
Stairway to
successful innovation
5000
1000
5000
1000

Stairway to successful innovation

An impact scan conducted by Maastricht University in collaboration with DOEN Foundation on the materials science company Ecovative Design LLC, Green Island, NY

Prof. Dr. H. Hummels
M.A. Röntgen, MSc

Maastricht University

ECCE

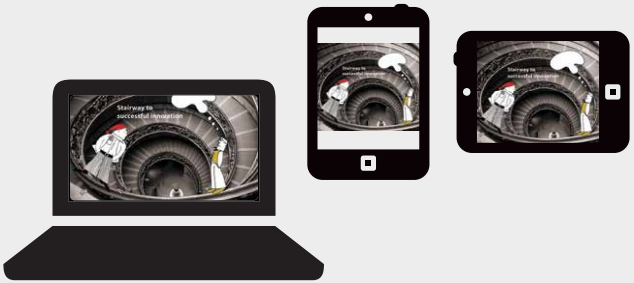
Table of Contents

List of figures and tables

About this publication

This publication comes to you in a digital format, specially designed for you to make reading easy on a portable device, like a tablet or notebook computer. So, now there is no need anymore to print the publication – something that is aligned with the core message of the study you are about to read and of its key stakeholders.
You save a few trees and still find pleasure in reading this document by simply scrolling the pages.

Happy readings.



This publication is published under the following creative commons conditions:

You are free to copy, distribute and transmit this work. When doing so you:

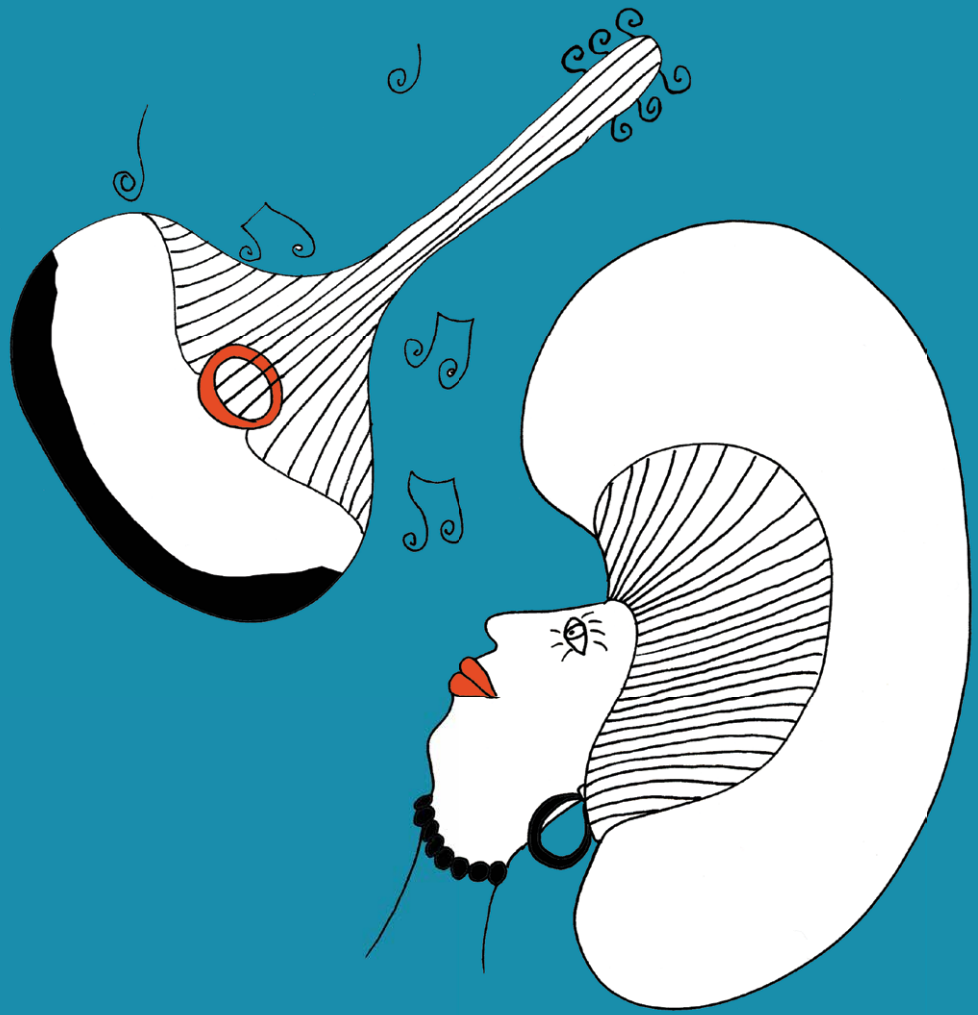
- must attribute the work in the manner specified by the authors (but not in any way that suggests that they endorse you or your use of the work)
- may not alter, transform, or build upon this work.

With the understanding that:

Waiver: Any of the above conditions can be waived if you get permission from the copyright holder.
Public Domain: Where the work or any of its elements is in the public domain under applicable law, that status is in no way affected by the license.
Other Rights: In no way are any of the following rights affected by the license:

- Your fair dealing or fair use rights, or other applicable copyright exceptions and limitations;
- The author's moral rights;
- Rights other persons may have either in the work itself or in how the work is used, such as publicity or privacy rights.

Notice: For any reuse or distribution, you must make clear to others the license terms of this work. The best way to do this is with a link to this web page.



Executive summary

Overview

Ecovative Design LLC is a materials science company that radically challenges current sustainability standards in a variety of industries. The company is a promising startup that focuses on using fungus-based technologies to fight our earth being overly polluded with Styrofoam. In doing so Ecovative has been able to attract investment capital from a number of committed impact investors, including the Dutch DOEN Foundation. This report evaluates the evolution of Ecovative and assesses to what extent the DOEN foundation – alongside its co-investors – has contributed to the growth and success of Ecovative. The report interweaves two storylines. One, it describes the idea of impact investing as an interplay between the financial world and the real world by referring to the concept of the 'double helix'. Two, using this interplay, we study the particular case of Ecovative and the DOEN foundation as the focal point of attention. We start by placing Ecovative's platform technology in the 'era of ferment' for the protective packaging industry, where it hopes to become the next dominant design.

Evaluating a start-up company with ambitions to solve a serious environmental problem is not an easy task. It takes years – if not more than a decade – to assess whether the company's biotech solutions are actually instrumental in curbing the pollution caused by Styrofoam. We have, therefore, opted for a different approach that focuses on the process of achieving the company's objectives instead of the realization of the objectives itself. To evaluate the contribution of Ecovative's technology platform and its concrete solutions to the (future) replacement, we use the criteria of 'enlightenment', 'adoption' and 'goal attainment', and reconstruct

a timeline that covers the major milestones in Ecovative's evolution. In the conclusions, scenario analysis helps to draft three possible scenarios of the development of Ecovative into the future.

Methodology

The study's methodology comprises in-depth interviews with key stakeholders and desk research of secondary data such as company memos, reports and other documentation made available by both the DOEN foundation and Ecovative. The output of the interviews, such as quotes and key insights helped to construct the abovementioned timeline and substantiate the objectives of the investment and enterprise theses as presented in section 3.1. The scope of the research does not permit to prove a causal relationship between the particular intervention and reported outcomes. However, linking the investment thesis to perspectives from key stakeholders helps to provide a deepened understanding of the various mechanisms at play in the stages between intervention and outcomes.

Part I & II: Company and industry analysis

Up until now Ecovative launched two concrete products; one with direct applications in the protective packaging market, the other with prospective applications in the insulation market. Based on the competitive analyses in the first three sections, we place Ecovative on a curve that follows the typical development of technological discontinuities. We conclude that:

- Ecovative (in the packaging space) can be positioned in the so-called 'era of ferment,' a period of tweaking existing technologies while competing for scalability. A licensing deal with Sealed Air Corporation (SAC) – a large US-based multinational in the packaging industry – will prove to be an anchor point for success in this regard, and a step further in Ecovative's pursuit of delivering the next dominant design.

- Ecovative's sustainable and well-protected competitive advantage lies in the fact that its price and sustainability propositions remain unparalleled. Ecovative makes use of the concepts of abundance and cradle-to-cradle as they are found in nature: its feedstocks are abundant, its resin is abundant, and Ecovative targets to produce an abundance of materials – all without generating waste. We label this: *strategically siding with nature*. Fungal physiology is the latest of techniques harnessed by the company and aims to out-compete plastics in terms of functional performance.
- Furthermore, the company's culture has many of the characteristics of a mycelial network itself: as natural glue it strengthens and weaves Ecovative's partnerships together – both internally with its workforce and externally with partners like SAC – and embeds knowledge and strength in its relationships. As such, Ecovative acts as a learning organization bound to *sustain* Ecovative's competitive edge into the future.
- Regarding Ecovative's impact, the R&D facility at 60 Cohoes Avenue, Green Island, performs the role of developing new products, whereas Ecovative's pilot manufacturing facility assesses whether these applications have commercial potential. If new applications do not survive in the manufacturing facility, these new applications are unable to create the 'impact' envisioned in impact investing.

Part III: Interplay DOEN & Ecovative

Using the metaphor of the double helix, we argue that the short and medium-term objectives of an impact investor are related to the long-term objectives of the target company. The double helix characterizes impact investing as the interplay between the real and the financial world, or, more specifically, between Ecovative and DOEN Foundation (hereafter DOEN). In biology and genetics, the double helix replicates by unwinding its strings before connecting to new strings. Similarly:

- It has been DOEN's goal to provide the initial string of capital and lead Ecovative to latch on to new – possibly more potent – strings of capital, and perform a 'bridging function' in the

period between 2009 and 2011, when the company went from running on grant and prize money to running on equity investments.

- In providing a first and a subsequent 'string of finance' DOEN enabled Ecovative to connect to a more potent string of finance. DOEN has been instrumental in attracting the right kind of capital that allowed Ecovative to develop the "string of real world activities", needed to grow the company and develop the platform technology. The company aimed at avoiding financiers that would take control over (parts of) the decision-making process. By attracting capital from carefully selected sources, Ecovative successfully protects its core philosophy. Actually, DOEN's investments have contributed to securing grants of federal endowments to explore new industries, which allowed the company to make considerable progress in the implementation of its platform technology in the protective packaging industry. It is here that both strands of the double helix are interconnected and reinforce the opportunities for Ecovative to create an encompassing strategy focused on making Styrofoam redundant.

To evaluate impact, we use the criteria of 'enlightenment', 'adoption' and 'goal attainment'. The effects of Ecovative's innovative technology slowly trickle down to relevant audiences and 'punctuate' current beliefs about sustainability standards as becomes clear from the attention of both popular and trade press. In this light:

- The impact of a novel technology is widespread. Impact encompasses much more than just 'delineated' quantifiable outcomes. Ecovative's ambitions have also grown along the way. Its theory of change has evolved from producing a sustainable range of products in-house, into improving a platform technology with licensees that control much of the supply chain.
- By focusing on its core competencies, Ecovative aims to increase its impact by siding with licensees. Should Mycobond – one of Ecovative's core products – after the termination of licensing agreements – be adopted by other parties, the technology would continue to further penetrate markets and reach other industries. It thereby increases enlightenment

and adoption of the technology and makes the impact of the technology (and the impact of the investors' interventions) only more meaningful. Due to the nonlinear development path, *evaluating* the impacts of an innovation is an uneven process in which the payoffs are rarely immediate.

Part IV: Scenario analysis

Scenario analysis helps to draft three possible scenarios of the development of Ecovative into the future. Industry trends hint at a continued focus on sustainability features that create increasingly favorable industry conditions for Ecovative. In turn, Ecovative reinforces this trend by actively promoting its technology at a variety of stages, including trade shows, conferences, and other associated events. We note that:

- The current team forms a strong entrepreneurial entity with a productive track record of developing new, radically sustainable materials. However, Ecovative remains a young and exotic company that has yet to prove its success in actually capturing projected shares of the targeted markets.
- Protective packaging is an established industry with a functioning infrastructure that provides low-cost solutions to virtually anyone's packaging needs. Although Ecovative hopes to challenge this cost proposition in the near term, the market's focus on improving sustainability records will prove to be crucial to Ecovative's success. The extent to which rivaling 'drop in' replacements (with *incremental* rather than *disruptive* sustainability propositions) are embraced by incumbent players will be a reflection of the market's 'inertia', or unwillingness to change.
- Indeed, success is dependent upon grander industry fluctuations and it remains unclear whether, and if so when we may see a 'tipping point' of the adoption of Ecovative's technology. In addition, among the many variables that determine future success for Ecovative must also rank Ecovative's governance and organizational characteristics. The company will need

to transform from an entrepreneurial entity into a solid SME enterprise. As a result, the team is likely to face changes as additional streams of capital and new financiers and/or investment rounds will determine part of the company's policy.

Proviso

The purpose of this impact scan has not been to construct a full-fledged impact assessment and its authors do not wish to apply the notion of attribution – which is a traditional characteristic of impact evaluations – to this scan. The research approach to this study has been 'to walk the impact evaluation path' with the purpose of giving an indication of the impact that DOEN creates with its investment. The study bases the majority of its findings upon documentation provided by and insights derived from key stakeholders of both the focal enterprise (Ecovative) and the focal investor (DOEN), and its findings are therefore inherently biased. As such, the objectivity of the market and product assessments cannot be guaranteed. To set up additional data gathering points and include external expertise has been deemed beyond the scope and ambition of this study. Due to the non-disclosure agreement between the researchers and Ecovative Design, financial data is not included in this study.

"Nature, which controls it all, will alter everything you see and use it as material for something else – over and over again – so that the world is continually renewed."

Marcus Aurelius (AD 121-180) "Meditations", Book 7: 2

What is the relationship between the spiral staircase of the Vatican Museum in Rome and a young and energetic company based in Green Island in the state of New York? This energetic company is called Ecovative Design, a start-up enterprise that developed in recent years a promising technology. It was able to do so because of the inspiration and determination of its two founders Eben Bayer and Gavin McIntyre, supported by a wide network of friends, family, professors and investors who believed in the two youngsters and saw the potential of their invention. This give-and-take relationship can be explained in terms of a double helix, as we will demonstrate later in this report. To capture that idea, what better can you do than simply imagine the magnificent staircase of the Vatican Museum designed by Giuseppe Momo?

1 | Introduction

This impact evaluation scan was conducted in collaboration with DOEN Foundation (hereafter DOEN) to study the evolution of Ecovative Design LLC in Green Island, New York (hereafter Ecovative). One of DOEN Foundation's goals is to help contribute to a new type of economy and, more broadly, build a sustainable world. In particular, DOEN is looking for pioneers who generate positive outcomes in the fight against climate change. As a result of this goal, DOEN

decided to invest in Ecovative Design in 2010. Two years down the road, DOEN is interested in learning what the company has achieved as a result of this investment and, more specifically, to what extent it is successful in developing its new – and potentially "disruptive" – technology. This report is the result of an "impact scan" conducted by Maastricht University (Finance department, School of Business and Economics). In assessing the added value of DOEN's investment to Ecovative, this report aims to meet two goals:

- To provide information that enables DOEN to demonstrate its added value – if any – to its constituents;
- To provide useful feedback to Ecovative regarding its added value to both investors and society.

We follow the main objectives for impact evaluation research as set out by Rugh[1], which are to:

- Provide a comprehensive understanding of important inputs, outputs, and outcomes;
- Follow a systematic and defensible data collection and analysis of evidence, and;
- Effectively manage the evaluation, including a transparent methodology.

More broadly, "Impact" in this study has been defined as follows. According to Webster's and Oxford dictionaries, in its most generic sense the word means 'coming into contact with another object'. In this context, impact deals with the influence or effect of an intervention – whether an act or a decision – on a recipient as is illustrated in McKinsey's definition of (social) impact:

"A meaningful change in economic, social, cultural, environmental, and/or political conditions due to specific actions and behavioural changes by individuals and families, communities and organizations, and/or society and systems".[2]

1 Rugh, J. (2011) What's Involved in Rigorous Impact Investing? Presented to NONIE conference in Paris, 28 March, 2011

2 McKinsey Social Sector, *Learning for social impact*, April 2010, p.2. See also www.mckinsey.com

Consequently, we define "impact investing" to refer to the entire spectrum of investments that aim to create shared value. Three things are important in this definition.

First, the creation of shared value refers to both financial and non-financial value, such as improving the environment, access to finance, education or health-care. Second, the notion of an investment means an allocation of capital leading to a financial gain. And third, the ability to determine what impact has been created as a result of the investment. Without measuring and managing impact, as well as reporting on the financial and non-financial output and outcomes of the investment, there simply can be no mentioning of impact investing.

The nature of an impact deserves particular attention, and we must ask three questions:[3]

- Is it produced directly by the intervention (like a splash) or indirectly (like a ripple)?
- Is it transformational or can the accomplishments easily be undone?
- Is the impact likely to be the result of a 'silver bullet' intervention that achieves results irrespective of context, or a 'ducks-lined-up' intervention' that achieves results only in conjunction with favorable circumstances, including other interventions.

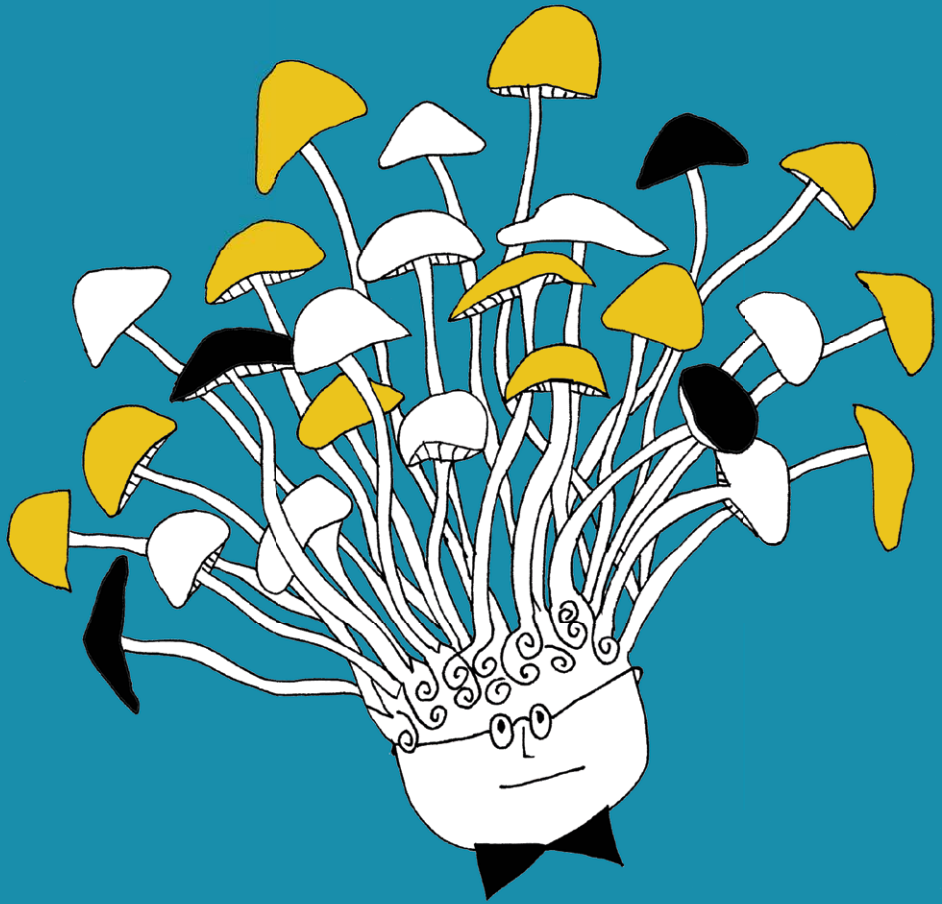
Upfront we would like to manage expectations by saying that the impact scan will remain on the surface and is not able to prove causal relations between the inputs and the outcomes. The notion of attribution – which is characteristic of every impact evaluation – does not apply to this scan. However, if an extensive more comprehensive research design is not possible, there are other methods for assessing the counterfactual: such as secondary data, longitudinal monitoring data, and qualitative methods to obtain perspectives of key stakeholders.[4] Due to budget and time constraints, for this study we have chosen to remain on the surface and conduct cross-sectional data only. As such, we hope to shed some light on the relationship between DOEN's investment – and the investment of DOEN's co-investors – and the growth and future perspectives of Ecovative Design.

3 Following R. Chambers, D. Karlan, M. Ravallion & P. Rogers (2009) "Designing impact evaluations: different perspectives". *International initiative on impact evaluation*, working paper 4, p. 25

4 Rugh, J. (2011) What's Involved in Rigorous Impact Investing? Presented to NONIE conference in Paris, 28 March, 2011

The report starts with an introduction and descriptive analysis of Ecovative Design, which aims to identify the company's current market position and prospects. Certain key stakeholder groups emerge that can be classified into investors, customers and partners. The focus throughout the report remains on the continued involvement of DOEN and the extent of the impact. In part two, we find empirical support to position Ecovative along a maturity curve and build the argument for three impact scenarios of Ecovative's platform technology, which in turn will be presented in part four. Primary data and desk research provide specific insights into the processes at play; the academic literature on start-up companies and novel technologies provides a framework that we use to analyze Ecovative and the industry it operates in. Part three focuses on the interplay between Ecovative and DOEN and introduces the concept of the double helix as a metaphor for this interplay.

All of the primary data gathered specifically for this report stems from interviews with several of the company's key stakeholders. All of the secondary data used in this report stems from desk research at DOEN and Ecovative and is complemented with information from public sources, such as press releases and other media coverage.



Part I

Company scan, industry dynamics & investment theses

In the first part, we acquaint the reader with some of the key developments surrounding Ecovative's operations. As such, the following sections will:

- Emphasize the key developments surrounding Ecovative;
- Introduce Ecovative's current product portfolio, the market segments it targets, and the technologies it competes with, and;
- Introduce key stakeholders, in particular the DOEN foundation as the focal stakeholder of this report.

