0.28</td>
<td>-0.16</td>
<td>-1.80</td>
<td>0.07</td>
</tr>
<tr>
<td>Technical cost</td>
<td>0.17</td>
<td>0.19</td>
<td>2.09</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

$R = 0.28$, $R^2 = 0.08$, $d.f. = 140$, $F = 4.078$, $p < 0.01$

### TABLE 4
Multiple Regression Analysis of Motivations on Gratifications of Digital Music Piracy

<table>
<thead>
<tr>
<th>Motivations</th>
<th>$B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>0.50</td>
<td>0.30</td>
<td>4.00</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Economic</td>
<td>0.25</td>
<td>0.15</td>
<td>2.04</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Social</td>
<td>0.54</td>
<td>0.32</td>
<td>4.33</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

$R = 0.46$, $R^2 = 0.22$, $d.f. = 141$, $F = 12.97$, $p < 0.001$
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**Figure 2 Cognitive Map**

![Cognitive Map Diagram]

* * P < 0.05; ** P < 0.001

A "*" sign represents a positive relationship between the two variables. A "−" sign represents an inverse relationship between the two variables. "NS" means that there is no relationship between the two variable.

**TABLE 5**

<table>
<thead>
<tr>
<th>Table Title</th>
<th>Intention to use a <em>legal program</em></th>
<th>Intention to use an <em>illegal program</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Overall 8 Concepts</td>
<td>4.23</td>
<td>4.39</td>
</tr>
<tr>
<td>Concept 1 &quot;Feel Lucky&quot;</td>
<td>4.51</td>
<td>4.53</td>
</tr>
<tr>
<td>Concept 2 &quot;STD&quot;</td>
<td>4.02</td>
<td>4.38</td>
</tr>
<tr>
<td>Concept 3 &quot;Virus&quot;</td>
<td>3.95</td>
<td>4.29</td>
</tr>
<tr>
<td>Concept 4 &quot;Reputation&quot;</td>
<td>4.76</td>
<td>4.57</td>
</tr>
<tr>
<td>Concept 5 &quot;Limewire screwed&quot;</td>
<td>4.07</td>
<td>4.09</td>
</tr>
<tr>
<td>Concept 6 &quot;One song&quot;</td>
<td>4.14</td>
<td>4.33</td>
</tr>
<tr>
<td>Concept 7 &quot;A great way&quot;</td>
<td>3.95</td>
<td>4.29</td>
</tr>
<tr>
<td>Concept 8 &quot;Getting a job&quot;</td>
<td>4.00</td>
<td>4.44</td>
</tr>
<tr>
<td>Generic concept &quot;Raisin Bran&quot;</td>
<td>4.44</td>
<td>4.47</td>
</tr>
</tbody>
</table>
### TABLE 6
Multiple Regression Analysis: Ad Convincing Effects of Music Downloading Campaign

<table>
<thead>
<tr>
<th>Campaign Predictors</th>
<th>Campaign 1</th>
<th></th>
<th>Campaign 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Legal download</td>
<td>Illegal download</td>
<td>Legal download</td>
<td>Illegal download</td>
</tr>
<tr>
<td>Intercept</td>
<td>5.70 ***</td>
<td>2.41 *</td>
<td>7.13 ****</td>
<td>2.24 *</td>
</tr>
<tr>
<td>Ad convincing</td>
<td>0.10</td>
<td>1.20 ns</td>
<td>-0.07 -1.90 0.06</td>
<td>0.24 4.82 **** -0.09 -3.98 ****</td>
</tr>
<tr>
<td>Monthly illegal download last year</td>
<td>-0.25 *** -2.92 ***</td>
<td>0.90 25.72 ****</td>
<td>-0.16 -3.24 **** 0.89 42.00 ****</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>0.06 0.72 ns</td>
<td>-0.01 -0.33 ns</td>
<td>0.06 1.24 ns</td>
<td>0.05 2.17 *</td>
</tr>
<tr>
<td>Year in college</td>
<td>-0.14 -1.71 #</td>
<td>0.01 0.32 ns</td>
<td>-0.09 -1.86 0.60</td>
<td>-0.01 -0.55 ns</td>
</tr>
</tbody>
</table>

\[ r = 0.32 \quad r = 0.92 \quad r = 0.35 \quad r = 0.91 \]
\[ R^2 = 0.10 \quad R^2 = 0.94 \quad R^2 = 0.12 \quad R^2 = 0.83 \]
\[ F = 3.72 \quad F = 17.56 \quad F = 14.58 \quad F = 504.94 \]
\[ df = 136 \quad df = 136 \quad df = 417 \quad df = 417 \]

*p ≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.005, ****p ≤ 0.001

### TABLE 7
Multiple Regression Analysis: Ad Persuasive Effects of Music Downloading Campaign

<table>
<thead>
<tr>
<th>Campaign Predictors</th>
<th>Campaign 1</th>
<th></th>
<th>Campaign 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Legal download</td>
<td>Illegal download</td>
<td>Legal download</td>
<td>Illegal download</td>
</tr>
<tr>
<td>Intercept</td>
<td>5.94 ****</td>
<td>2.35 *</td>
<td>8.01 ****</td>
<td>1.21 ns</td>
</tr>
<tr>
<td>Ad persuasions</td>
<td>0.01 0.13 ns</td>
<td>-0.06 -1.76 #</td>
<td>0.12 2.42 *</td>
<td>-0.05 -2.09 *</td>
</tr>
<tr>
<td>Monthly illegal download last year</td>
<td>-0.28 **** -3.28 ****</td>
<td>0.91 25.19 ****</td>
<td>-0.19 -3.93 **** 0.91 43.08 ****</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>0.09 1.02 ns</td>
<td>-0.02 -0.54 ns</td>
<td>0.09 1.75 #</td>
<td>0.04 1.82 #</td>
</tr>
<tr>
<td>Year in college</td>
<td>-0.13 -1.60 ns</td>
<td>0.01 0.15 ns</td>
<td>-0.98 -2.04 *</td>
<td>-0.01 -0.34 ns</td>
</tr>
</tbody>
</table>

\[ r = 0.31 \quad r = 0.91 \quad r = 0.29 \quad r = 0.91 \]
\[ R^2 = 0.10 \quad R^2 = 0.94 \quad R^2 = 0.09 \quad R^2 = 0.83 \]
\[ F = 3.39 \quad F = 161.83 \quad F = 9.62 \quad F = 492.37 \]
\[ df = 136 \quad df = 136 \quad df = 414 \quad df = 414 \]

*p ≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.005, ****p ≤ 0.001
XIII. Appendix C- Example of Counterfeit Products


http://www.dailymail.co.uk/sciencetech/article-2024878/hiPhone-5-Fake-Chinese-version-Apples-iPhone-5-sale-months-real-thing.html

http://petapixel.com/2011/06/13/real-vs-counterfeit-nikon-accessories/
The Threat of Home-Based Counterfeiting on the Electronics Industry


XIV. Appendix D - Additive Manufacturing Printing Examples

http://www.modearte.com/3d-printed-fashion-x-iris-van-herpen/

The Threat of Home-Based Counterfeiting on the Electronics Industry


http://on3dprinting.com/tag/ucreate3d/