By doing so, we reconstruct DOEN's "investment thesis", which we couple to Ecovative's complementing "enterprise thesis". In impact investing, the investment thesis sets out the expectations and considerations of the investor towards the focal company. Conversely, the enterprise thesis translates the expectations and considerations of the focal company towards its investor.

2 | Ecovative's environmental proposition

The United Nations Environmental Program (UNEP) reports that every year large amounts of plastic debris enter the ocean, where they slowly fragment into tiny particles and accumulate in convergence zones, resulting in an undefined amount of plastic elements populating our oceans. Styrofoam – as a prominent plastic – makes up a major part of these waste streams, particularly due to its inability to decay. These reservoirs of waste have been evocatively described as ocean landfills, plastic soups or garbage patches.[5] Ecovative LLC, founded in 2007, is built around the idea that natural materials can provide a sustainable alternative to petroleum-based plastics. More specifically, Ecovative has successfully used the root structures of mushrooms to transform and bind agricultural byproducts into strong functional composites that are a 100% compostable. This technology radically challenges our current sustainability standards in a variety of industries. Ecovative labeled its naturally-grown composites MycoBond™. These composites are applicable to many markets, including commercial insulation, structural cores, and protective packaging, among others. As such, Ecovative pioneers a disruptive platform technology with the aim of providing a commercially viable alternative to the reigning supreme of malign plastic materials.

2.1 | The cradle of Ecovative's technology

The story of Ecovative starts at Rensselaer Polytechnic Institute (RPI) in Troy (NY) in 2007, when two young entrepreneurs, under the auspices of their professors, lived up to the school's motto: "*Rensselaer, why not change the world?*" Ecovative's practices and solutions for functional composites have been recognized as very innovative and powerful in serving the needs of our society, but with no negative environmental impact. This is illustrated by the recent press coverage in influential media. Figure 1 depicts a steep curve in media interest over the period 2007 – 2012. What precisely happened in between? What events have brought Ecovative to where it stands today?

5 United Nations Environment Program. Year book 2011 http://www.unep.org/yearbook/2011/ Accessed 25 August 2012

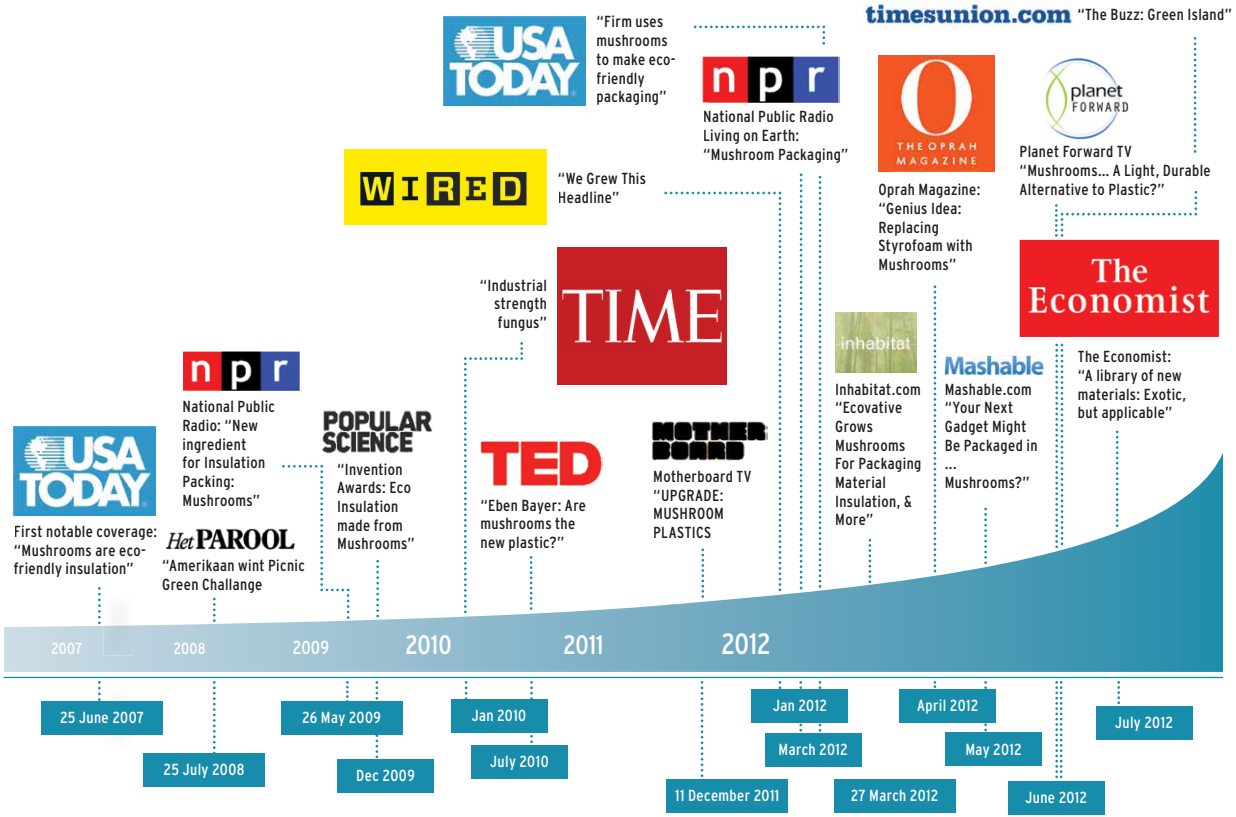


Figure 1: Popular press coverage 2007-2012

As said, it started in the classrooms of RPI, the polytechnic institute which was founded in 1824 by a statesman of Dutch descent, but is now best known for its mission of transferring technology to the marketplace. In their final year of study, Rensselaer seniors Eben Bayer and Gavin McIntyre enrolled in a course called *The Inventor's Studio*, and attracted the attention of their professor with an experimental approach to the cultivation of fungal mycelium. Soon after, in Gavin's attic, the company name was created after they started to combine fragments from their notebooks. Eben chose "eco" and "innovative", while Gavin added "design". Trained as mechanical engineers, the two enterprising youths harnessed remarkable business acumen and succeeded in translating their technique into a commercial equation. As Eben explains:

"Inventing a new technology and thinking about a business construct is not that different [...] in physics all the equations have personalities and things that constrain you what to do. In business, all the businesses have personalities and things they won't and can't do."

In the following years the company evolved and attracted a workforce that avowedly makes it its mission to promote a product that, according to the team "replaces some of the worst materials you can have" with much more environmentally friendly alternative using biology. That alternative was mycelium – nature's glue that binds together a lot of the planet's soil and turns out to be great for binding together all kinds of functional shapes as well.

2.2 | Industry dynamics: protective packaging and insulation

Ecovative's larger goal is to replace all types of conventional plastics and foams by continuously developing new MycoBond materials. To this end, Ecovative has put a focus on entering two market segments that provide significant commercial potential for the near term: protective packaging and insulation. The protective packaging materials market is estimated to be a ≥ 20 billion dollar industry [6] with foamed plastics servicing roughly a fifth of this market. "Ecocradle" is the name given to Ecovative's packaging line products. The US insulation market is estimated to represent an 8-12 billion dollar industry [7], and can be broadly divided in two segments: rigid and non-rigid board insulation. Ecovative's technology and product best applies to the rigid board segment with a focus on "Structural Insulation Particles" (SIPs) and roof insulation. "Greensulate™" is the name given to Ecovative's insulation line products.

Both markets are dominated by Expanded Polystyrene (EPS) and other plastics due to their low cost, high adaptability and proven functionality standards. The main drawback of these plastics is their problematic end-of-life solution and their contribution to the swelling of landfills. It is estimated that between 25% and 30% of our landfills are filled with plastics and foams.[8] More worrying is the fact that many of the disposed plastics end up in marine environments. Other players in the packaging space are producers of so-called "bio-plastics". As a niche player, bio-plastics capture a small share of the market, and are made of virgin (i.e. not waste) food crops and also require energy intensive treatments. The recyclability of bio-plastics is a complex process, involving careful waste separation and high temperature treatments. As such, bio-plastics struggle to offer a viable alternative to Styrofoam in terms of quality and price as will be suggested in section three.

Styrofoam's worrisome sustainability features have increased the call for environmentally-friendly alternatives in these markets. Consumers have pushed for greener solutions and have

6 The Freedonia Group http://www.freedoniagroup.com/Protective-Packaging.html Accessed 5 November, 2012.

7 Ecovative business and marketing plan 2011

8 Earth Resource Foundation http://www.earthresource.org/campaigns/capp/capp-styrofoam.html Accessed 1 November, 2012

identified bio-degradable packaging as an important innovation in the packaging industry[9]. Other relevant markets, such as insulation are increasingly under scrutiny by eco-labels and sustainability standards.[10] Since the packaging space is the first market Ecovative has decided to enter, we will remain focused on this particular industry and further introduce Ecovative's principal product: "Ecocradle".

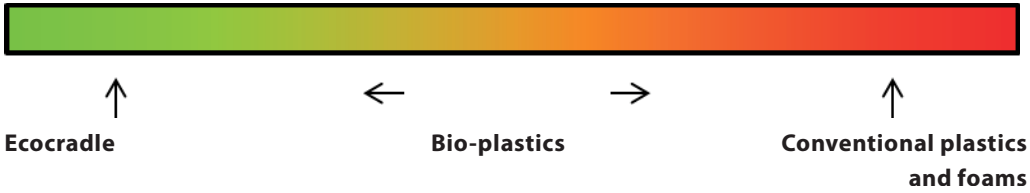


Figure 2: Sustainability spectrum protective packaging materials

"Ecocradle" is the trademark name for Ecovative's packaging line products and can function in various markets as a direct substitute for EPS and other plastics, except that Ecocradle requires eight to ten times less energy than EPS. Whereas Styrofoam is made in a chemical process from the rapid expansion of small plastic pellets, Ecovative simply *grows* its feedstocks into the final product with mycelium acting as natural glue. Ecovative does not need to add extra light, heat or air conditioning to the process. As will be illuminated in the following sections, the versatility of Ecocradle lies in the fact that, as we see it, *Ecovative constantly teams up with and makes use of the forces of nature.*

9 Lifestyles of Health and Sustainability (2012) http://www.lohas.com/lohas-journal Accessed 2 October 2012

10 Green Building Certification Institute: LEED (2012) Leadership in Energy and Environmental Design. www.gbci.org Accessed 9 November 2012

Ecocradle can be used for the shipment of industrial and consumer goods such as computers, wine bottles, and furniture, among many others. Ecovative has identified the packaging area as the one with 'the lowest hanging fruit' and the least barriers of entry. Figure 3 lists the market segments within packaging that relate to Ecocradle's primary strengths.

Packaging segment	
Protective packaging buffers	Containers used to ship food products and medical products. Dominated by EPS, cardboards, and molded paper pulp.
Insulating shipping containers	Either fully molded enclosures or flat inserts into cardboard boxes. Dominated by EPS, few eco-friendly alternatives, except for the relatively small GreenCell[11] that produces starch-based foams.
High value/specialty packaging	More innovative packaging for cosmetics, wine, jewelry that differentiate themselves through branding rather than price only. Custom molded EPS and custom molded paper pulp inserts dominate this segment.

Figure 3: Ecovative's targeted segments in the protective packaging space

11 Green Cell Foam http://www.greencellfoam.com/ Accessed 23 July 2012

3 | Supplies of finance: grants and investments

In order to effectuate its promise Ecovative has enjoyed the support of federal bodies, donors and – more recently – investors. The company was basically founded upon the prize money of different business competitions and the grants that were obtained from federal and state governments. The most sizable of these business competitions was the Postcode Lottery's (PCL) Green Challenge award. The award winning € 500K provided Ecovative with a kick-start. More recently, in 2010 and 2011, two investment rounds took place that each contributed significantly to the company's development and estimated net worth.[12]

From Green Challenge to investment: DOEN Foundation stepping in

DOEN works with subsidies, loans, guarantees and equity investments according to the principle: "loans, guarantees or equity investments where possible, subsidies where necessary".[13] With the banking sector under increased scrutiny, DOEN finds that banks may be less inclined to issue loans to risky initiatives in the sustainability domain. DOEN has committed itself to supporting experimental, potentially disruptive initiatives, rather than fill in the gaps that arise when other suppliers of finance pull out. DOEN believes that precisely these investments pave the way for a more sustainable world. DOEN is an investor that manages its portfolio in a 'decentralized' manner. As such DOEN typically limits its direct influence on business operations, and remains involved as a knowledgeable partner with a potent network at the target company's disposal.

Grantors vs. investors

After winning the PCL Green Challenge in 2008, Ecovative used the € 500 K to leave the business incubator at RPI and move into a 10,000 ft^2 (930 m^2) facility in Green Island. Personnel and machinery allowed Ecovative to start producing pilot products. Soon became clear that in order

12 See figure 4.

13 DOEN annual report 2011 http://services.gdl-webservices.nl/DOEN/jaarverslagen/2011UK/magazine.html Accessed 2 October 2012

to approach and win customers production had to be scaled up and additional funds were needed. DOEN reappeared on Ecovative's radar as an *investor* after having performed the role of *grantor* (DOEN had managed the allotment of the PCL prize money between 2008 and 2009 in two tranches). DOEN participated in both of the aforementioned investment rounds and is now among the principal holders of Ecovative stock.

Figure 4 (see next page) distinguishes between the research grants that allowed Ecovative to test and develop its Mycobond technology on one hand, and the investments with the aim of commercializing the technology on the other. As is shown, DOEN's first two involvements are the allotments of the PCL prize money, whereas the last two depict the investments made by "DOEN" directly.

3.1 | Investment and enterprise theses

In impact investing, the investment thesis sets out the expectations and considerations of the involved investor towards the focal company. On the other side, the enterprise thesis translates the expectations and considerations of the focal company towards its investor.

Investment thesis DOEN

As stated in the introductory part, one of the ambitions of the DOEN Foundation is to help contribute to a green economy and, more broadly, build a sustainable world by investing in companies, ventures or projects that have the potential of making a significant contribution to this economy and a better world. More concretely, DOEN is looking for pioneers who generate positive outcomes amongst others in the fight against climate change. Ecovative approached DOEN seeking investment. This proposal was met with the following investment **considerations** by DOEN based upon five of the company's features:

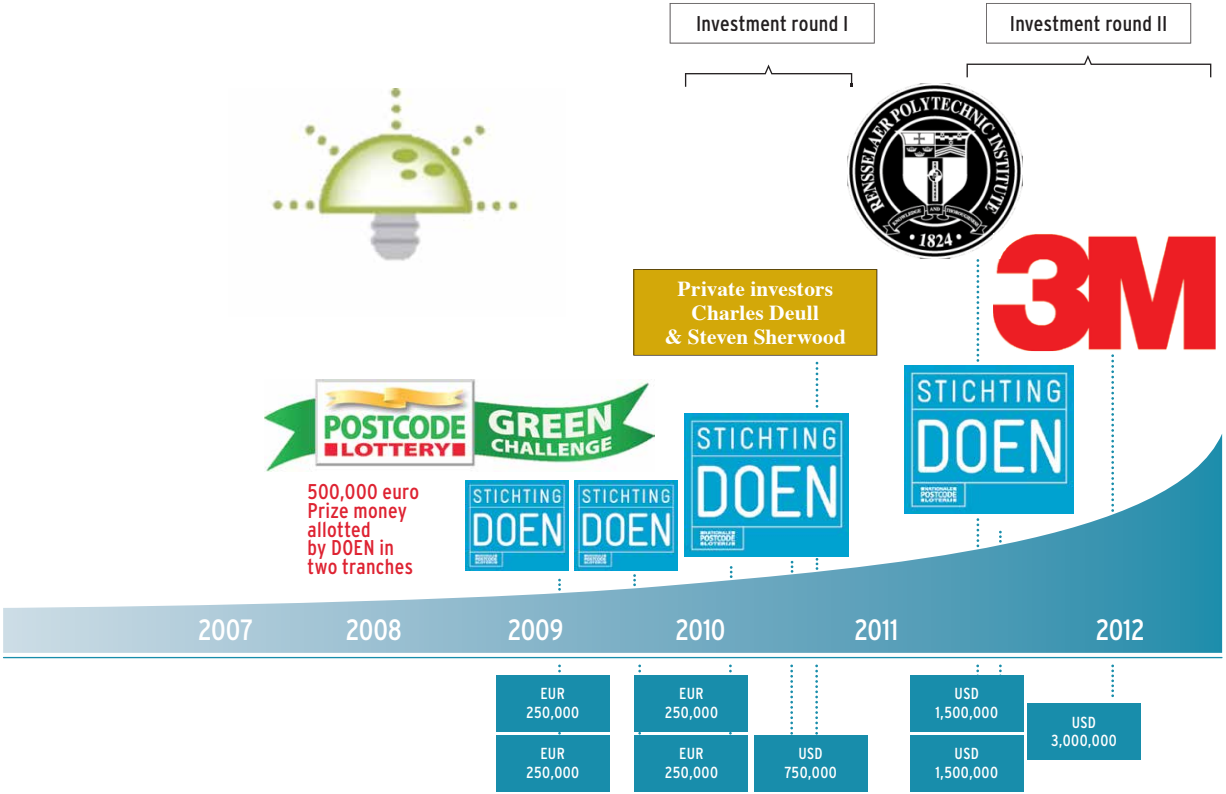


Figure 4: Investment timeline Ecovative

• **Management qualities**: Repeated contact with Eben Bayer revealed his creative character and commitment to use this bold technology to make a toxic material obsolete. Eben proved to be a true entrepreneur who was always "looking three steps ahead". Together with Gavin McIntyre, the chief scientist, they formed a promising team. Jasper Snoek, CFO DOEN foundation says:

"All in all, we had the impression that this young and very complementary team could bring about change in a particular segment of our economy. As long as the company did not yet generate its own revenues, we might be able to make a difference".

• **Team**: Besides Eben and Gavin as the company founders, a team of young dedicated members started to take shape. With their limited budget they knew how to implement innovative solutions, keep payroll costs low, and nurture a strong company culture. Many of the team members were formerly interns at the company, who slowly but surely claimed their value for the company. As a balance to this young company core, notable experts had joined the team, such as an expert in mycology and a senior mechanical engineer.

• **Industry prospects**: The protective packaging space is in serious need of environmentally-friendly solutions. Plastic foams have been characterized as toxic white stuff and Ecovative's green materials already harvested the attention of Fortune 500 parties including Dell, Steelcase, and Bloomberg. Different industries look to reduce their oil-dependency and manage the disposal of their plastic waste. To date, no other biopolymer producers produce viable alternatives.

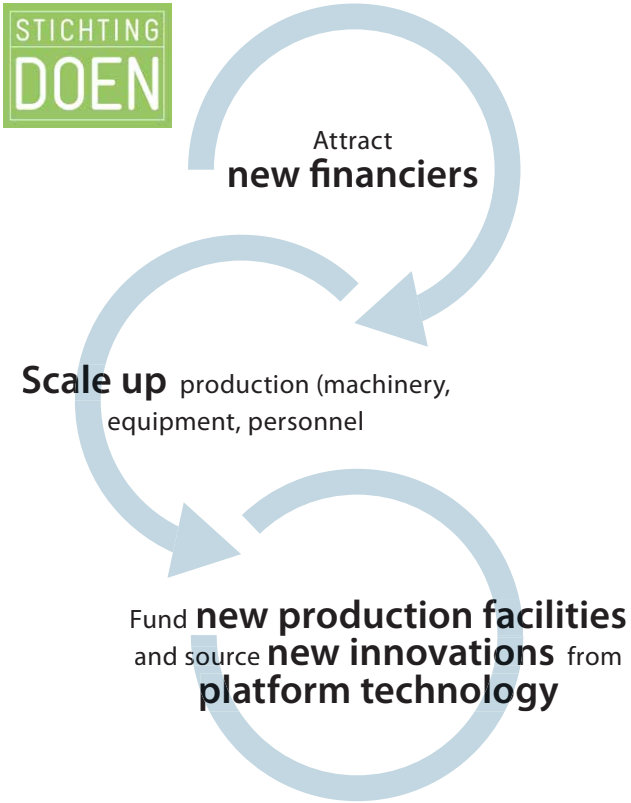


Figure 5: Investment expectations DOEN

• **Governance**: Besides having a young team that was passionate about bringing their technique to the marketplace, Ecovative also attracted credible members to its board of directors. Managers, experts and entrepreneurs with proven track records in different industries and with start-up companies and novel patentable technologies. It was believed this board would provide the necessary counterweight to the growing team.

• **Financials**: Besides the initial interest of several customers, Ecovative had successfully set up a steady grant pipeline from various federal bodies including the Environmental Protection Agency (EPA). Again the low payroll costs convinced that the team could responsibly manage the financial side of the story.

Taken together, these considerations formed the basis of the following investment *expectations* as depicted in figure 5.

As seen in figure 5, the investments made by DOEN in rounds I and II aimed to:

- Enable Ecovative to attract new financiers. Ecovative had a promising business proposition but at the same time could be categorized as a risky enterprise. The eventual involvement from other investors would help mitigate that risk, both for Ecovative and for DOEN.

- With the backing of new capital, additional resources could be acquired, such as machinery and personnel. Production could thus be scaled up to demonstrate its feasibility and accommodate an increasingly large customer base.
- An increasingly large customer base would ideally lead to yet another increase in production capacity via the funding and construction of new production facilities.
- Ultimately, the platform technology sources new innovations into new sectors and industries.

Enterprise thesis Ecovative

From the other side of the table comes Ecovative's enterprise thesis. What were the prime considerations when Ecovative decided to approach DOEN?

- **Impact**: The most important element for Ecovative was staying true to its mission of becoming a truly sustainable materials company. To be able to match that ambition, Ecovative sought an investor with an aligned philosophy and patient capital. Ecovative regarded DOEN as a partner who would care about financial returns, but who would also have a long-term vision in terms of making Ecovative a successful sustainable business.

"DOEN for us represented a shareholder that cared about physical returns, but at the same time they cared about more than physical returns. Specifically they cared about impact." [14]

14 Interview Eben Bayer

E-mail contact 28 September 2009 Eben Bayer to Jeff Prins:

"My thought in working with the DOEN foundation on an investment is that our interests would be aligned from both a mission perspective (Making a profit, but also having a big positive impact on our planet and the people who live on it) and also having a time horizon appropriate to a disruptive technology such as ours."

• **Control**: partnering up with the DOEN foundation would decrease the risk of having to cede control over the company to finance-first investor groups. Besides making a cost-competitive product, Ecovative wants to be an intrinsically good company and offer intrinsically good products.[15] As Eben writes to Jeff in September 2009:

"So far we have been less than thrilled with the investment choices offered by professional groups, as I mentioned it is clear that they are setting up our somewhat young (yet very talented) team for a loss of control at the next funding milestones."

Overall, the ambitions and expectation from Ecovative suited Eben's conviction that the ecological and the economical are ideally a 100% aligned, i.e. that environmentally-friendly options can have true economic viability.

15 See footnote #14

Figure 6: Enterprise expectations Ecovative

Concluding remarks to part I

Part one presented an overview of the key developments surrounding the evolution of Ecovative. Ecovative is a young materials company with a truly disruptive sustainability proposition: exploring the potential of replacing expanded plastics and foams in a variety of markets. Two concrete products have been launched, one with direct applications in the protective packaging market, the other with prospective applications in the insulation market. In their quest of bringing this novel technology to the marketplace, Ecovative has found in the DOEN foundation a partner that supports the company's philosophy of becoming a truly sustainable materials company. The investment thesis of DOEN voices the investment considerations and expected outcomes for the near-to-long term. The collaboration also fits in with Ecovative's general conviction that the ecological and the economical ideally are a 100% aligned.


1000
5000

Part II

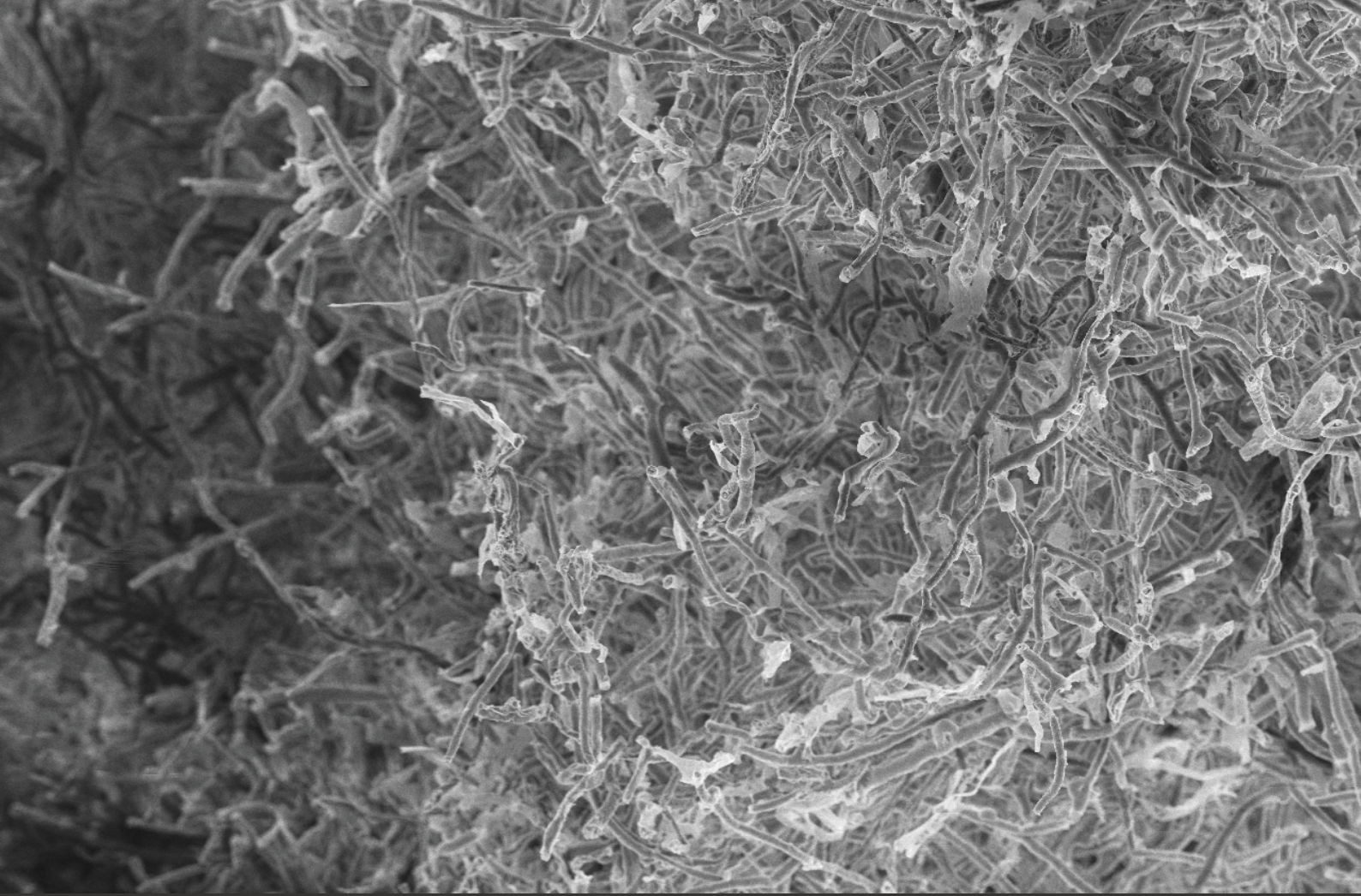
Empirics
Ecovative's genetics

Part two discusses the evolution of Ecovative. It reveals the genetics of Ecovative as a young sustainable materials company, which reflects on the company's chances for survival in a dynamic environment.

Secondly, this part sheds light on DOEN's role to support Ecovative in surviving in a competitive marketplace. Part II describes Ecovative's platform technology more in depth and makes a connection with academic strategic and innovation theory.

Furthermore we describe Mycobond as Ecovative's platform technology in the packaging industry, discuss its strategic partnerships with Sealed Air Corporation (SAC) and 3M, and portrays Ecovative as a "learning organization" built around the company's "core competencies".

Finally, we describe to what extent Ecovative's material innovation can be labeled a disruptive technology with the intention of renewing or "creatively destructing" the industry it operates in. We end this part with the impact evaluation path as a systematic way to assess the progress of an intervention from input to impact.



4 | Building a competitive advantage

4.1 | Platform technology

Ecovative uses what is called a 'platform technology'. That is, it uses its knowledge and specially designed equipment to produce a single base technology that can be altered to fit many markets. According to Simon (2012), "Building a powerful platform lets you cultivate an ecosystem of developers, partners, users, and other collaborators who contribute to – and may drive – innovation at your company".[16]

Ecovative's platform brings together mycelium and organic matter. That organic matter can be anything – ranging from agricultural byproducts such as corn husks to low value bulks of hemp – and turns the technology into a platform for experimentation and production. In other words, the technology is not a one-off, but a source for infinite creations of new compounds. Ecovative 'feeds' its platform technology two natural products:

- Fungal mycelium, and;
- Agricultural waste.

Firstly, the growing organism mycelium binds together the choice of feedstock as a natural resin. The type of fungal strain is a key determinant of the strength and characteristics of the final product. Each fungus has different opportunities on offer. Chief mycologist Sue van Hook explains that fungi have great insulating potential, are fire-retardant, can be both hydrophobic (water repellent) and hydrophilic (capable to interact with water), are a good cushioning material, and can be rigid. Moreover, depending on the growing conditions, Ecovative is able to tweak the density and compression strengths of the material.[17] The second natural product is the feedstock. Currently Ecovative uses various kinds of agricultural waste, collected in coordination with the US department of agriculture. Hundreds of feedstocks are being tested, since different raw materials in various blends create different material properties. Ecovative, consequently,

16 P. Simon "Don't build products, build platforms". Inc. Magazine, 19 March 2012.

17 Interview transcript Sue van Hook

constantly looks out for new feedstocks since they directly influence the characteristics and the performance of its end products. The possibilities are seemingly infinite, says chief mycologist Sue van Hook: "Tapping into nature's riches opens up a wondrous world of opportunities."[18]
The paragraphs below describe the technology when applied to the marketplace in terms of:

- Functionality
- Cost-competitiveness, and
- Sustainability.

In all these respects Ecovative's technology differs from two existing and competitive solutions: Expanded Polystyrene (EPS) (or Styrofoam), and Bio-plastics. To start our exploration the overview in table 1 (next page) compares all three solutions on the three criteria mentioned and some sub-criteria. Table 1 has been compiled using data provided by Ecovative LLC. Statistics are intended to elicit the main challenges Ecovative is currently facing. Please note that data may be subject to change.

4.2 | Functionality

As mentioned in §3.2, Ecocradle can function in various markets as a direct substitute for Expanded Polystyrene (EPS) and can be used for the shipment of most industrial and consumer goods. Ecovative's target customers ship items that require protection, weigh ≥ 10 lbs. and use custom molded shapes. The key proposition is that Ecocradle protects like EPS, but is also a hundred percent compostable. Ecovative also has competition in the form of bio-plastics, such as Polylactic acid (PLA) or Polyhydroxyalkanoates (PHA), or other alternatives like molded paper pulp. Besides some limitations that bio-plastics alternatives have in terms of environmental performance, they seem to perform far less in terms of cushioning and molding abilities. In addition, bio-plastics are often significantly more expensive[19].

18 See footnote #17

19 Data as provided by Ecovative Design LLC., Steelcase Inc. and Sealed Air Corporation.

* *The higher the R-value, the better the material's insulation effectiveness.*

** *Biodegradable polymers, such as starch-based blends require a price premium compared to conventional polymers such as EPS (Zheng & Yanful, 2005: p. 245).*

*** *(Expanded) polystyrene is non-biodegradable; its half-life is estimated to be so extensive that degradability is deemed negligible. In terms of recyclability, in practice only a tiny fraction of municipal plastic waste is actually recycled. The vast majority of plastics and foams end up as solid waste in landfills or incinerators (Gautam et al. (2007: p.86)*[20].

	EPS (E.g. Tegrant, Pregis)	Bio-plastics (E.g. Green Cell, Metabolix)	Ecocradle
Functionality	+++	+	++
Thermal*	R5	Not used	R3.5
Cushioning	++	+	++
Scalability	+++	++	+++
Cost-competitiveness**	++	+	++
Local production	++	+	+++
Raw material	Petroleum	Edible food crops	Low-value food crops
Sustainability***	--	+	+++
Input	Petroleum-based material, polluter and contributor to climate change	Edible feedstock, affects food supply	Low-value agricultural *by*-products
Bioconversion rate	0%	~10%	100%
Recyclability	Extensive half-life, usually 'down streamed'	High temperature processing required	Home compostable, renewable
Compostability	--	-/+	+++

Table 1: Competitive analysis protective packaging

However, an exact comparison remains difficult. PHA may be used for thin plastic sheets, whereas Ecocradle competes with foamed materials. Despite the fact that some of these bio-plastics have existed for a longer time and use a technology that is more widespread, bio-plastics are weakened by the fact that they have more geometrical constraints and a problem to many of the starch-based foams is that they dissolve in water.[21]

4.3 | Cost-competitiveness

Instead of requiring a price premium, Ecovative is able to offer an attractive value proposition. This value proposition stems from the low costs for raw materials, manufacturing and tooling, which enables Ecovative to be cost competitive in relatively low volumes (< 10,000 units), which in turn is essential to compete with the heavily commoditized EPS applications. The trick lies in the concept of the "**ideal conversion loop**". This basically means that one unit of feedstock grows into one unit of material. Ecovative's conversion loop fundamentally challenges those of its competitors. For example, the bio-plastic PHA needs three units of gas for one unit of product.[22] Instead, as CEO Eben Bayer explains, "the approach of using the feedstock in the final product, and using the entire organism without breaking it up afterwards, really gives you stellar economic advantages." Secondly, Ecovative successfully avoids having to use inputs that are becoming more expensive over time, whether they are fossil fuels (to produce plastics) or food stocks (to produce bio-plastics). Such solutions are essentially coupled to the same economics of the products they compete with. Instead, Ecovative uses different byproducts that only have a small cost, and are the opposite of volatile raw materials that fluctuate in price and availability regularly. "It is a wonderful way of picking new feedstocks", explains Sue van Hook.

20 Gautam et al. (2007) "A Review of Biodegradation of Synthetic Plastic and Foams". Applied Biochemistry and Biotechnology, 141 (1), pp. 85-108.
21 Interview Sam Harrington
22 Interview Eben Bayer

4.4 | Sustainability

As we see it, the core goal of the sustainability proposition is 'tapping into nature's riches'. By virtue of growing an organism that transforms agricultural byproducts into functional

composites, Ecovative's polymers are *readily renewable* and *environmentally benign*. As mentioned earlier, this biomaterial will not affect food supplies, unlike the production of bio-plastics. Also, Mycobond materials are completely compostable, unlike bio-plastics, which are only bio-degradable. Terms like "biodegradable" or "oxo-degradable" seem to be in vogue and are used to promote products made from traditional plastics that have been supplemented with specific 'degrading additives'[23]. The term suggests the product can undergo true biodegradation, whereas in reality the main effect of oxidation is only fragmentation[24]. According to the Bio-plastics council, a special interest group of the trade association SPI (Society of the Plastics Industry): "Fragmentation is not a solution to the waste problem, but rather the conversion of *visible* contaminants (such as bags) into tiny *invisible* contaminants (plastic fragments)." Mechanical engineer and Ecovative's marketing director Sam Harrington also defines biodegradable through a comparison with "compostable":

"Compostable means something turns into soil, biodegradable means just that something biological degrades it – and if that something degrades it into plastic dust, then that just makes it impossible to clean up."

Embodying the cradle-to-cradle principle

The cradle-to-cradle principle models industrial processes after nature's closed loop systems. The idea of cradle to cradle is that one process or cycle's waste serves as the basic resource for the next process. In other words, there is no waste, only production resources. Indeed, Ecovative uses streams of 'waste' that have served a different primary purpose.[25] Ecovative uses the production resources (mycelium and agricultural waste) and creates an end product, which is also 100% compostable and a resource for the next phase, process or cycle. The back-end solution of the process

23 Federal Trade Commission (2012) FTC "Green Guide", Revised October 2012. See: http://www.ftc.gov/opa/2012/10/greenguides.shtm

24 Bioplastics Council (2010) Position paper on oxo-biodegradables and other degradable additives, p.3. www.bioplasticscouncil.org Accessed 1 November 2012.

25 Interview Sue van Hook

allows Ecovative's products to be composted in a residential backyard. The mycelium is so potent that no waste is left behind. To illustrate, one of Ecovative's feedstocks are seed husks that contain lignin, a tough polymer found in the cell walls of plants. The only thing that degrades lignin in the environment is fungus.[26] Lignin is a waste product that in some industries, such as the paper industry, ends up polluting rivers and waterways.[27] With Ecovative's cradle to cradle principle, however, lignin is being sourced back into nature as an ingredient for something else.

Marginalizing energy use

As mentioned in part one, Ecovative grows its products without extra light, heat or air conditioning. For the few processes that do need energy, Ecovative works to reduce energy use in the following ways: Firstly, to pasteurize the substrate/feedstock, Ecovative experiments with "plant essential oil tinctures", which can be used as an alcohol to disinfect the feedstock mixtures. Secondly, casting can eventually make obsolete the plastic molds in which the materials are grown. Thirdly, solar-dehydration panels mounted on the roof can eventually replace the ovens in which Ecovative stops the growth process of its materials.

By keeping the feedstock local, and keeping the fungal strain local, Ecovative reduces all the CO_2 emissions normally involved with transportation. As such, Ecovative is fossil fuel *in*dependent, severely reduces energy use in the production process, and does not generate any waste consigned to landfills.

In addition, Ecovative is not dependent on any one feedstock, such as is the case with oil or gas. In the event of blight or other crop diseases, therefore, Ecovative can simply switch over to another feedstock. Indeed, options are numerous. For example, summer or winter strains that are adapted to warmer and cooler temperatures can be chosen according to the season and other conditions.

26 Interview Sue van Hook

27 See footnote #26

4.5 | Performance, price and sustainability combined: strategically siding with nature

The way Ecovative uses natural systems to produce functional composites has formed the basis for its current value and sustainable proposition. As we see it, Ecovative 'sides with nature' and uses abundant sources, which not only ensure its sustainability but also reduces its cost propositions. Packaging industry leaders and Ecovative's key customers have not previously encountered a bio-product with a cost structure that is competitive with foamed plastics. Angela Nahikian, director of global and environmental sustainability at Steelcase Inc., and Tim McInerney, product manager at Sealed Air Corporation[28], assert that Ecovative's technology truly offers a disruptive proposition: a bio-product at cost parity with conventional foams such as EPS.

Avenue to success: fungal physiology

But Ecovative's disruptiveness is ultimately demonstrated by the performance of its materials. "Now we're on performance parity with EPS," says chief scientist Gavin McIntyre, "but in the future we'll go beyond that." And Ecovative is planning to *better* the performance of EPS via "fungal physiology", the most state-of-the-art of its technologies. Fungal physiology is the third lever of Ecovative's technology. Next to changing the fungus and changing the raw material, Ecovative can now successfully use fungal physiology to apply chemical post-processing. The key opportunity with fungal physiology is in the chemical tweaking of the characteristics of "chitin", which is found in the cell walls of mycelia and is the same polymer that the external skeletons of insect bodies (e.g. beetles, scorpions) and crustaceans (e.g. crabs, lobsters) are made of. Ecovative draws inspiration from the ocean, which it sees as the archetypal chemistry lab. As Gavin McIntyre states: "So for example why is a lobster shell mineralized, whereas a fungal cell is not? It appears that if the environment in which an organism is producing the chitin is really rich and abundant in things like calcium bicarbonate, such as the oceans, it's really as simple as using baseline chemistry in order to quantify the characteristics and immersing it in a solution such as

28 Interview Angela Nahikian, Steelcase Inc.; interview Tim McInerney, Product Manager SAC. Note that both Steelcase Inc. and SAC are respectively clients and partners of Ecovative.

seawater to get the added characteristics." McIntyre wraps up: "So we ask ourselves things like, how do we make a surfboard made from lobster shell?

At the moment the design team in Ecovative's test laboratory (located at and also referred to as "60 Cohoes") can tweak the fungal chitin to such an extent that it becomes a hydrogel and can absorb water readily. As such, Ecovative has produced a "floral foam",[29] which is a 100% compostable instead of the conventional version made from oil derivatives. The applications of the material are numerous, while always preserving the sustainability proposition. As McIntyre notes: "It enables us to look at replacements for wood, table tops and things of that nature. Biochemistry processes could be very applicable in making very hard surfaces, without having any of the volatile organic compounds (VOC's), the bad chemicals required in engineered woods." Although Ecovative has been hailed as an example of bio-mimicry, Ecovative prefers the term "bio-adaptation" to describe this process. We come back to this terminology in section 8.1. In sum, many new market entry points present themselves as various companies are keen to explore the characteristics of the mycelium and the applicability to their respective industries. Since Ecovative can only dispose of a limited amount of resources, its main challenge is to carefully assess which market opportunities to scale up, and which to forgo.

5 | Strategic partnerships

Strategic and licensing partnerships play a crucial role in Ecovative's business model. Licensing deals, in combination with the platform technology are an integral element for the company's future success, as the Green Island facility is too small to reach the type of impact Ecovative wishes to make. Licensing agreements allow for a rapid distribution of Mycobond materials, using the capacity of partners with vast production capacities and logistical networks. Part of entering

29 Foams used in the floral industry, also known as OASIS® Floral Products

into new partnerships is the knowledge transfer that ensues. This section assesses such knowledge transfers, particularly in relation with the protection of Ecovative's intellectual property. This section will elaborate on the patent status of Mycobond as a key factor in the durability of Ecovative's competitive edge, before treating Ecovative's most notable partnerships individually.

5.1 | Intellectual property rights Mycobond™

Ecovative's intellectual property rights are related to using fungal mycelium as a structural component in materials, specifically as a resin to hold different particles together. Ecovative's manufacturing methods and the composition of its materials are pending patent approval in over thirty countries, including the US, China and Europe.[30] From interviews with Ecovative's management, it shows that important patents will be issued in the next 12-24 month in another dozen countries. "Patents are really limited time monopolies in a specific area", explains Charles Deull, "Patent rights go back to the time you filed, but they extend only a certain number of years from the time they are actually issued." This means that in some countries the patent will issue slower than in others. Ecovative continues to file additional patents around derivative technologies and reports that its technology is a novel and unexplored technique. So far, Ecovative has compiled a string library of over a 100 fungi. Ecovative has enjoyed the benefits of working for four years with Sue van Hook, who is a leading mycologist. Mycologists seem scarce and it has benefitted the company to obtain one. When we follow the judgment of the Ecovative team we can only conclude that Ecovative seems to be ahead of the curve regarding the development of commercially viable mycology-based solutions. No other company, as far as we can assess, is known to work with a similar technology – and should such a company start operations – Ecovative remains the pioneer having developed and worked with the technology for over six years. To what extent the technology is truly shielded from patent infringement, the researchers deem hard to determine. What can be said is that the legal divisions of companies like 3M and Sealed Air have scrutinized the patents and have deemed them strong enough to collaborate.

30 Ecovative marketing and business plan 2011

5.2 | "Accessing" versus "acquiring" knowledge

To scale up the production of Mycobond materials, and to fully capitalize on the growth potential of the platform technology, commercial partnerships are a key strategy for the Ecovative team.[31] We are interested in the relation between commercial partnerships and competitive advantage. Commercial partnerships are also prominently featured in the academic literature. Grant and Baden-Fuller[32], for example, describe competitive advantage as "knowledge that competing firms want to obtain" in order, as we would like to add, to outperform the competition. The authors apply this thinking in the context of strategic alliances, where two firms decide to join forces and therefore – to some extent – have to 'show their cards' to their new companions. A firm can take one of two positions: either *acquire* its new partner's knowledge or merely *access* it. Grant and Baden-Fuller argue that for success in the long run a policy of knowledge access has a longer life and in this way the alliance's stability will increase rather than decline with time. Therefore, the competitive advantage of strategic alliances is only sustainable, according to the authors, when based on knowledge *accessing* rather than on knowledge *acquiring*. Now we will apply strategic partnership logic to Ecovative's two principal partnerships; those with 3M New Ventures and Sealed Air Corporation.

31 Interview Charles Deull, board member Ecovative

32 R. Grant & C. Baden-Fuller (2004) "A knowledge accessing theory of strategic alliances," *Journal of Management Studies*, 41, (1), p. 61-84.

33 3M Corporation http://solutions.3m.com/wps/portal/3M/en_US/3M-Company/Information/AboutUs/ Businesses/NewVentures/ Accessed 23 November 2012

34 Interview Young-Jin, 3M New Ventures

3M New Ventures

The 3M Corporation operates six business units spread over almost 70 countries with a workforce of almost 85,000. 3M prides itself on its holistic innovation strategy, which aims to supplement the current brand portfolio with new innovative technologies where possible.[33] Ecovative has been described by 3M New Ventures, the company's new venture division, as one of the prime companies they want to invest in – especially because of its platform technology.[34] 3M New Ventures does not see its participation as a financial investment, but as a strategic investment and hopes to facilitate new applications for the Mycobond technology that can be used by 3M Corporate. 3M's innovation model is comprised of 46 platform technologies that are categorized in figure 7.

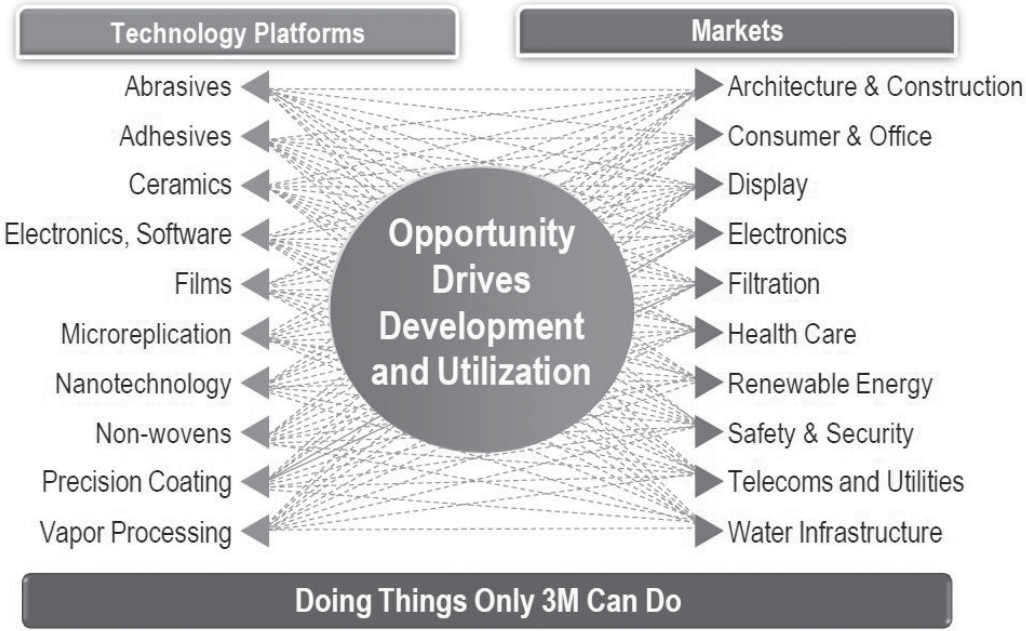


Figure 7: 3M innovation model

Currently, 3M is one of the leading investors in Ecovative. 3M explores Mycobond applications in its globalized (future) brand portfolio, though the intellectual property remains with Ecovative. In commercial partnership logic, we then characterize the partnership as a partnership of knowledge accessing rather than knowledge acquiring, which increases rather than threatens the resilience of Ecovative's platform technology.

Sealed Air Corporation

The Sealed Air Corporation (SAC) is the sole licensee of Ecocradle™ for the North American region and the agreement forms a transformation in the way Ecovative's identity is shaped towards an R&D company rather than a manufacturing company. By teaming up with SAC, Ecovative foregoes the opportunity of working with other licensees to manufacture Ecocradle. What does this mean for the anticipated distribution of Ecocradle in the packaging industry? SAC is built around five business units spread over more than 60 countries with a workforce of over 26,000 employees. Its food packaging and protective packaging business units together make up over 40% of the company's sales. Within the protective packaging space SAC offers a range of products that meet cushioning, void fill, containment, and surface protection needs. Although specific market share ratios cannot be disclosed, SAC is among the leading players in the protective packaging space.[35] The SAC partnership is the first of Ecovative's licensing agreements. The licensing agreement allows SAC to manufacture Ecovative's products without becoming owners of the relevant patents or technologies. With the license being active, SAC *accesses* rather than *acquires* Ecovative's knowledge. In turn, Ecovative accesses the production capabilities and vast logistic network of SAC. Ecovative benefits in two ways from the partnership:

- Regarding Ecovative's environmental proposition, the production capacity of SAC is being used to industrially produce Mycobond technology and distribute it on a commercial scale.

35 Interview Tim McInerney, SAC

- The partnership benefits Ecovative's price proposition, since Ecovative can carry on improving its platform technology and develop new Mycobond materials.

The Sealed Air partnership serves as a prototype partnership for future markets. With its unparalleled price and sustainability propositions, Ecovative's strategy will be to strengthen its material characteristics to such an extent that they perform on par or better than the materials it competes with. In each of its target markets, Ecovative aims to cause enough disruption to get the attention of large incumbent players, before these incumbents may enter as licensing partners. Parallel to scaling the distribution and manufacturing processes, Ecovative's success may be ultimately defined by how it can strengthen its disruptive proposition, or, can *sustain* its competitive advantage. To which extent Ecovative can constantly improve and expand its technology, using its core competencies, is the topic of the next section.

6 | Sustaining Ecovative's competitive advantage: Learning organization

Ecovative can be characterized as a "learning organization".[36] At the core a learning organization is an organization that continuously captures its organizational knowledge, and, as such, is able to cope with organizational change. Prahalad and Hamel (1990) describe such collective learning as a necessary condition to remain competitive in the marketplace. Ecovative's organizational learning leads to the fact that they can sustain their competitive edge. The concept of a learning organization we see particularly relevant to Ecovative since knowledge sharing is at the core of the organization. Continuously new solutions are being invented, both within the organization and in conjunction with external parties, i.e. the licensing agreement with SAC.

36 Prahalad and Hamel (1990) "The core competencies of the organization" *Harvard Business Review*, p.79-91.

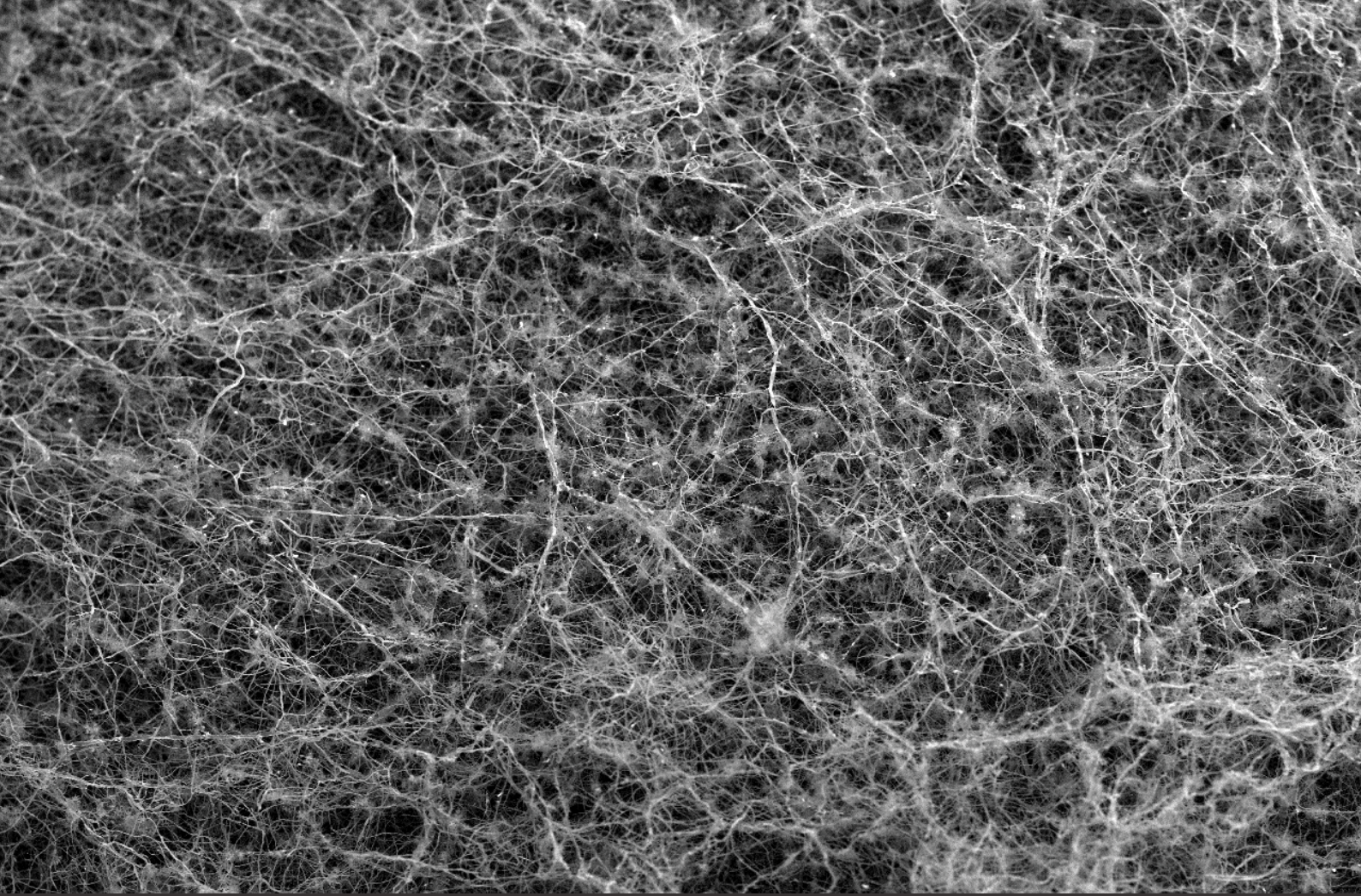
Most importantly, we see Ecovative sourcing individual knowledge into the general consciousness of the company. For example, Sue van Hook performs a specific teaching role: she teaches both management and production line staff on a variety of technological issues and dissipates knowledge throughout the company. Sue actually aims to bind together all the employees' knowledge much like how the mycelium binds together the feedstock. To illustrate and to highlight the humble beginnings of it all, here follows one of the first questions Sue posed to Eben and Gavin:

"So do you know anything about mushrooms?"

They replied:

"We ate a few, that's all."

Because of Sue's teaching, Gavin has developed one of the most inspiring commercial environments for developing, producing and selling mycelium-based solutions. Also, employees are encouraged to generate personal wiki pages, with which they keep track of their achievements, and are accessible to all. Important success features of an intangible nature, i.e. reputation, experience, company culture, *and knowledge* can help to sustain Ecovative's competitive advantage as defined in section 5.2. The collective learning of an organization helps the organization to change and successfully adapt to its environment.



7 | In pursuit of the next dominant design

To evaluate the chances for survival of Ecovative as a rising company, we must also incorporate the concerning industry dynamics. As such, we introduce the theory of "cycles of technological change"[37]. This concept helps to place Ecovative on an industry progression curve and constructs a baseline post hoc for future reference. As such, we take into account the environment of the given industry to more aptly assess the extent of Ecovative's disruptive potential.

The theory of cycles of technological change claims that technological developments – in a wide array of industries – progress in repetitive fashion along discernible patterns[38] and Tushman and Anderson explain the cyclical process as follows:

"An industry evolves through a succession of technology cycles. Each cycle begins with a technological discontinuity. Discontinuities are typically breakthrough innovations that advance by an order of magnitude the technological state-of-the-art that characterizes an industry. They are based on technologies whose technical limits are inherently greater than those of the previous dominant technology, along economically relevant dimensions of merit."

37 Tushman and Anderson (1991) "Managing through cycles of technological change" Research Technology Management, 34, 3, p. 26

38 Tushman and Anderson (1990) "Technological discontinuities and dominant designs: a cyclical model of technological change". Administrative Science Quarterly, 35, p. 604-633.

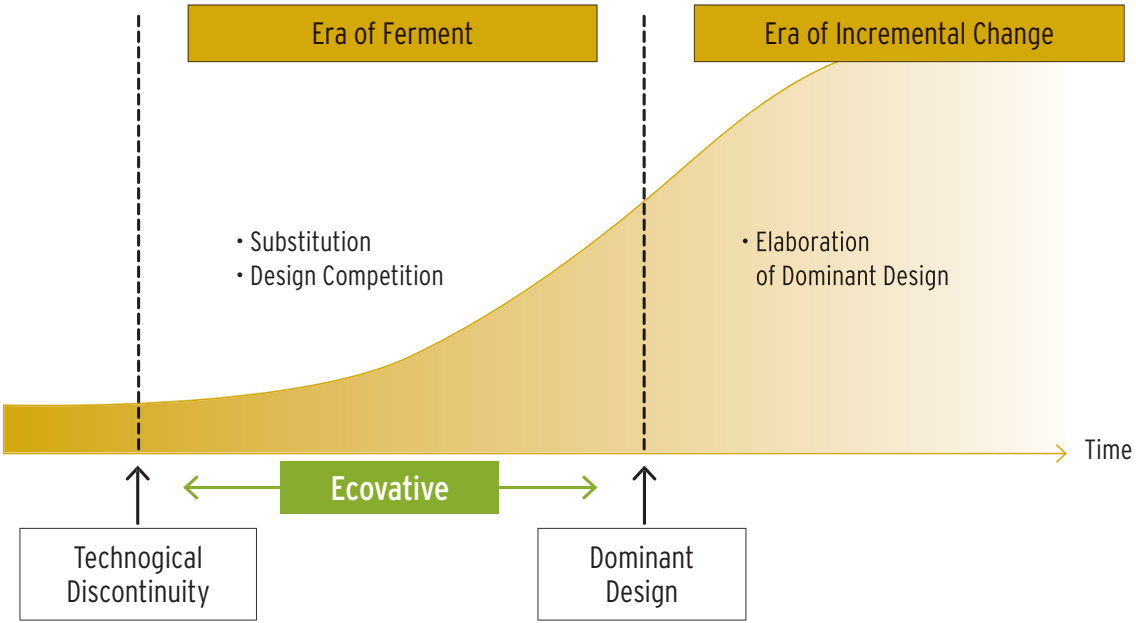


Figure 8: Disrupting Technologies (Tushman and Anderson, 1991)

In order for Ecovative to deliver the next dominant design it needs to successfully substitute the incumbent technology (Styrofoam) and triumph over the subsequent design competition (successful scaling and collaboration with Sealed Air, and other potent partners). Ecovative points out that it is constantly evolving, making the Mycobond material lighter, softer, less abrasive, and always changing its properties. In relation to the theory of technology cycles, Ecovative can currently be placed in the *era of ferment*. As Sam Harrington explains, "Being a disruptive technology, many of the characteristics are not as good as a refined product, like plastic that's been out over a fifty years."[39]

One of the reasons MycoBond technology is seen as disruptive is that it requires more than simply taking mushroom pellets and importing them into a plastics extruder. Ecovative ideally makes this process obsolete. As such, Ecovative is trying to bring about a paradigm shift in the plastics industry to get its incumbent competitors listening. In teaming up with Sealed Air, Ecovative has found a Fortune 500 company dedicated to:

- Adapt its infrastructure,
- Support the platform technology, and;
- Make the collaboration as successful as possible.

As such, Ecovative has succeeded in insuring itself against the principle risk discussed in the academic literature concerning disruptive innovations, which is that the innovator's technology is copied and brought to the market by an established industry incumbent.

7.1 | On being disrupted

To provide a complete perspective on the theory of cyclical change in a given industry, we consider here the possibility of other solutions that will in turn "disrupt" Ecovative. Thus, we must count with the possibility that Ecovative will itself be disrupted. If this occurs, Ecovative's management argues that such a new disruption:

39 Interview Sam Harrington

- Challenges Ecovative's *polymer* rather than its entire *technology*: The technology is awaiting patent approval, but cannot cover every possible polymer. Mycelium may not be the best polymer. Eben: "What for example if you could work with the polymer found in rhino tusks, that's a neat material."
- Sheds new light on Ecovative;s current value proposition and adds even more value to consumers than Ecovative's compelling and sustainable proposition does in today's environment.

Ecovative is ahead of the curve with its knowledge and expertise and its technological platform. It is lagging the competition, however, when it comes to the functional characteristics of a commodity like Styrofoam, which has a complete infrastructure in place and proven functionality records. As such, Sealed Air is an anchor client since they are helping Ecovative put a Mycobond infrastructure in place. Unlike what SAC does, most novel technologies are typically drop-in replacements that uphold the current industry infrastructure. As Sam Harrington explains: "Anybody entrenched in plastics, would sort of need to scrap everything. So if they can make this incremental improvement that makes it 10% better, or make it sound better, they're going to make that choice."

Whether Ecovative may at some point itself be disrupted by a competing innovation remains hard to determine. New initiatives do pop up, but Ecovative with partners like SAC, 3M and DOEN Foundation it is at least well prepared to enter the fight with new competitors. Examples of potential competitors from the bio-plastic / bio-polymer field are:

Domestic market

- KTM Industries produces "Greencell" foams from corn starches and is able to create corrugated foam as a replacement for EPS foams. As menti oned earlier, a disadvantage is the fact that edible food crops as feedstock on a greater scale impact global food supplies. Greencell foams are industrially compostable and are being sourced to a variety of US customers.[40]

40 http://www.greencellfoam.com/content/tech_data.php Accessed 4 January 2013

- The public company Metabolix produces a range of bio-based, bio-degradable, and chemical alternatives to petroleum based products, most notably thin plastic films. Metabolix can be considered as an example of an incremental innovator of conventional plastics. Metabolix recently marketed a new biopolymer product, "Mvera"[41], which is an industrially compostable film used for (organic) garbage bags and shopping and retail bags. The resins are made in a fermentation process using plant-derived sugars. According to investment bank ACI[42] the production of this bioplastic still requires a significant price premium, which is likely to count among the reasons for former key partner Archer Daniel's Midland (ADM) Company to withdraw from the partnership. However, Metabolix shows its ambition to enter other regions as they recently entered into a distribution agreement with Kenmare Srl., a European partner and packaging distribution company.[43]

- Mango Materials (MM) is a US company that collects methane from landfills to produce a biodegradable plastic. Tapping methane from landfills allows for a smart way of collecting natural gas and MM uses bacteria to turn the methane into a biopolymer. Using natural gas, however, does not decouple MM from the petrol market, and thus relies on a raw material that is essentially finite and expected to become increasingly more expensive. What is striking, is that MM's bacteria, just like Ecovative's fungi, digest toxic gases and turn them into usable contamination-free materials. Mango Materials was founded in 2010 and shows its future potential by having won the PCL Green Challenge award in 2012.

Foreign markets

Outside of the US, sustainable packaging is also being pioneered. As an example, we mention Synbra Holding Group, based in the Netherlands. The Synbra group operates 26 business units in six European countries. What is special about Synbra is that besides conventional EPS, they produce bio-plastics such as Polylactic Acid (PLA) at industrial levels (current capacity of 5000

41 Businesswire http://www.businesswire.com/news/home/20121203005187/en Accessed 4 January 2013

42 Ardour Capital Investments http://www.icis.com/Articles/2012/03/12/9539958/telles-failure-highlights-risks-of-technology-development.html Accessed 4 January 2013

43 Metabolix http://ir.metabolix.com/releasedetail.cfm?ReleaseID=726391 Accessed 4 Januart 2013

tons/year). One of Synbra's most innovative and sustainable products is Biofoam©.[44] Biofoam's feedstock is sugarcane, which after processing is formed into pellets and can be processed in standard plastic molding facilities. Biofoam has some strong sustainability features, such as "cradle-to-cradle" certification and the fact that it is *industrially*, i.e. not 'home', compostable. However, for the near to long term, Synbra firstly seeks to consolidate the European market and does not have capacity and/or inclination to expand to other regions. As mentioned in part two, bioplastics are an incremental improvement and other disruptions do not seem to arrive to industrial production levels in the near term (0-5 years).

In sum, when we consider the competition and/or possible disruptors to Ecovative, we cannot locate any direct rivaling innovations. What we do see, is an established industry with a functioning infrastructure that provides low-cost solutions to virtually anyone's packaging needs. Although Ecovative hopes to challenge this cost proposition in the near term, the market's focus on improving sustainability records will prove to be crucial to Ecovative's success. To uphold current infrastructures, incumbent players are likely to explore 'drop-in' replacements first. Bioplastic producers – despite the price premium they currently ask – seek to answer to this demand. Therefore, it is likely that Ecovative's competition will come in the shape of a drop-in replacement, which capitalizes on "market inertia", or resistance to change. Most importantly, Ecovative's learning capacity makes it fit for a competitive struggle in an exciting but challenging environment. In the end, however, as we have seen with other fundamental changes in the industry, it will not only depend on the companies that are in fierce competition, who will ultimately provide the dominant solution. It will also depend on, for instance, the state of the art of the technology, the regulatory environment, the capacity to deliver, and, ultimately, a bit of luck. Apart from the last element, which no one is able to control, Ecovative seems well prepared to face the competition.

44 Biofoam http://www.biofoam.nl/index.php?page=synbra-technology-bv
Accessed 1 December 2012

8 | Assessing Ecovative's impact on the packaging industry: an indicative approach

How can we measure the (potential) impact of Ecovative's solutions – both in terms of its technology and its platform – in the global market of packaging? According to the literature[45], an impact assessment starts with a baseline study explaining the objectives of the intervention. With the intervention both the management and the investor have some clear objectives that they want to realize. The question now is whether they have made any progress in establishing change and furthering their objectives. Unfortunately, DOEN conducted no baseline study prior to the investment. Expectations were shared, which is, however, not the same as executing a proper ex ante study outlining the change that both investor and management foresee. Also, no comparison with a comparable study can be made, since no control group was established at the start of the investment process. That leads to the conclusion that only a 'post-test' evaluation scenario is available to assess the impact of the intervention. As box 1 shows, this is considered to be one of the weaker evaluation scenarios. Add to this observation the limited time and resources available to conduct this study and we have sufficient reason to denote this analysis as an **evaluative scan** rather than a full-fledged evaluative study.

8.1 | Methodology

To substantiate the investment and enterprise theses, twelve interview meetings have been conducted with a selection of key stakeholders who were chosen on the basis of expertise and to reflect a variety of viewpoints: of the investor, of the investee and of client and partner organizations. For the full list of interviewees please see appendix A. Most interviews were conducted in person, whereas others were conducted using teleconferencing software such as "Skype". Average length of the interviews approximated one hour.

45 Bamberger, M. (2006) "Conducting quality impact evaluations under budget, time and data Constraints." World Bank, Independent Evaluation Group (IEG), Washington, D.C.

The impact evaluation path in box 1 requires us to focus on the investment theory. The investment theory can be defined as how and why a particular investment will pay off. Measuring progress helps to define whether the focal company lives up to the expectations set out in the investment theory. Paragraph 4.5 learned that DOEN regards Ecovative as a team of pioneers that generates positive outcomes in the fight against climate change. DOEN holds certain more specific investment expectations, and it is our objective with this impact scan to assess the (potential) impact of Ecovative's products and technology solutions on changing the current packaging sector. We will, therefore, connect 'input' with 'impact' (as seen in figure 9) by focusing on the different involved stages of an impact assessment such as activities, outputs and outcomes. As the final step in box 1 suggests, mixed methods have been used to validate findings as much as possibe.

The research design now requires us to analyse the investment theory and try to find evidence on Ecovative's evolution as an innovative material sciences company and its initial successes (or failures). In addition, we will analyse alternative data sets that shed some light on the progress the company makes in fulfilling its ambitions – as laid down in its investment theory. An important question is what criteria and indicators we will use to decide whether Ecovative is on the right track and what potential it has to create impact in the world of packaging and beyond?

Taken together, the program theory approach allows tracking the micro-steps that lead from program inputs through to outcomes. The findings are obtained from the interview meetings and functions as a descriptive component by providing snapshots at a series of specific moments (cf. Bjurulf et al., 2013). We have selected three criteria from the evaluation literature: 'enlightenment', 'adoption' and 'goal attainment' to help shape the indication path that links input to impact.

The impact evaluation path from the perspective of the evaluator

1. Every evaluation starts with the fundamental question: ***"Does the investor want to know what impact the investment has created?"*** Is the answer:

a. Yes, go to 2
b. No, negotiate with the investor on (the depth of) his evaluation objective

2. Are there any constraints in terms of budget, data availability and time?

a. No, go to 3
b. Yes, negotiate with the investor the limits of the evaluation in terms of resources

3. Design the evaluation and choose the strongest research design depending on investors' needs:

a. Pre-test post-test of investment group and comparison group(s)
b. Pre-test post-test of the investment group; post-test of comparison group
c. Delayed pre-test post-test of investment group and comparison group
d. Post-test comparison of investment group and comparison group
e. Pre-test post-test comparison of investment group
f. Post-test analysis of investment group

4. Develop the investment theory

5. Select alternative data sources and conduct secondary data analysis

6. Use mixed methods to validate the findings as much as possible

Box 1: The impact evaluation path

From input to impact

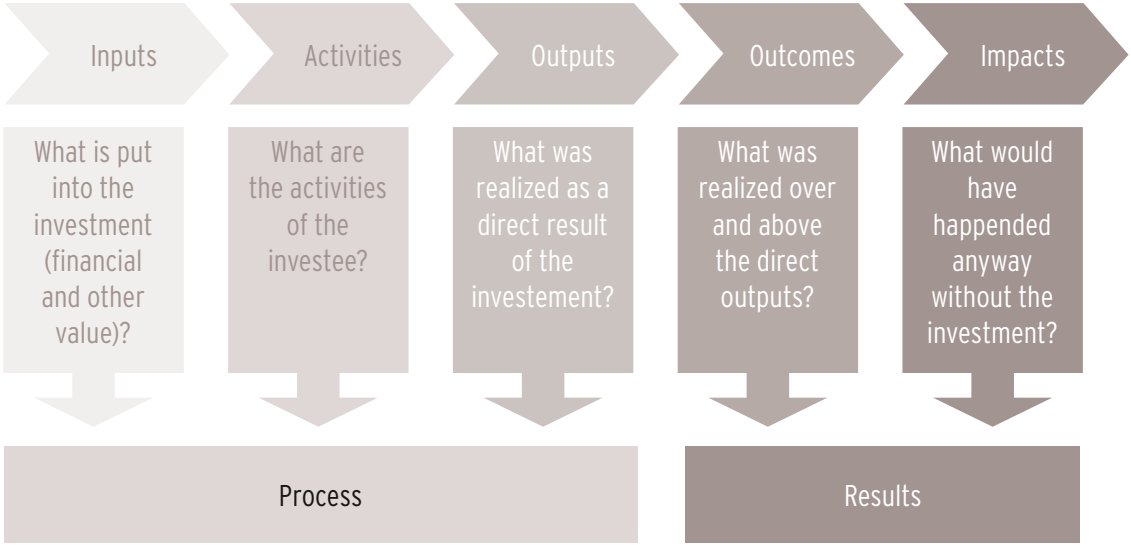


Figure 9: From input to impact. Linear program theory model as also described by Coryn et al. (2012)

Enlightenment refers to what extent the innovation punctures old myths and offers new perspectives and – as such – is reflected in the current state of mind of the popular and scientific thinking.[46] We have operationalized enlightenment by looking at the media attention Ecovative received (particularly by relevant industry press).
Adoption[47] can be described as to what extent and by who these ideas have been embraced – as reflected in concrete solutions. Adoption was operationalized by the extent to which Ecovative found co-producers or co-developers of its technology.
Goal attainment, finally, refers to what extent the goals as set out in the investment thesis have been achieved.[48] Goal attainment was thus operationalized by comparing investment goals with company achievements.

Note that these criteria were chosen to be able to describe the evolution of an innovative technology from a bird's eye perspective. The ultimate payoff of the investment, replacing plastics such as EPS in a variety of markets, will only demonstrate itself in the long term. Therefore, the ongoing monitoring of the investment into the future on a set of particular (environmental) indicators we deem highly useful. The Impact Reporting and Investment Standards (IRIS) – a Global Impact Investing Network program to develop a taxonomy for measuring impact – provide a useful framework for the analysis of the current investment case. In appendix B we suggest a selection of IRIS indicators that can be used for monitoring into the future. As such, the three criteria and its operalizations by no means paint an exhaustive picture, however, within the scope of the research they provide a systematic account of Ecovative's development as a provider of an innovative platform technology.

Impact, *ultimately*, refers to the extent the attainment of the goals can be attributed to the particular intervention and is described in the evaluation literature as a "perennial challenge" because of the multitude of potentially influencing variables.

46 Weiss, C. (1999) "The interface between evaluation and public policy." *Evaluation,* 5, (4): 468-486.

47 Tornatzky and Klein (1982) "Innovation characteristics and innovation adoption-implementation: a meta-analysis of findings. *Transactions of engineering management*, 29, (1): 28-46.

48 Marra, M. (2000) "How much does evaluation matter?" Evaluation, 6, (1): 22-36.

In this sense, it is way too early to decide on the effective use of Ecovative's solutions to solve some of the problems (like reducing the plastic soup in the world's oceans) to which Ecovative aspires to contribute, let alone prove that such outcomes can be attributed to precisely DOEN's involvement Indeed, according to the literature, "Innovations are generally long term in nature […], the progress uneven rather than continuous and the payoff rarely immediate".[49] But what we can do, in order to be able to shed light on the impact of figure 9, is to chronologically reconstruct the processes, outputs and outcomes during the evolution of Ecovative at the time they received support by the DOEN foundation, which will be the subject of part III.

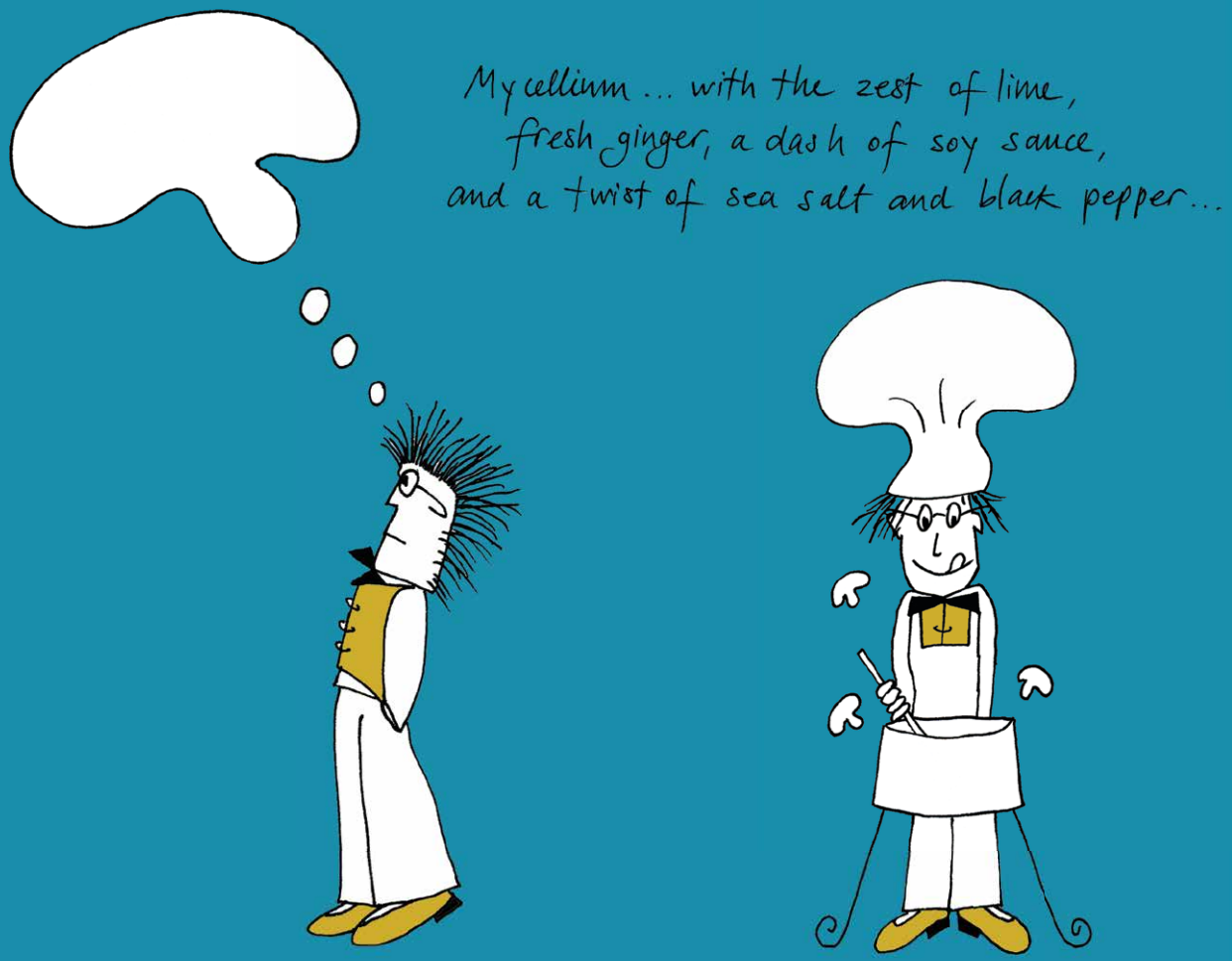
Concluding remarks to part II

Based on the competitive analyses in the first three sections, we have been able to place Ecovative on a curve that follows the typical development of technological discontinuities. We concluded that Ecovative (in the packaging space) can be positioned in the so-called 'era of ferment,' a period of tweaking existing technologies while competing for scalability. The licensing deal with SAC will prove to be an anchor point for success in this regard, and a step further in Ecovative's pursuit of delivering the next dominant design. Ecovative's sustainable and well-protected competitive advantage lies in the fact that its price and sustainability propositions remain unparalleled. In addition, its Mycobond technology is pending patent approval in over thirty countries and has applications in a widening array of markets. The seemingly infinite applications of its products and feedstock mixtures make ubiquity of the material at least theoretically possible. To keep the productive knowledge within the company, we have seen that Ecovative is a learning organization with a culture based on a strong mission, which *sustains* Ecovative's competitive edge. Taken together, these sections have described Ecovative's intention of "disrupting" or creatively destructing the industry it operates in and delivering the next dominant design.

49 Perrin, B. (2000) "How to and how not to evaluate innovation". Presentation to the UK Evaluation Society Conference, London. 8 December, 2000.

As we have discussed, Ecovative aims to achieve this by continually "siding with nature": Ecovative capitalizes on nature's abundant resources to secure its price and sustainability propositions. Fungal physiology is the latest of techniques harnessed by the company and promises to out-compete plastics in terms of functional performance. Furthermore, the company's culture has many of the characteristics of a mycelial network itself: as natural glue it strengthens and weaves Ecovative's partnerships together – both internally with its workforce and externally with partners like SAC – and embeds knowledge and strength in its relationships. Regarding Ecovative's impact, the R&D facility at 60 Cohoes Avenue, Green Island, performs the role of developing new Mycobond based products, whereas Ecovative's pilot manufacturing facility assesses whether these applications have commercial potential. If new applications do not survive in the manufacturing facility, these new applications are unable to create the "impact" envisioned in impact investing. As such, we come across an essential characteristic of the impact investing equation: *without commercial viability there is no impact*.

Using strategic management literature, part two has discussed Ecovative's competitive position and shed light on Ecovative's 'chances for survival' in the packaging space and beyond. Walking the 'impact evaluation path', we propose a systematic way to evaluate the goals, outputs and outcomes as put forward in the investment thesis. More specifically, to which extent DOEN's investment has benefited Ecovative's competitive position or has increased its chances for survival will be the subject of part three.


Mycellium ... with the zest of lime,
fresh ginger, a dash of soy sauce,
and a twist of sea salt and black pepper...

Part III

Interplay DOEN & Ecovative

Typically, the early development of companies is contingent on access to favorable types of capital. The pioneering and R&D activities of a startup company may be hampered by investors that place returns on investment or on assets above all. Startup companies working with financiers with a long term horizon and a willingness to assist management in realizing their financial and societal objectives can design their pioneering R&D differently.

This part focuses on the interplay between Ecovative and DOEN Foundation as the supplier of sustainable finance. We will use the concept of the "double helix" to characterize this interplay. This double helix is composed of two strands that enable genes to replicate by constantly forming new connections. Likewise, Impact investing is founded upon the idea of forming new connections between the financial string and the string of the real or corporate world. Innovative companies need suppliers of capital acting as enablers for growth and change, while responsible financiers require real world investments to realize their societal potention.

The following sections assess to what extent Ecovative's evolution and its competitive position can be linked to the repetitive financial involvement of DOEN Foundation. Because measuring innovation is a complex process and covers a long time horizon, we use the criteria introduced in part 2 to interpret the development of Ecovative. Enlightenment, adoption, and goal attainment are used to shed light on the inputs, processes, outputs and outcomes of Ecovative's platform technology and its partnerships with leading companies. We conclude with how Ecovative itself has adjusted its ambitions and shaped its 'theory of change' and analyse the role

9 | Reaching relevant audiences and punctuating existing beliefs

9.1 | Enlightenment

An indication of broader impact by Ecovative is provided by the news coverage it receives, which in the evaluation literature is denoted by *enlightenment*. The extent to which Ecovative and its products are picked up by the popular and the scientific press – while the solutions of the competition are not or to a lesser extent – provides us with an indication that Ecovative's solution may be viable. More important, however, than the news itself is whether the coverage actually is picked up by – or trickles down to – relevant audiences. Among others, these audiences consist of politicians, regulatory bodies, and academics proving the viability of Ecovative's technology, potential business partners, or potential consumers – and particularly those that are currently making use of non-sustainable solutions. Although it is difficult to measure the effect Ecovative's creativity has on all of these audiences, we do find a clear indication of the viability of their ideas when we look at the coverage of their ideas in the relevant industry press. What is important here is that the news has trickled down and reached wished-for audiences.
See figure 10 (next page).

Another indication that Ecovative is in on the right track is provided by ongoing developments in the packaging industry concerning sustainability standards. Even though the standards have not been influenced by Ecovative's pioneering work the company and the standards are 100% aligned. It is actually more the other way round: Ecovative was positively influenced by the development of the new standards – a case of 'dynamic enlightenment'[50] – even though the standards were not even available at the time Ecovative started building the company.

Standards are used to prove conformity with technical requirements and whereas they are often not official legislation, they are generally accepted norms. Standardization bodies such as the

50 With 'dynamic enlightenment' we refer to the process that Ecovative was actually able to inspire and influence its network environment – in terms of media, industry, investors, et cetera – through the enlightenment that resulted from the process of standard setting. So, Ecovative was influenced and influential at the same time.

Figure 10: Trade press coverage 2007-2012

International Standards Organization (ISO), and regional regulatory bodies such as the European Union (directives on packaging and packaging waste), increase and emphasize their requirements for degradable/compostable and other sustainable packaging materials. The most recent of developments regarding international standards for packaging and the environment come at the account of ISO, which oversees the widely used series of ISO certifications. For the protective packaging market, a new ISO subcommittee called "Packaging and the environment"[51] has developed six standards that have come into effect 7 December 2012[52]. These standards address source reduction, reuse, recycling, energy recovery, chemical recovery, composting and biodegradation.[53] This is in line with findings from industry trend experts (most notably The Freedonia Group as a leading expert) who foresee:

- A growing emphasis on packaging sustainability, especially in developed countries with more established environmental regulations.
- Tightened legislation that will constrain the potential for conventional foamed plastic protective packaging to some extent, and:
- Performance and environmental advantages among the main factors driving growth.[54]

Such trends and increased focus on sustainability features, creates increasingly favorable industry conditions for Ecovative. Also, this encourages new innovative companies to jump on the environmental bandwagon and increase the sustainable market scope. Ecovative actively reinforces this trend by promoting its technology at a variety of stages, including trade shows, conferences, and other associated events.[55] As such, we see a virtuous cycle of favorable industry dynamics and pioneering companies such as Ecovative.

Positive press coverage and full alignment with the latest standards lead us to conclude that Ecovative is clearly creating prolific fungal solutions and a successful platform technology that will ultimately contribute to reducing the problems which Styrofoam creates. Since we have not

51 Greener Package, http://www.greenerpackage.com/metrics_standards_and_lca/global_standardization_around_sustainable_packaging Accessed 10 November 2012

52 Nederlands Verpakkingscentrum, interview meeting with secretariat 29 November 2012

53 Environmental and Energy Management News http://www.environmentalleader.com/2009/12/10/iso-begins-work-on-international-sustainable-packaging-standards/ Accessed 22 November, 2012

54 The Freedonia Group http://www.freedoniagroup.com/brochure/28xx/2839smwe.pdf Accessed 12 November, 2012

55 Eben, Gavin and Sam are regular speakers at events including TED talks, Poptech, WEF Davos, and a variety of trade and industry shows.

made a comparable analysis of Ecovative's competition we cannot assess the success of alternative solutions. However, looking at popular and academic articles we do not find alternatives that are presented and discussed as much and as vigorous as Ecovative's solutions. This at least provides an indication that Ecovative is on the right track.

9.2 | Adoption and goal attainment – Ecovative's step towards proliferation

To interpret the notions of adoption and goal attainment, we will offer a chronological overview that describes the milestone events in the evolution of Ecovative. Closely related to the proliferation of Ecovative's technology is its current strategy of 'related diversification'. A strategy that allows Ecovative to mitigate risk and position itself for maximal impact: The platform technology in liaison with its licensing strategy forms an important accelerator for growth and impact.

Adoption encompasses *the overall proliferation of the technology*. Licensing partners are a good example, the agreement with SAC is a direct example of adoption, but also the strategic partnership with 3M as it was intended to jointly develop new materials. Through these alliances Ecovative can further expand its market reach. We regard the adoption of the technology as a predictor of goal attainment: With the spreading of the technology, sustainability standards can be increased to ultimately fulfill the goals as set out in the investment and enterprise theses.

We subdivide the notion of goal attainment into *short term* goals and *long term* goals. Short term goals on behalf of the financier refer particularly to the investment objectives (as set out in the investment thesis), while the long-term goals refer particularly to the enterprise objectives (as set out in the enterprise thesis)[56]. No innovation, however, can become a truly global solution for fighting environmental degradation without the involvement of capital. Following initial grants very soon other types of capital with different risk profiles – ranging from seed capital to private equity and from private debt to (very often) public equity – are required to finance

56 Obviously, the financier or investor can be motivated by, or even finds the reason for investing in the long-term objectives of the enterprise. In addition, however, it is only with a few exceptions that investors and financiers do not have financial objectives on the relatively short term. Those exceptions can be found in the world of philanthropy and, sometimes, in that of impact investing. But most investors require market rate returns on a 3 to 5 year basis.

growth. DOEN Foundation has played a central role in providing Ecovative with the capital it required in the first stages of its development so far.

9.3 | The role of DOEN Foundation as a financial enabler of change

DOEN's involvement can be divided into two parts. The first involvement concerns the prize money awarded by the Postcode Lottery's (PCL) Green Challenge award (administered by DOEN), while the second involvement – and focus of this report – consists of DOEN Participations' investments in 2010 and 2011.

We clearly distinguish between the grant pipeline that forms the main source for Ecovative's R&D activities, and the inflow of capital coming from investment parties that bear investment risks. To reconstruct the growth path of Ecovative, we list certain key events that relate to winning the Postcode Lottery's prize money, which in turn emerges as a catalyzing force to acquire other grants. For a chronological breakdown of Ecovative's grant pipeline see table two below. It is of use to note this pipeline since it is a substantial factor for Ecovative to develop particularly as a R&D company. The R&D focus of Ecovative, in combination with its licensing model, is ultimately believed to realize the technology's maximum impact. See table 2 (next page).

To reconstruct the change Eben and Gavin have experienced, we go back to the founding of Ecovative in 2007 when RPI professor Burt Swersey stressed the exceptionality of the idea and the project consequently began to evolve. After initial tests with the technology, they started asking themselves; in what sectors might this technology be valuable? From early on, Ecovative chose agricultural waste stocks, instead of food crops, which led into a philosophy of not just making materials neutral, but making products truly sustainable.

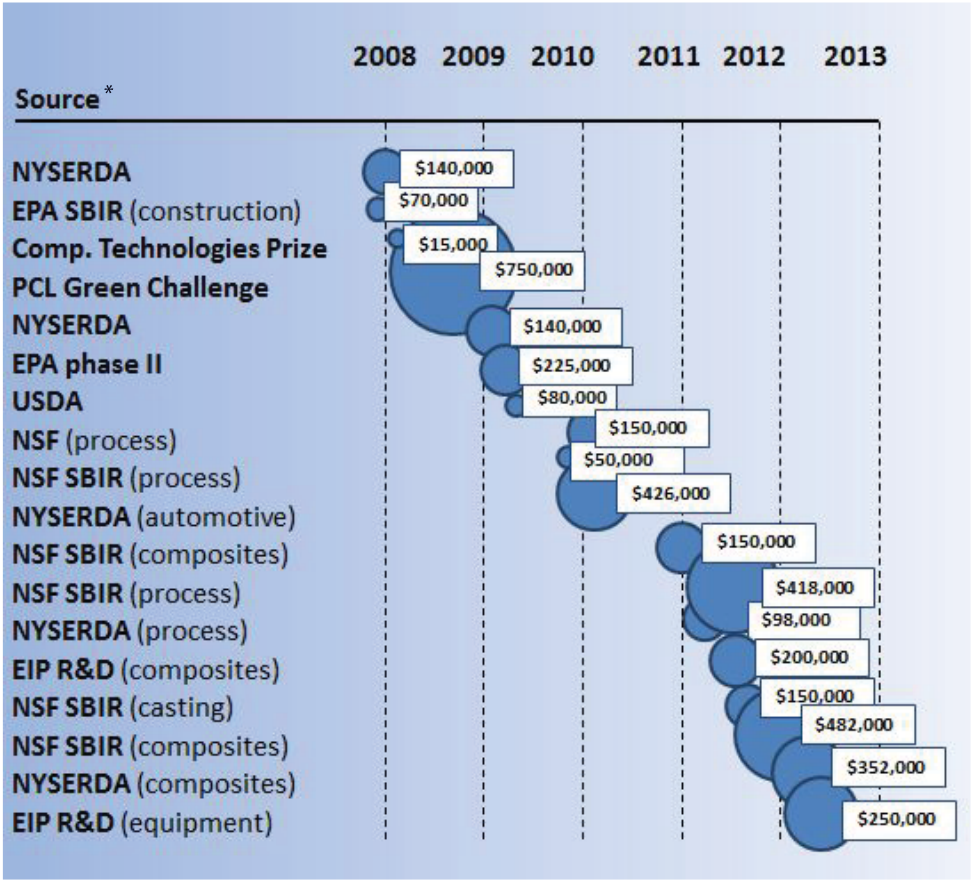


Table 2: Grant pipeline Ecovative, totaling $4,15M in grant and award money

** NYSERDA (New York State Research Development Authority), EPA (Environmental Protection Agency, SBIR (Small Business Innovation Research), NSF (National Science Foundation, EIP (Environmental Investment Program).*

2007-2009: Initial grants and first notable prize money from the PCL

The period 2008-2009 was defined by winning a breakthrough competition in the form of the PCL Green Challenge award[57]. At that time Ecovative consisted of about five people, but with the prize money they could expand that team. In doing so, Ecovative outgrew RPI's basement incubator and started with the construction of a facility of its own. Previous grants mainly tested proofs of concepts, with goals such as: grow ten rectangles and measure the properties[58]. However, the Green Challenge allowed Ecovative to take the idea to the next level. Sam Harrington explains the impact of the PCL prize money was significant in the following way:

"To get that money from somewhere else it would've taken us much longer, and I think we'd be in a much worse place now if we hadn't won that prize."[59]

During the period 2008-2009 the research grant pipeline is also reinforced by additional commitments from the US government, now including the department of agriculture (USDA). Sue van Hook, who was responsible for applying for the first EPA grants, explains that the recognition from Europe – in the form of the PCL award and DOEN's corollary involvement – was actually an impetus for the EPA to support Ecovative with its first substantial funding: a commitment from the EPA in 2009 of $225,000.

"The Green Challenge and with it the recognition from Europe, got the EPA really impressed."[60]

57 Before winning the Green Challenge Award Ecovative already won several ≤ 20k business competitions in the US and the UK, and also secured its first research grants from federal bodies such as the New York State Research and Development Authority (NYSERDA), as well as the Environmental Protection Agency's (EPA) Small Business Innovative Research (SBIR) program – intended to explore applications in the construction industry.

58 Interview Sam Harrington

59 Interview Sue van Hook

60 See footnote #59

The PCL prize money allowed Ecovative to move to Green Island, NY, where a 10,000 square feet facility would soon provide the space for Ecovative to grow its operations. Eben recalls the fact that competitions like the Green Challenge gives one the opportunity to dream, as big as possible:

"The whole energy is about making a big impact. Actually winning it is more of the opposite, then you realize you have to do all of them. You have to deal with the fruits of your ambition."[61]

The prize money gave Ecovative the ability to talk to customers, to put it at the vanguard in the environmental sector, and enable it to move to Green Island, where it built the plant at 60 Cohoes Avenue. The move to Green Island and its corollary ability to expand its team size meant that Ecovative could start growing prototypes and approach real customers. Besides Sue van Hook, another key member was hired: mechanical engineer Ed Browka. Burt Swersey recalls: "Ed was really someone who made do with what he had. He literally built the first machines and got operations going."[62]

2009-2010: DOEN enters as investor alongside private parties

After extensively looking at the technical aspects of their materials, now Ecovative needed to prove its commercial viability. As such, the period 2009-2010 represented yet a new phase for Ecovative. With the factory up and running, contacts had to be established in the packaging industry. A crucial event was the fact that Ecovative could exhibit at the 2010 "EastPack fair", a trade show dedicated to the packaging industry, and an ideal stage to reach out to potential customers. Their exhibit at EastPack created considerable excitement in the industry, and from

61 Interview Eben Bayer
62 Interview Burt Swersey

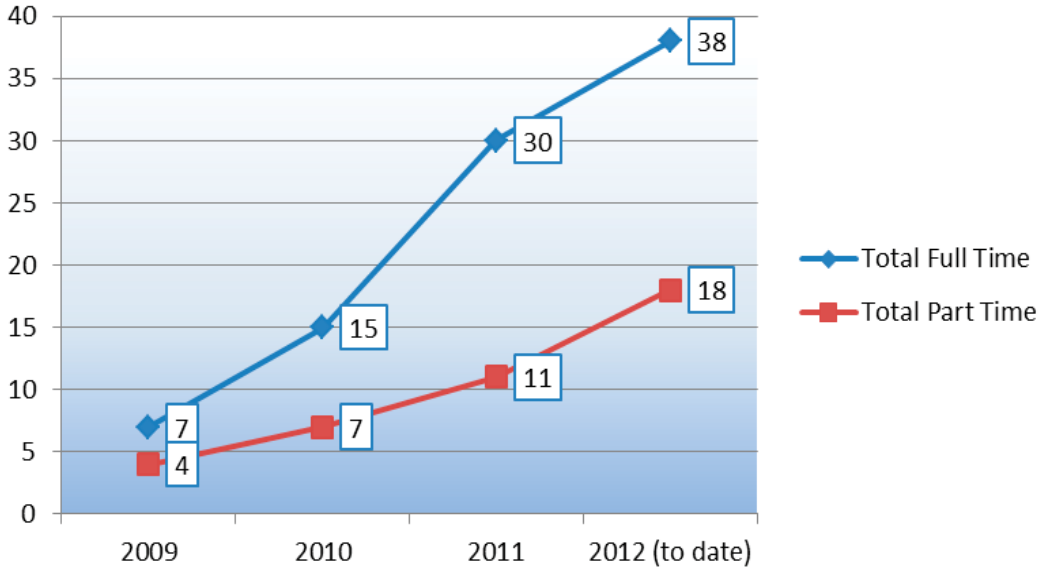


Table 3: Ecovative team size 2009-2012

there it was a question of finding the best partner, one who would be willing to take a risk.[63] Indeed, in the spring of 2010, Fortune 500 Company Steelcase Inc. became Ecovative's first customer and proudly featured their successful collaboration with Ecovative in its 2010 corporate sustainability report.[64] It was around this time that Eben started contemplating:

63 Interview Sam Harrington

64 Annual sustainability report 2010 Steelcase Inc.

"This really could work. If we can do packaging, let's do it again in different markets."

Until this point in time, the grant money acquired by Ecovative had been used to develop a new material, together with the machinery to produce it. Also the company hired new staff. The process, however, was not yet price-competitive. If Ecovative wanted to come closer to the dream of competing with, and ultimately replacing plastics and foams, it would need to **scale up production** to answer to the demand of interested parties. Without commercial viability the project would not survive. As such, a first investment round had to be planned to secure a larger production facility and increase production capacity. Board member and investor Charles Deull noticed the increased interest from various Venture Capital (VC) groups, but – alongside with other board members – was hesitant in accepting their conditions. In his view, VC's have damaging, often outrageous terms, and have quite a different vision in mind than the company itself.[65]

Having decided to reject all offers from VCs, Ecovative approached DOEN Foundation – alongside two other private investors[66] – which allowed Ecovative to stay true to its impact-first mission. Instead of having to dilute its stock and concede control over operations, DOEN was the type of investor with an aligned philosophy that would not mingle with business decisions but would support Ecovative in becoming the company they aspired to be. Here Eben sees the involvement of DOEN as transformational:

"Our company was basically founded upon grants and other business competition prizes. But DOEN's involvement was transformative in the sense that we were still not a conventional investable business."

65 Interview Charles Deull
66 Charles Deull and Steven Sherwood

With the financial involvement of DOEN came other valuable benefits, most notably, a transatlantic network that would act as a platform to promote the company. Most notably, CEO Eben Bayer acts as an ambassador for the Green Challenge competition, and has been introduced to forerunners in the sustainability domain like William McDonough and the Clinton Global Initiative, amongst others.

2010-2011: DOEN renews commitment to support Ecovative in 6 million investment round

Precisely because of the fact that Ecovative was not a conventional investable business, DOEN could live up to its ambition of investing in promising ventures that make a meaningful contribution to the creation of a sustainable world. Over the period leading to 2011, DOEN acted as an investor who secured the interests of Ecovative as a company that was still vulnerable to the demands of common type investors. As such, we implicate that DOEN performed a "bridging function", as can be seen in figure 12, and allowed Ecovative to attract:

- **New customers**: Although Steelcase was a Fortune 500 Company, they were not well known in the eyes of the public. The visibility of the Dell Inc. deal really put Ecovative on the map and opened up many doors to other customers.[67] Soon Bloomberg LP followed as a customer, together with Crate and Barrel Company Inc. and Puma Inc., and;
- **New investors**: Because of the bridging function that DOEN performed, new investors found their way to Ecovative. And in 2011 the second investment round, comprising 6 million US dollars, was planned. At this time, 3M New Ventures entered as an investor. During this round DOEN was paramount in guaranteeing the impact philosophy on the capitalization table. As Eben explains:

"So they [DOEN] were highly aligned with our philosophy. And when we brought 3M in they were similar-sized on the cap table. It allows me – when I talk to future investors – to point at them, and say this isn't just a philosophy; people have to buy in to our philosophy."[68]

67 Interview Sam Harrington
68 Interview Eben Bayer

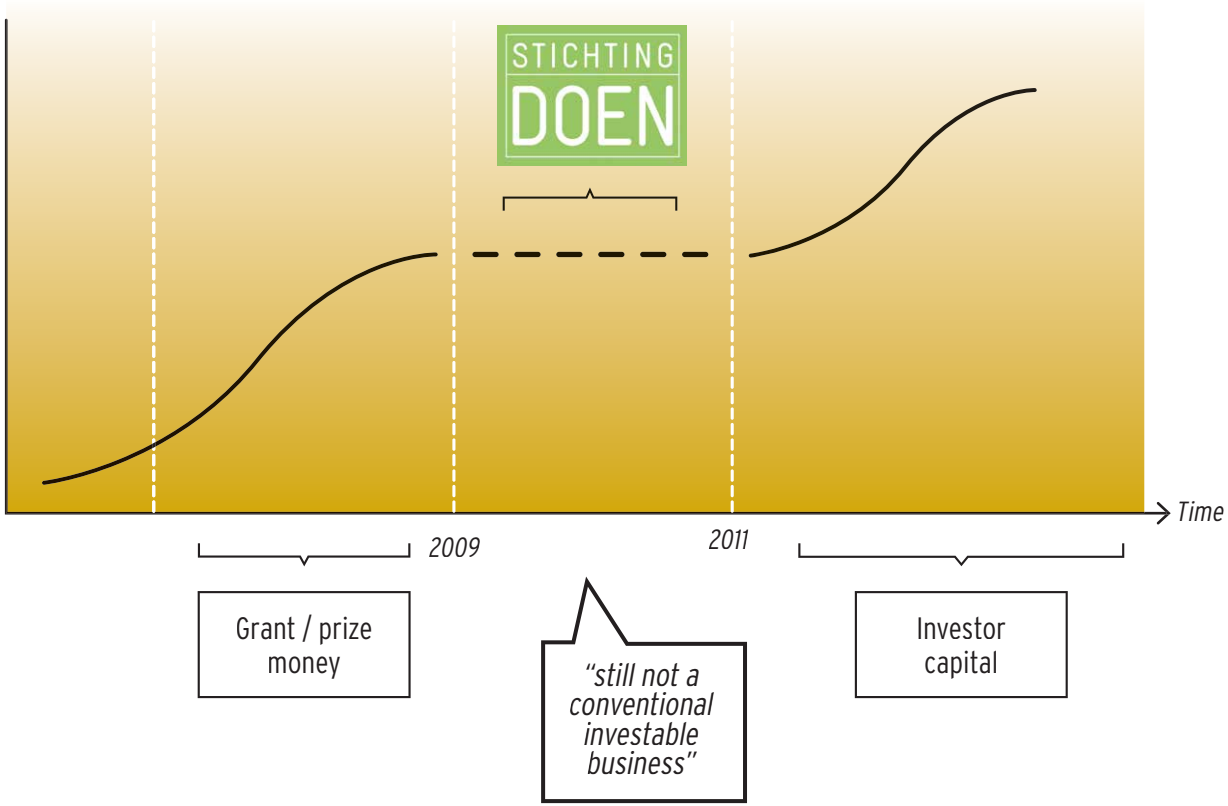


Figure 11: Bridging function DOEN

After the Steelcase collaboration, Eben's ambitions concerning the amount of markets they could hit grew. As Charles Deull explains:

"So the vision of the company is to be a great R&D company with sufficient manufacturing to proof-concept, and then to be a licensor or partner to the right groups in countries around the world, so the product becomes ubiquitous."[69]

The team size almost doubled in 2011, and concurrently, the grant pipeline was reinforced by endowments from the National Science Foundation (NSF) and NYSERDA to explore Mycobond applications in the automotive industry.

2011-2012: New partnerships have materialized

The period 2011-2012 starts with investment round II, in which 3M New Ventures joined Ecovative as a strategic partner and investor. The strategic element lies in the fact that 3M aims to play a role in co-developing new applications of the technology. This investment round allowed Ecovative to expand its facility at 70 Cohoes Avenue, which in turn led to the licensing agreement between Ecovative and Sealed Air Corporation (SAC). This period covers several important milestones in the coming of age of Ecovative:

- This first licensing agreement positions Ecovative as a materials R&D company, while significantly increasing the scope of its production capacity. From being a competitor in the packaging space, SAC – through the agreement – suddenly became a partner with the infrastructure and production clout to match Ecovative's ambitions of substituting plastic foams. SAC is in the process of constructing a Chicago-based plant with a capacity to process almost 500 tons

69 Interview Charles Deull

of agricultural waste per year, which is a 160% increase compared to the plant at 70 Cohoes Avenue.

- The SAC deal solidifies one market and will greatly increase Ecovative's credibility and legitimacy in future markets. The deal frees up space to explore new markets, such as automotive and insulation, sectors in which Ecovative continues to receive grants from the EPA, NSF and NYSERDA.
- As mentioned in the final section of part two, media attention from trade and industry press caused an influx of orders by potential customers since early 2011. As such, many pilot products are now in the pipeline and have opened up an even wider range of markets. Ecovative tries to recognize which markets show the biggest opportunity and thus will be scaled up first.
- The team has grown to nearly fifty fte's and is starting to realize that Ecovative can answer to many product characteristic wishes. For example, Ecovative can make shoes, floral foams, and wood replacements. But varying the feedstock mixtures enables Ecovative now to also produce a range of bendy materials, which again opens up a new array of possible applications. Siding with nature, as explained in part two, really means capitalizing on the endless opportunities available in the environment.

Despite these breakthroughs, economical and biological constraints do come up. For example, new products will need geometry on all six sides, which for now limits the scope of what is possible. In their quest to replace all Styrofoam, Ecovative also realizes that in reality they can only do so much as nature and their current span of control allow them to.[70]

70 Interview Sam Harrington

9.4 | Ecovative's theory of change: from bio-mimicry & bio-adaptation to bio-transformation

Initial press hailed Ecovative as an example of bio-mimicry. After some time Ecovative realized that what it does is not mimicry, but rather adaptation. Bio-mimicry examples include 'Velcro'[71], which imitates the adhesive ability of certain species. Another example is wind turbine plates shaped like whale fins, a technique that makes them 20% more efficient. Ecovative found that its work is actually closer to bio-adaption as it poses the question: how do you take these organisms that have evolved for millions of years to perform a specific function? Bio-adaptation can best be compared with the rise of farming practices and the domestication of plants and animals in pre-historic times. Sam Harrington thinks Ecovative is at the beginning of a similar process with its fungi:

> "During the last 10,000 years we've changed cows, and gone from wild steer to the modern domesticated dairy cow, and it's a very different creature. We take an organism from nature, and learn how to make them happy. Our job is to make the fungi really, really happy. Here in the facility, we adapt nature and shape it as a corner block."

Thus, between 2007 and 2010 as the idea itself evolved the ambitions grew. Whereas in 2008 Ecovative described itself as: "A bio-tech startup that creates biological composites that can replace plastics and foams, such as EPS, with the long term goal to become the leader in sustainable materials" (Business and marketing plan, 2008). In 2009, Ecovative changed its own characterization into being a "materials science company, positioned to be a world leader in

71 Velcro™ produced by Velcro Industries Inc.

sustainable materials" (Ecovative executive summary, 2009). Besides protective packaging, many more market opportunities open up. Fungal physiology, as described in paragraph 4.5, has formed the basis for what we would describe as "bio-transformation". Not only does Ecovative harness the qualities and characteristics of living organisms, i.e. fungi, but more importantly, it *aims to discover features the fungus itself did not know it possessed*. Its platform technology enables Ecovative to use the fungi in many more ways and consequently puts the fungi's features to practical use. This goes beyond adaption, and becomes *transformation*. From an innovation standpoint and in terms of market potential, transformation is a much more potent construct. It allows for diversification and mitigates risk. In other words, it increases Ecovative's chances for survival in the market place. This also means an increase in market potential, albeit on the condition that the organization responsibly manages its capabilities: if the organization grows too fast, or 'mushrooms', it may overextend and cease to grow in a sustainable manner. Such would be as big as a risk as a failure in Ecovative's technical R&D division.

Roughly since 2011, Gavin McIntyre sees a major influx of requests about what else Mycobond material can do: fabricating shoe soles, engineered wood replacements, and Gavin's latest TED talk explains how he uses mycology to 'grow' a resistor that is able to conduct electricity. These initiatives come to life in Ecovative's R&D facility, which fosters a 'sky-is-the-limit' culture. The R&D team encourages unconventional ideas, like the possibility of 'growing' an iPhone in 50 years. In order to make it from the R&D facility to the pilot manufacturing facility an important selection needs to occur as the pilot manufacturing facility located at 70 Cohoes counts with the *commercial viability* of these inventions. Indeed, with the increase in market applications, Ecovative's primary issue is to determine how many resources they have for these new market entry points, and assess which markets deserve immediate attention and which markets can wait.

Concluding remarks to part III

This part has discussed the chronological breakdown of risk (investor) and non-risk (grantor) capital flows into the company. DOEN's intention as a grantor – disbursing the prize money from the Postcode Lottery – has been to enable Ecovative to build its organization and to help create an environment in which Ecovative could grow its technology and connect to new investors. In this part we made a distinction between Ecovative and DOEN's long-term objectives of creating a company that intends to develop an encompassing alternative to the production of Styrofoam and DOEN's short or medium-term objectives as a grantor and investor. Using the metaphor of the double helix, we argued that the short and medium-term objectives as an investor are related to the long-term objectives of replacing Styrofoam.

Figure 12: The double helix unwinds and connects to new complementary strings
Illustration from National Human Genome Research Institute (www.genome.gov)

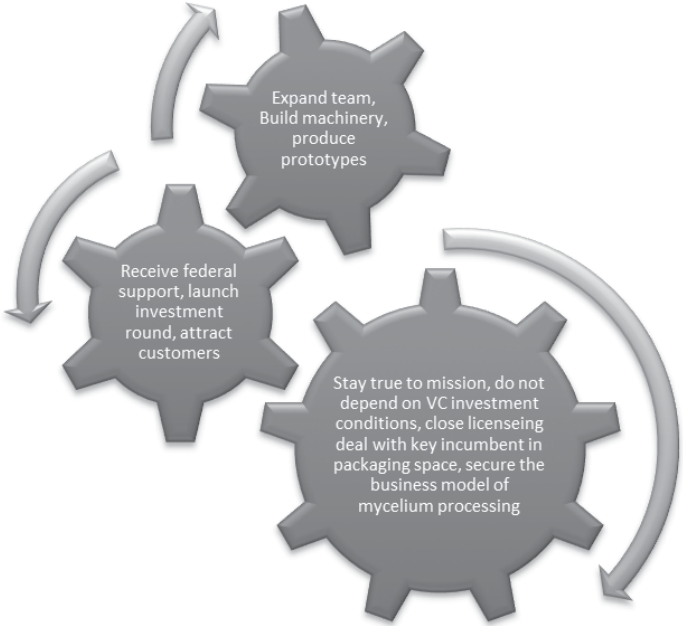


Figure 13: Investment and enterprise theses combined

72 Obviously, DOEN can also retain its position as an investor for the years to come. It is likely, however, that with the growth of the company DOEN will gradually dilute its share in the company. Such a dilution – particularly if new or existing investors with a comparable philosophy step in – can be seen as a success of DOEN's impact investing philosophy and strategy.

In figure 13 we see that the strings that represent the financial and the real worlds unwind. As soon as Ecovative can successfully 'replicate', DOEN may wish to withdraw, and in turn, aims to connect to new investment opportunities[72].

Besides this bridging function Ecovative and DOEN intended to scale up production to bring the technology into practice. If the commercial equation does not add up, impact cannot be realized. Therefore, we characterize DOEN's involvement – starting with the Postcode Lottery's Green Challenge Award and alongside other investors – as an accelerator of and necessary condition for Ecovative's growth.

Conversely, Ecovative's enterprise thesis was primarily concerned with deploying capital to boost its innovation – both in terms of its technology platform and its focus on strategic alliances. In providing a first and a subsequent "string of finance" DOEN enabled Ecovative to connect to a more potent string of finance. DOEN has been instrumental in attracting the right kind of capital that allowed Ecovative to develop the "string of real world activities", needed to grow the company and develop the platform technology. The company aimed at avoiding financiers that would take control over (parts of) the decision-making process. See matrix below.

By attracting capital from carefully selected sources, Ecovative has successfully protected its core philosophy. Actually, DOEN's investments have contributed to securing grants of federal endowments to explore new industries, which allowed the company to make considerable progress in the implementation of its platform technology in the protective packaging industry. It is here that both strands of the double helix are interconnected and reinforce the opportunities for Ecovative to create an encompassing strategy focused on making Styrofoam redundant.

We have interpreted the chronological developments using the criteria of enlightenment, adoption, and – to a lesser extent – goal attainment. The effects of Ecovative's innovative technology slowly trickle down to relevant audiences and surely have 'punctuated' current beliefs about sustainability standards as becomes clear from the attention of both popular and trade press. In this light, the impact of a novel technology is widespread. Impact encompasses much more than just 'delineated' quantifiable outcomes.

Ecovative has also adjusted its ambitions along the way. Its theory of change has evolved from producing a sustainable range of products in-house, into improving a platform technology with licensees that control much of the supply chain. By focusing on its core competencies, Ecovative aims to increase its impact by siding with licensees. Should Mycobond – after the termination of licensing agreements – be adopted by other parties, the technology would continue to further penetrate markets and reach other industries, increasing 'enlightenment' and making the impact of the technology (and the impact of the investors' interventions) only more meaningful. Due to the nonlinear development path, *evaluating* the impacts of an innovation is an uneven process in which the payoffs are rarely immediate. Following Perrin[73], we find that by its very nature, innovation is unpredictable, it is uncertain who will benefit, when exactly, and under what circumstances.

73 Perrin, B. (2000)

It is therefore too soon to speak of goal attainment of the long-term enterprise objectives leading to full replacement of Styrofoam. Demonstrating goal attainment would require us to provide evidence that the market shares of conventional solutions are shrinking. And finally, if we would want to evaluate whether Ecovative and DOEN have had impact in achieving this objective we have to demonstrate that Ecovative's solutions and technology platform have actively contributed to this decline. That is not possible – certainly not in this stage of the company's development. However, we do argue that Ecovative is on the right track, a track that ultimately might lead to the desired decrease of the pollution of petroleum-based materials and products. Considering the enablers of change (stricter standards and legislation, market demand, access to streams of capital), Ecovative's sustainable, fungus-based innovations are well positioned for success. Whether Ecovative itself will be the organization that emerges as the dominant player is a point of contention about which it is too early to make predictions.

Part IV
Scenario analysis

No one is able to foresee the future. Even though Ecovative is very successful in further developing its technology and its strategic alliances, we reckon with the possibility of alternative solutions that will be more successful in replacing Styrofoam than Ecovative's fungus-based solutions. Note that such alternatives do not in any way mean that Ecovative's platform technology will cease to exist. It can possibly be integrated in other solutions. In other words, fungus-based materials may be adopted and/or improved by rival firms (large incumbents, former licensees, or new competitors). The platform technology would then live on, either under the guidance of Ecovative, or under the supervision of other firms. Part four discusses the potential development of Ecovative using three scenarios.

These scenarios are:

1 Ecovative as a niche player
2 Ecovative as an important mycobond player
3 Ecovative as a ubiquitous player

10 | Scenario analysis & the counterfactual

In order to shed light and to some extent quantify the impact Ecovative is realizing, section 10 introduces three different impact scenarios. These scenarios are based on the competitive analyses discussed in part two and the milestone events discussed in part three. Scenario analysis allows us to combine these events, assess the 'counterfactual', or, to eliminate rival explanations, and make different assumptions of how much positive environmental impact may be expected in the near to long term. In each of the three scenarios, Ecovative is positioned on the industry curve taken from section 7 and links back the notions of "era of ferment", "era of incremental change" and "dominant design". The disruptive potential of Mycobond materials is outlined according to varying industry conditions. Important to note is that Ecovative's current efforts focus on the protective packaging market, and CEO Eben Bayer estimates that:

- 80% of efforts are directed at providing assistance to SAC in building their plant and supplying them with the best raw materials. Although Ecovative cannot control the sales part, it can continuously improve the technology. If the SAC facility runs smoothly, and the platform proves successful, this can be regarded as an anchor for success;
- In the remaining 20%, Ecovative focuses on specialty chemical development (like the Puma© surfboard project) and prepares for market entry number two: the construction industry.[74]

Scenario I – Niche player

Scenario one is based on the following grounds over a 0-5 year period:

- The anticipated exponential industry curve does not effectuate. Mycobond materials remain 'exotic'. Ecovative will successfully capture a niche market share, but will not become the dominant design in the packaging industry.
- Industry standards stress importance of sustainability but also benefit bio-plastics.

74 Interview Eben Bayer

- Other players outside the US (e.g. Synbra, NL, which also targets packaging and insulation as entry markets) capture parts of the packaging and insulation markets in Europe and Asia.
- Bio-plastics that fit existing infrastructure increase in sustainability and performance standards and capture new shares of the market and stifle innovation by offering incremental gains rather than true advancement leaps.

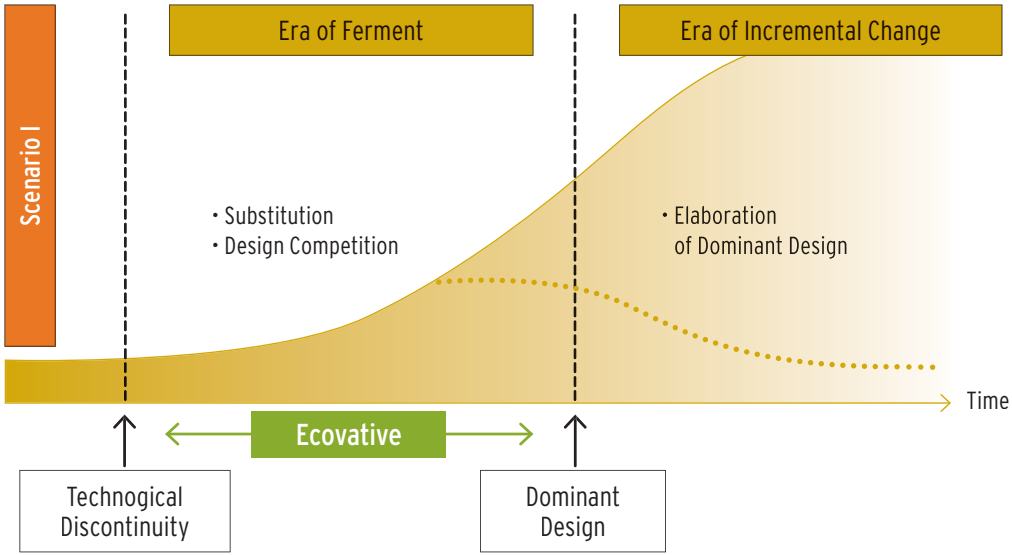


Figure 14: Scenario I "niche player"

Figure 14 places Ecovative in the era of ferment of the packaging industry as introduced earlier in section 7. The dotted line portrays the evolution of Ecovative into the near future: Although Ecovative gains a foothold in Packaging and successfully develops some Mycobond materials, it cannot follow the steep curve which is characteristic of a new dominant design.

Scenario II – Mycobond player

Scenario two is based on the following grounds over a 0-5 year period:

- Ecovative sees market shares rise in the packaging industry but also in the insulation industry. Mycobond materials lose their 'exotic' character. Ecovative will successfully capture a significant portion of the market, but will not dominate the industry.
- Oil and food prices continue to rise; radically sustainable options seem to further discourage the industry to adopt forms of incremental change.
- Stricter legislation and industry standards generate increasingly favorable industry conditions.
- Bio-plastics capture niche market shares due to their specific product features (such as making thin plastic films). Other players outside the US (e.g. Synbra, NL) capture parts of the packaging and insulation markets in Europe but struggle to enter the US.

For the predicted evolution curve under scenario two, see figure 15 (next page).

Ecovative's sustainable growth and sustainable competitive advantage challenge incumbent technologies and increasingly start to substitute foamed plastics in the packaging and insulation industries. Key is the fact that agricultural waste as feedstock decouples Ecovative from the petrol market. Also, Ecovative remains unaffected by price fluctuations in the food industry, which are likely to continue to increase in time according to bodies such as the UN Food and Agriculture Organization.[75] The prototype licensing agreement with SAC is a breakthrough development in the scaling of Mycobond materials and matches the anticipated production

75 UNFAO http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/ Accessed 22 December 2012

levels. The successful SAC facility allows for the construction of another regional facility. In the insulation market, a key incumbent player becomes a licensee (just like SAC). In both markets, Mycobond conquers significant shares of the market (and does replace EPS), but Ecovative cannot direct enough of its resources to conquer additional industries. More specifically, constructing the production facilities requires extensive involvement from the Ecovative team, which may hold back the pace of anticipated growth. Over a 0-5 year period two SAC production plants have been constructed and function as planned.

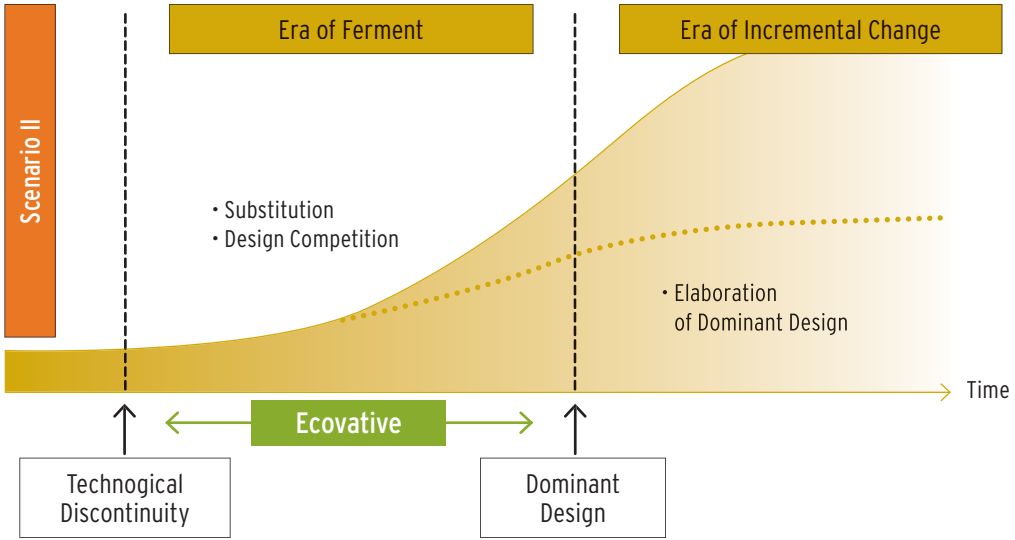


Figure 15: Scenario II "Mycobond player"

Scenario III – Ubiquitous player

Scenario three is based on the below grounds and is subdivided into a near-term (0-5 year) and a long-term (5-10 year) period.

For the near-term:

- SAC facility delivers materials as planned. Production can be scaled up further such that economies of scale start to effectuate. Ecovative's price proposition becomes more attractive and overtakes the EPS proposition.
- Oil and food prices continue to rise; the packaging and construction industries, but also players in Automotive and Apparel seek ways to 'reinvent' themselves to become sustainable enterprises.
- Stricter legislation (US and EU) and new industry standards (ISO) generate increasingly favorable industry conditions.
- Bio-plastics capture niche market shares due to their specific product features (such as making thin plastic films). Other players outside the US (e.g. Synbra, NL) capture parts of the packaging and insulation markets in Europe and may successfully explore foreign markets such as the US.

For the long-term:

Up until now the platform technology has proven resilient; a sustainable growth strategy has enabled Ecovative to team up with likeminded parties and did not succumb to possibly hostile investor conditions. The partnerships so far have had an access-only character and seem to legally protect Ecovative from patent infringements by competing parties.

In the long-term variant of scenario three, we envision multiple facilities operating in the US. SAC has expressed the desire to build five plants in the near term servicing the domestic US

market[76]. Plants function as regional production facilities, rather than vast centralized locations, and capitalize on minimal transportation costs. Apart from an increase in volumes, new applications beyond Mycobond, i.e. via fungal chitin chemistry, which are tested in the 60 Cohoes Avenue facility yield commercial applicability. New attractive industries (such as automotive) present themselves. As the SAC facility works as planned; new applications can be scaled to industrial levels. Just as how the SAC deal replaces a share of the EPS market with Mycobond, it does so too with insulation and automotive. For the predicted evolution curve under scenario three, see figure 16.

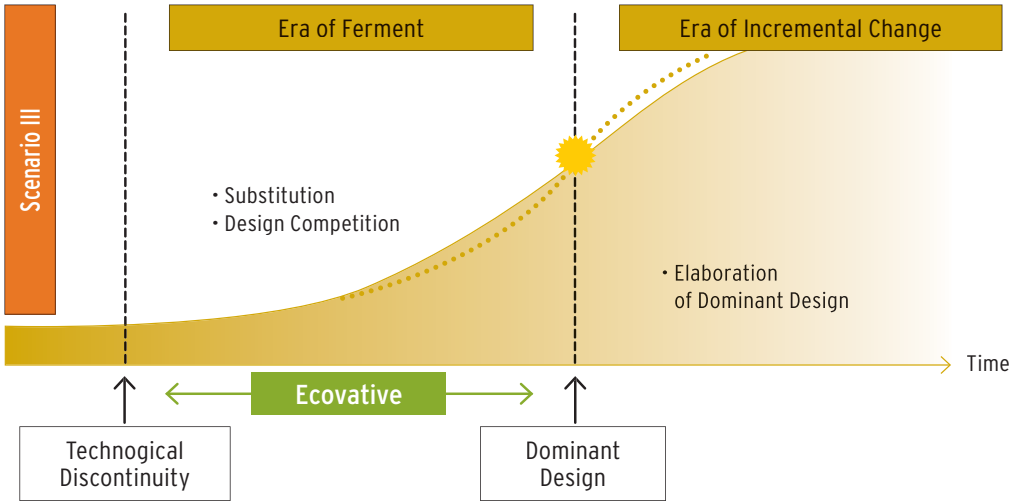
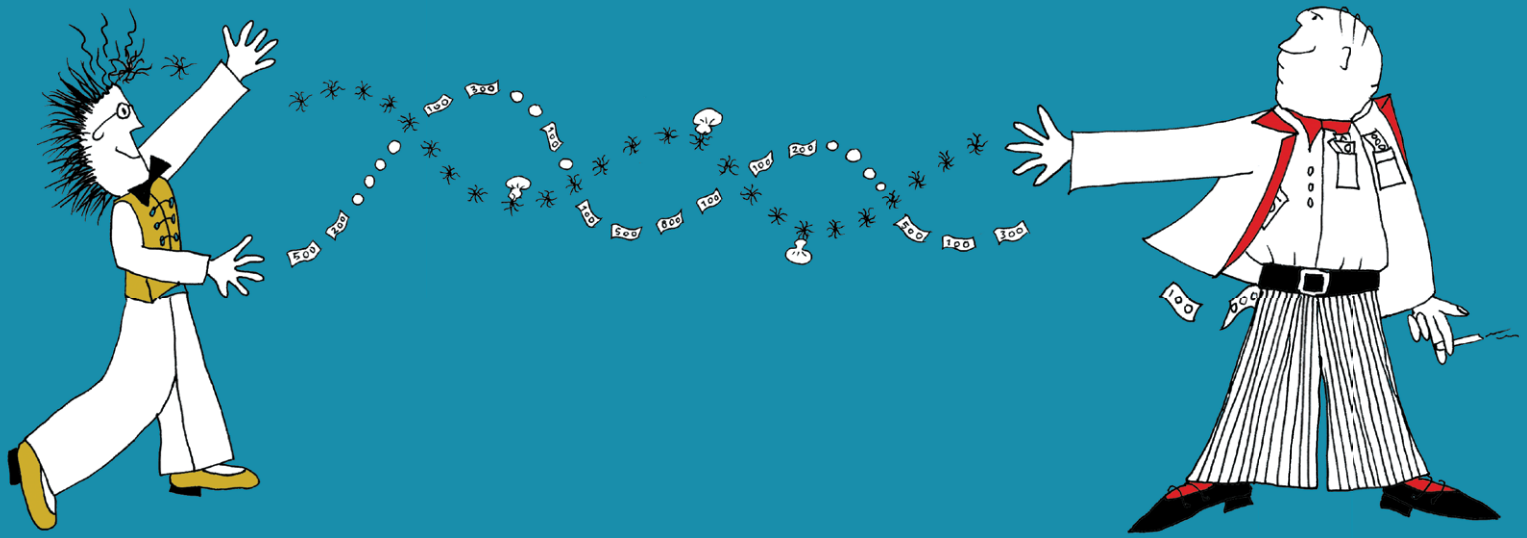


Figure 16: Scenario III "ubiquitous player"

76 Interview meeting Tim McInerney, Product Manager, SAC.

Concluding remarks to part IV

Building different scenarios allows for looking at the future and assessing impact. Also, scenarios allow for challenging rival explanations, i.e. different courses of action. We have anticipated various levels of growth for the near to long term and may conclude that Ecovative is well positioned for success in the protective packaging market. The current team forms a strong entrepreneurial entity with a productive track record of developing new, radically sustainable materials. However, Ecovative remains a young and exotic company that has yet to prove its success in actually capturing projected shares of the targeted markets. As we have seen in section 7.1, packaging is an established industry with a functioning infrastructure that provides low-cost solutions to virtually anyone's packaging needs. Although Ecovative hopes to challenge this cost proposition in the near term, the market's focus on improving sustainability records will prove to be crucial to Ecovative's success. The extent to which rivaling 'drop in' replacements (with *incremental* rather than *disruptive* sustainability propositions) are embraced by incumbent players will be a reflection of the market's 'inertia', or unwillingness to change. Indeed, success is dependent upon grander industry fluctuations and it remains unclear whether, and if so when we may see a 'tipping point' of the adoption of Ecovative's technology. In addition, among the many variables that determine future success for Ecovative must also rank Ecovative's governance and organizational characteristics. The company will need to transform from an entrepreneurial entity into a solid SME enterprise. As a result, the team is likely to face changes as additional streams of capital and new financiers and/or investment rounds may determine part of the company's policy.



Part V
Conclusions

11 | Ecovative is on the right track… and DOEN made a significant contribution

Impact was defined in the introduction to this study as 'the influence or effect of an intervention – whether an act or a decision – on a recipient'. We set out to assess the impact of Ecovative's promising technology platform and its strategy of teaming up with powerful players in the packaging industry. The verdict is still out on Ecovative's potential impact on its contribution to replacing Styrofoam as the prime resource for packaging material, but the signs are promising. With regard to DOEN Foundation's impact on the development of Ecovative the signs are not ambiguous at all. There is a clear positive relation between the growth and development of Ecovative and the grants and investments coming from DOEN and the Postcode Lottery Green Challenge – and for that matter between DOEN's investments and the development of Ecovative's innovative environmental solutions. In this concluding section we will summarize the key findings and present our conclusions.

In this concluding section we like to point at the importance of *measuring impact* as inextricably linked to the actual impact investment itself. As such, this report aimed to provide information that 1) enables DOEN to demonstrate its added value – if any – to its constituents, and 2) to provide useful feedback to Ecovative regarding its added value to both investors and society. We evaluated the extent to which DOEN's investments have contributed to the growth of Ecovative, and asked ourselves what would have happened to Ecovative if DOEN had not decided to invest.

After sketching the context in which Ecovative operates in part one and introducing the key propositions its technology is founded upon, part two focused on Ecovative's "genetics". That is, we wanted to reveal Ecovative's key propositions in order to deduct its "chances for survival" in the protective packaging industry. We found that Ecovative enjoys a strong competitive advantage vis-à-vis its direct competitors (foamed plastics and bio-plastics).

We have seen that Ecovative sustains that competitive advantage by fostering a *learning organization*. Ecovative intends to scale up operations via its prototype licensing agreements with SAC. As such, Ecovative:

- strengthens its environmental proposition by using the production and distribution clout of SAC to industrially produce Mycobond technology and distribute it on a commercial scale, and;
- improves its price proposition, since the team can carry on perfecting the platform technology and continue to develop new Mycobond materials.

Section seven positioned Ecovative in the 'era of ferment' of the packaging industry, in which the main challenge is to out-compete incumbent players and deliver the next 'dominant design'. By partnering up with the largest incumbent (SAC), Ecovative has shown its ambition to making the technology become dominant.

Part three introduced the concept of the double helix to characterize impact investing as the interplay between the financial and the real world, or, more specifically, between DOEN and Ecovative. In biology and genetics, the double helix replicates by unwinding its strings before connecting to new strings. Similarly, it has been DOEN's goal to:

- provide the initial string of capital and lead Ecovative to latch on to new – possibly more potent – strings of capital, and
- perform a "bridging function" in the period between 2009 and 2011, when the company went from running on grant and prize money to running on equity investments.

By investing in Ecovative in addition to the prize money that was granted by the Dutch Postcode Lottery, DOEN has exerted a very positive influence on the investment climate for Ecovative. As we have shown, it was partly because of the positive support from DOEN Foundation that Ecovative was able to attract additional capital.

It is *not* our contention, however, that without the assistance of DOEN Ecovative would not have blossomed in the way it currently does. But it would, very likely, have been much more difficult to uphold the company's core philosophy and core context in which it was possible for Ecovative's management to build the company in the way it has done in the past few years.

Part four discussed three scenarios, which for the near-to-long term, helped define Ecovative's positive environmental impact in the protective packaging industry – and beyond. The questions regarding the nature of the impact[77], namely: 1) is impact produced directly by the intervention (like a splash) or indirectly (like a ripple), 2) is the impact transformational or can the accomplishments easily be undone, and 3) is the impact likely to be the result of a 'silver bullet' intervention that achieves results irrespective of context – or a 'ducks-lined-up' intervention' that achieves results only in conjunction with favorable circumstances, including other interventions, can be answered as follows:

- We have learned that the repetitive involvement by the DOEN foundation has produced several 'ripples' akin to the effect of a blowing wind. And if we continue with this metaphor, it follows that "When strong winds blow for a consecutive time, it gives the water sufficient energy that it then takes on a character of its own."[78] As such, Ecovative has made progress in becoming independent of the wind, since it has been able to reach out to new streams of capital.
- As such, Ecovative's accomplishments up to now – including the realized construction of two production facilities and the planned construction of a third one – qualify the nature of the impact as transformational.
- Thirdly, we find that the impact of DOEN's interventions has been achieved in conjunction with other interventions, including access to other streams of capital and an overall context receptive to radically increasing sustainability standards.

77 Following R. Chambers, D. Karlan, M. Ravallion & P. Rogers (2009) "Designing impact evaluations: different perspectives". *International initiative on impact evaluation*, working paper 4, p. 25

78 Gooley, T. (2012) "The natural navigator" http://www.naturalnavigator.com/tristan-gooley/ Accessed 22 November 2012

Indeed, industry trends hint at a continued focus on sustainability features, which creates increasingly favorable industry conditions for Ecovative. In turn, Ecovative reinforces this trend by actively promoting its technology at a variety of stages, including trade shows, conferences, and other associated events.

In sum, we have come to learn how Ecovative pioneers a disruptive – potentially dominant – technology that provides an alternative to plastic foams in the protective packaging space and beyond. One of DOEN Foundation's goals is to help contribute to a new type of economy and, more broadly, build a sustainable world. Unambiguously, DOEN has found in Ecovative a team of pioneers that generate positive outcomes in the fight against climate change.

Following Rugh's (2011) remark that "[i]n the real world, *deviant* versions of full-fledged impact evaluations are common practice due to a variety of practical constraints"[79], we managed expectations by saying that the impact scan will remain on the surface and is not able to detect causal relations between the inputs and the outcomes. That particularly is true for our study of the potential impact of Ecovative's platform technology and its associations with the industry in making Styrofoam redundant. As mentioned, it is too early to decide on the effective use of Ecovative's solutions to solve some of the problems (like reducing the plastic soup in the world's oceans) to which investor and investee aspire to contribute. Indeed, "innovations are generally long term in nature and the payoff rarely immediate".[80] However, we hope to have shed some light on the relationship between DOEN's investment – and the investment of DOEN's co-investors – and the growth and future potential of Ecovative Design. By providing some insight into the context in which Ecovative operates and the relationships between the various key actors we hope to have provided a framework that allows both DOEN Foundation and Ecovative to reflect on their mutual relation – now and in the future. To this extent the IRIS Framework that we have applied to this case

79 Rugh, J. (2011) What's Involved in Rigorous Impact Investing? Presented to NONIE conference in Paris, 28 March, 2011.

80 Perrin, B. (2000) "How to and how not to evaluate innovation". Presentation to the UK Evaluation Society Conference, London. 8 December, 2000.

– and added some suggestions for broadening the scope of IRIS when dealing with process relations in Appendix B – can provide useful guidance for the actors involved. They can easily follow the relevant development on the indicators set out in Appendix B.

This report has been compiled using primary and secondary data from a variety of sources. The secondary data included desk research covering the period 2007-2012, whereas the primary data included a set of semi-structured interviews with key stakeholders. These interviews were conducted in the summer and fall of 2012. Taken together, the report has constructed a baseline post hoc profile for Ecovative and can thus be used for future reference. Without the measurement and management of impact – and reporting on the financial and non-financial output and outcomes of the investment – there simply can be no mentioning of impact investing.

References

Bamberger, M. (2006)
"Conducting quality impact evaluations under budget, time and data Constraints."
World Bank, Independent Evaluation Group (IEG), Washington, D.C.

Bioplastics Council (2010)
"Position paper on oxo-biodegradables and other degradable additives".
www.bioplasticscouncil.org Accessed 1 November 2012.

Bjurulf, S., Vedung, E. & Larsson, C. (2012)
A triangulation approach to impact evaluation, 19, 1: 56-73

Chambers, R., Karlan, D., Ravallion, M. and Rogers, P. (2009)
"Designing impact evaluations: different perspectives". *International initiative on impact evaluation*, working paper 4, p. 25

Coryn, C., Noakes, L., Westine, C. and Schröter, D. (2012)
A Systematic Review of Theory-Driven Evaluation Practice from 1990 to 2009. *American Journal of Evaluation*, 32: 2

Earth Resource Foundation (2012)
"Polystyrene foam report". http://www.earthresource.org/campaigns/capp/capp-styrofoam.html Accessed 1 November, 2012

Federal Trade Commission (2012)
"FTC Green Guide, Revised October 2012". http://www.ftc.gov/opa/2012/10/greenguides.shtm Accessed 12 January 2013

Gautam, R., Bassi, A.S., Yanful, E.K. (2007)
"A review of biodegradation of synthetic plastic and foams." *Applied Biochemistry and Biotechnology*, 141 (1), p. 85-108

Gooley, T. (2012)
"The natural navigator" http://www.naturalnavigator.com/tristan-gooley/ Accessed 22 November 2012

Grant, R. and Baden-Fuller, C. (2004)
"A knowledge accessing theory of strategic alliances." *Journal of Management Studies*, 41, (1), p. 61-84

Green Building Certification Institute: LEED (2012)
Leadership in Energy and Environmental Design. www.gbci.org Accessed 9 November 2012

Marra, M. (2000)
"How much does evaluation matter?" *Evaluation*, 6, (1): 22-36

McKinsey Social Sector, *Learning for social impact*, April 2010, p.2.
See also www.mckinsey.com

Perrin, B. (2000)
"How to and how not to evaluate innovation". Presentation to the UK Evaluation Society Conference, London. 8 December, 2000

Prahalad and Hamel (1990)
"The core competencies of the organization" *Harvard Business Review*, p.79-91

Rugh, J. (2011)
What's Involved in Rigorous Impact Investing? Presented to NONIE conference in Paris, 28 March, 2011

Saunders, M. (2011)
Capturing effects of interventions, policies and programmes in the European context: a social practice perspective. *Evaluation,* 17, (1): 89–102

Simon, P. (2012)
Don't build products, build platforms. Inc. Magazine, 19 March 2012

Tornatzky and Klein (1982)
"Innovation characteristics and innovation adoption-implementation: a meta-analysis of findings. *Transactions of engineering management*, 29, (1): 28-46

Tushman, M. and Anderson, P. (1990)
"Technological discontinuities and dominant designs: a cyclical model of technological change". Administrative Science Quarterly, 35, p. 604-633

Tushman, M. and Anderson, P. (1991)
"Managing through cycles of technological change" Research Technology Management, 34, 3, p. 26

United Nations Environment Program (2011)
"Year book 2011" http://www.unep.org/yearbook/2011/ Accessed 25 August 2012

United Nations Food and Agriculture Organization (2012)
"FAO food price index" http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/ Accessed 22 December 2012

Weiss, C. (1999)
"The interface between evaluation and public policy." *Evaluation,* 5, (4): 468-486

Zheng, Y. and Yanful, K. (2005)
A review of plastic waste biodegradation. *Criticial Reviews in Biotechnology,* 25, p. 243-250

About the authors

Prof. Dr. Harry Hummels is a full professor at the School of Business and Economics at Maastricht University. Also he is a fellow of the European Centre for Corporate Engagement (ECCE) and of the Caux Round Table. He holds a PhD in Philosophy. In addition to philosophy, he studied economics and public administration. When he was asked to come to Maastricht he left a position at Nyenrode University behind as chairman of the European Institute for Business Ethics and as the first European Professor in Responsible Investing. His current fields of interest are Responsible Investing, Impact Investing, Ethics, Corporate Responsibility, Sustainability, Trust and Cooking. In addition, Harry is Managing Director of SNS Impact Investing, a position he shares with his dear friend and colleague Theo Brouwers. SNS Impact Investing is the development investment arm of SNS REAAL – a bancassurance company in The Netherlands. Before joining SNS REAAL in 2006, Theo Brouwers and Harry Hummels were responsible for setting up and leading ING Bank Sustainable Investments for 6 years. Next to these jobs he holds the position of European Liaison of the Global Impact Investing Network (GIIN). In this capacity he services GIIN members in the Benelux and provides the GIIN head office in New York with relevant information on developments in Europe. Also he is member of the Supervisory Board of Pluryn – a large institution for physically and mentally disabled persons. Harry is the corresponding author of this study. For any questions or suggestions please send an email to: **h.hummels@maastrichtuniversity.nl**

M. Alexander Röntgen graduated with honours at the Faculty of Economics and Business at the University of Amsterdam. During his study he specialized in the field of Corporate Social Responsibility at the Carroll School of Management of Boston College under the supervision of Prof. Sandra Waddock. Since 2012 Alexander holds a position as researcher at the School of Business and Economics of Maastricht University as part of the PROOF Impact research program, which is directed by Prof. Harry Hummels.

Glossary

Bio-adaptation "Modification of an organism or its parts that makes it more fit for existence under the conditions of its environment."[81] "Bio-adaptation is about aligning the fundamental purpose of an organism to meet a real need of people on this planet. Farming is an example of bio-adaptation. Ecovative is harnessing mycelium to do what it's evolved for millions of years to do: break down tough compounds like lignin and cellulose in woody biomass and glue the forest floor together. The only thing Ecovative is tweaking is that it constrains the mycelium to grow into a defined shape that has a human purpose."[82]

Bio-degradable So-called biodegradable plastics include starches that degrade upon exposure to sunlight (photo-degradation), (…) Degradation occurs because radiation in the near-ultraviolet and blue end of the visible spectrum contains sufficient energy to break chemical bonds within polymers of many types (…) but a fine plastic residue remains, and the degradable additives *preclude recycling of these products*.[83]

Bio-mimicry "A superficial resemblance of one organism to another or to natural objects among which it lives that secures it a selective advantage (as protection from predation)."[84] "Bio-mimicry can be defined as 'innovation inspired by nature.' Most bio-mimicry success stories tout increases in efficiency, or decreases in material use, "Velcro™" was inspired by the burdock plant which created tiny hooks that would latch onto any tangled or looped fibers.[85]

81 Merriam-Webster dictionary http://www.merriam-webster.com/dictionary/adaptation Accessed 30 November, 2012

82 Interview transcript Sam Harrington

83 See footnote #81

84 http://www.merriam-webster.com/dictionary/mimicry Accessed 30 November, 2012

85 Sam Harrington (Ecovative) to "Hello Materials" http://hellomaterialsblog.ddc.dk/2012/03/29/bio-adaptation-of-fungi-to-grow-materials/

Chitin White substance found in the cell walls of mushrooms and in the outer skeleton of insects, crabs, and lobsters and in the internal structures of other invertebrates. It is a polysaccharide consisting of units of the amino sugar glucosamine.[86]

Compostable In general, unqualified claims of "compostability" should be proved by evidence that the product will completely break down and return to nature, that is, decompose into elements found in nature, within a short period of time after consumers dispose of it in the customary way (…) all the materials in the product or package will break down into, or otherwise become a part of, usable compost (e.g., soil conditioning material, mulch). This should take place in a safe and timely manner in an appropriate composting program or facility, or in a home compost pile or device.[87]

Mycelium The mass of branched, tubular filaments (hyphae) of fungi. (…) The mycelium makes up the "thallus", or undifferentiated body, of a typical fungus. At a certain stage it produces spores, directly or through special fruiting bodies.[88]

86 See footnote #82

87 Federal Trade Commission (2012) FTC "Green Guide", Revised October 2012. See: http://www.ftc.gov/opa/2012/10/greenguides.shtm

88 Brittanica online encyclopedia, accessed 23 November, 2012

Abbreviations

CEO	Chief Executive Officer
EPA	Environmental Protection Agency
EPS	Expanded Polystyrene
LLC	Limited Liability Company
NSF	National Science Foundation
NYSERDA	New York State Energy and Research Development Authority
PCL	Postcode Lottery ("Nationale Postcode Loterij")
PHA	Polyhydroxyalkanoate
PLA	Polylactic Acid
RPI	Rensselaer Polytechnic Institute (NY)
R&D	Research and Development
SAC	Sealed Air Corporation
SBIR	Small Business Innovation Research
VC	Venture Capitalist
VOC	Volatile Organic Compound

List of interviewees

The DOEN Foundation:

Jasper Snoek, CFO
(17 August 2012)
Jeffrey Prins, Program Manager
(9 August 2012)

(Affiliated to) Ecovative Design, LLC:

Eben Bayer, co-founder and CEO
(19 October 2012)
Gavin McIntyre, co-founder and Chief Scientist
(19 November 2012)
Sue van Hook, Chief Mycologist
(18 October 2012)
Sam Harrington, Marketing Director
(17 October 2012)
Burt Swersey, former member of the board of directors and tutor at Rensselaer Polytechnic Institute (RPI)
(18 October 2012)
Charles Deull, member of the board of directors
(16 August 2012)

Client and partner companies:

Young-Jin Choi, Manager New Ventures, 3M New Ventures
(17 August 2012)
Dennis Carlson, Operations manager, Steelcase Inc.
(13 November 2012)
Angela Nahikian, Director Global Environmental Sustainability, Steelcase Inc.
(13 November 2012)
Tim McInerney, Product Manager, Sealed Air Corporation
(21 November 2012)

The IRIS Analysis of the rise of Ecovative Design

The Impact Reporting and Investment Standards (IRIS) – a Global Impact Investing Network program to develop a taxonomy for measuring impact – provide a useful framework for the analysis of the current investment case. As we have shown in this report, DOEN's investment has two sides when it comes to creating environmental and social impact. In the first place, IRIS can provide a meaningful framework for the analysis of Ecovative's development from a mere incubator initiative of Rensselaer Polytechnic Institute to a full blown company producing for a B2B-market. Secondly, IRIS is useful in analyzing DOEN's investment policies and practices in bringing Ecovative to the level it has now reached as a company. In order to properly assess the environmental and social value added, we need to distinguish between direct and indirect contributions and between long-term and short-term orientations.

Looking at the overarching objective of replacing Styrofoam, Ecovative's activities – and in particular the growth of those activities – can be seen as direct contributions to that objective. In addition, Ecovative has a long-term horizon regarding the attainment of its goals. DOEN's investments constitute a very relevant, but indirect contribution to the overall objective of reducing or replacing Styrofoam. In addition to its support for the ultimate goal of Ecovative to replace Styrofoam, DOEN itself has a medium-term horizon when it comes to its investment in the company and its commitment to reach out to other investors to co-invest. Just like any investor in a fast-growing company DOEN will ultimately dilute its shareholding in the company and eventually even terminate its involvement.

The overview of IRIS categories, indictors and measures in this paragraph consists of indicators that we think are relevant for the analysis of Ecovative's progress. The framework is not only relevant in retrospect to determine what has been achieved so far; it is of good use for DOEN to monitor Ecovative's development in the years to come and therefore can be used prospectively. While doing our analysis, we have found that a few indicators which are relevant to understand the development of Ecovative, the impact of DOEN and the interaction between both parties could not be fully captured by the existing framework. Therefore, we suggest adding some new criteria to the IRIS framework in an attempt to make it more relevant for the investor – investee interaction.

The analysis of Ecovative

IRIS Category	IRIS Indicator	Unit of Measure	Explanation
Organization Description			
Name of Organization	OD5828		Ecovative
Year Founded	OD3520		2007
Legal Structure	OD2999		Limited Liability Company
Customer Model	OD8350		B2C / B2B
Operational Model	OD6306		Production/Manufacturing, R&D
Mission Statement	OD2735		Becoming the world leader in sustainable materials
Environmental Impact Objectives	OD4108		Pollution prevention and waste management

IRIS Category		IRIS Indicator	Unit of Measure	Explanation
Product Description				
Product / Service	Detailed Type	PD1516		a) Environmentally-friendly Consumer Products
				b) Waste Management and Recycling Services

IRIS Category		IRIS Indicator	Unit of Measure	Explanation
Operational Impact				
Environmental Performance	Waste Produced: Non-hazardous Waste	OI7442	No. of metric tonnes	
	Waste Produced: Hazardous Waste	OI134	No. of metric tonnes	
	Pounds of EPS replaced	**	@ 1.5lb/ft^3	Amount of EPS replaced calculated using the amounts of agri-waste that enter as raw substrate

	Waste Disposed: Composted / Recycled / Landfill	OI6192		Amount of waste disposed during the reporting period
	Waste Reductions	OI7920		Waste reductions achieved during the reporting period through programs for substitution, recycling or recovery.
	Recycled Materials	OI4328	No. of metric tonnes	Amount of recycled materials used in products (including packaging) during the reporting period
	Toxic Materials	OI5942	No. of metric tonnes	Amount of toxic materials used in the manufacturing process
	Biodegradable Materials	OI5101	No. of metric tonnes	Amount of biodegradable materials used in products (including packaging) during the reporting period
Governance and Policies	Governance Policies	OI2330	Yes / No	Corporate governance policies/ charters in place
	Board of Directors	OI1075	No. of people	

Employees	Full Time Employees	OI3160	No. of people	
	Full Time Employees: Female	OI6213	No. of people	
	Full-time Employees: Managers	OI8251	No. of people	
Wages	Full-time Wages	OI5887	$ / €	
	Full-time Wages: Management	OI6069	$ / €	
Training and Assessment	Employees Trained	OI4229	No. of people	
	Total Employee Training Hours	OI7877	#	
	Total Employee Training Costs	OI7390	$ / €	

IRIS Category		IRIS Indicator	Unit of Measure	Explanation
Product Impact				
Distributor info	Partnerships to increase outreach: no micro-entrepreneurs	**	No. partners & outreach	No. of partners X outreach partner X quality of partner networks
Quantity and Reach	Sales	PI1775	$ / €	Revenue from sales of the product or service during the reporting period
	Units/Volume Produced	PI1290	No. of units	Amount of the product or service produced by the organization during the reporting period.
	Units/Volume Sold	PI1263	No. of units	Amount of the product or service sold by the organization during the reporting period.

	New products/Product Development (NEW)	**	$ / €	Dollar value of new products or No. of new products introduced
Quality and Performance	Culture/Innovation/Learning Organization (NEW)	**		Qualitative assessment of learning capacity of the organization
	Patents (NEW)	**		No. of patents registered
	Enterprise/Business Development (learning)	PI1193	No. of people	Number of beneficiaries participating in enterprise or business development training during the reporting period
	Enlightenment (NEW)	**		Extent to which leading concepts and ideas are picked up by social environment: network, media, etc.
	Non-hazardous Waste Avoided	PI8177	Number of kilograms	Solid waste disposal avoided based on refurbishing, reusing, or recycling, during reporting period

Client Information	Client Organizations	PI9652	#	Number of businesses or other organizations that were clients during the reporting period
	New Client Organizations	PI6894	#	Number of businesses or other organizations that were first-time clients during the reporting period
	Nature of Clients (NEW)	**		International outreach (markets served) & type of outreach (B2B or B2C)
	Client organisations provided new access	PI2575	#	Number of clients, businesses or organizations, who were served by the organization and provided access, during the reporting period, to products or services they were unable to access prior to the reporting period

Colophon

Research and report

Prof. Dr. Harry Hummels, Professor of Ethics, Organisations and Society
Maastricht University, h.hummels@maastrichtuniversity.nl
M.A. Röntgen, Researcher Department of Finance School of Business and Economics
Maastricht University, m.rontgen@maastrichtuniversity.nl

Graphic design and layout

Walter Breedveld, Thoben Offset Nijmegen, www.thoben.nl

Illustrations