This article introduces a creative approach to sustainable packaging as one of the 100 innovations that shape “The Blue Economy”. This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market
The worldwide sales of chemicals in 2009 reached €1.9 trillion. Europe represents the largest - all be it a declining - share with 27.1 percent, closely followed by China with 22.2 percent, for the first time surpassing the North American Free Trade Association with 21.2 percent. Comparing 2009 to 1999, the total value of sales has grown over one decade by 60 percent. The European share dropped over the same period by 8 percent. The polyurethane foam (PUF) in Europe represents €130 billion, involving 23,500 companies with an estimated 800,000 employees through the whole value chain. The US PUF industry represents $50.9 billion and 207,000 employees. The Chinese market for PUF grows at 10 percent per year, making it the largest one in the world by 2015 at the latest.

PU uses an estimated 3,000 chemicals. The production of expandable foam, buoyancy foam, extruded foam and packaging foam relies on additives, many of which have never been formally approved by the European Union under an individual registration scheme, and therefore were never subjected to the same rigor of controls as the “new” chemicals. Whereas the EU estimates that the approval procedures for one chemical would cost as little as €70,000, the cost of applying the rigorous control mechanisms could reach as much as €29 billion for all, with a single toxicity test running as high as €1 million. Whereas the French chemical industry calculated that the testing and the subsequent banning of several ingredients would lead to 360,000 job losses, the Danish Government submitted an analysis that the stringent controls would have measurable health benefits estimated between €90 and €700 million over the next 30 years.

The Innovation
The PUF market has many advantages for industry: a light and cheap material, a clean cushion, easily cut or molded to size. It is no surprise it has been selected as the preferred packaging material for electronics, cameras and precision tools. Approximately 90 percent of all PUF is recycled, mainly as carpet cushion for home or office. However, it is the inclusion of these additives that worry EU officials since these have never been tested and the long term - even especially as a recycled material - in highly insulated air controlled buildings could lead to the build up of trace chemicals with unknown effect for the occupants.
Gavin McIntyre grew up as an amateur mycologist, and obtained a bachelor’s degree in mechanical engineering, product design and innovation from Rensselaer Polytechnic Institute in 2007, America’s oldest technological university based in Troy, New York. He and his fellow university graduate Eben Bayer studied mycelium, the root system of mushrooms. This network of fibers function like a natural binding agent that holds together widely available agricultural and forestry waste, such as rice husks, corn kernels, buckwheat and cotton seed hull, even non-recyclable pulp and paper or coffee grounds. These innovators imagined how to produce mycelium foam to replace polystyrene and PU foam in everything including cups, building insulation and packaging for electronics. The substitution of a chemical product with a biological one, converting abundant waste that generates methane in its decomposition that is price competitive, fits perfectly within the proposals of the Blue Economy.

While the idea seemed easy enough, Gavin and Eben needed to find a way to grow the sturdy root system into various shapes. It proved possible to keep the inoculated substrate in a dark room for about five days after which it is cooked and dried. This simple treatment turns it into a waterproof and fireproof solid foam that can decompose within four weeks when buried. While alternatives on the market include cellulose from wheat straw, keratin from chicken feathers and algae, the real value is in the conversion of a waste that can be shaped into precise forms with only one tenth of the energy. The inventors raised some $4 million dollars in grants and moved quickly from concept to product. Gavin and Eben went on to create Ecovative LLC in Green Island, New York. They have applied for a patent which is still pending.

**The First Cash Flow**

Steelcase, the Michigan-based publicly traded furniture company with approximately $2.3 billion in revenue and nearly 13,000 employees around the world was looking for a new and cutting edge environmental packaging for its ready to assemble (RTA) office furniture. The team at Ecovative developed the "EcoCradle" protective packaging and launched its first commercial product with Steelcase in 2010. Whereas the pilot worked perfect and met all performance milestones set by the furniture giant, the next challenge concentrates on the development of a mass manufacturing system. Instead of building a series of prototypes, the mission is to roll out thousands, and soon millions of units.

The media attention stirred a broad interest and Dell Computers has committed to use the EcoCradle to ship its computer servers by the end of 2012, using cotton waste as the core substrate to produce the protective packaging with fungi. Texas, the home state of Dell has "cotton waste mountains" that could be mined within a hundred miles from the computer giant's world headquarters. The corner block and flat panels of EcoCradle are already available at the cost of $0.75 per unit, representing a total of $6 for a complete computer ready to ship envelop. The confirmed orders from these two multinational corporations and a pricing that competes directly with PS and PU foam creates the energies to resolve the production challenges. The key target is to produce a foam with a uniform density (thus
performance), without air pockets. Since the starting point is a living organism, this requires a
tight control of the environment in order to achieve a predictable result. However, since each
cubic inch of "EcoCradle" contains a matrix of 8 miles of tiny fibers of mycelium, it does
appear that a predictable result is within reach.

The Opportunity
Eben and Gavin see numerous opportunities ranging from a fungus-based, biodegradable
foam for bumpers, doors and dashboard. Gavin even imagines that one day it is possible to
compost major portions of a car. Ford Motors has tied up with Ecovative and looks forward to
push the envelope incorporating eco-friendly alternatives to petroleum-based foams that are
subject to close scrutiny under the rigid REACH (Registration, Evaluation, Authorisation and
Restriction of Chemicals) legislative framework for chemicals that came into force in the
European Union. Another, more realistic and short term innovative niche is the wine bottle
shipper, which is one of the large consumer of PS.

Later this year Ecovative is expected to introduce "Greensulate" to the market, an insulation
that reduces energy consumption without any addition of fire retardants. The dried mycelium
is naturally fireproof with a tested class 1 fire rating. The plan is to produce standard 4’ x 8’
sheets of various thicknesses for use in commercial and residential construction as above
the ground exterior insulation, roof insulation and floor insulation. Since the "Greensulate"
can be grown to order, it could be produced in almost any custom size and shape needed.

The product is stronger than synthetic foam, making it a structural insulating panel. Thus the
panel performs multiple functions: insulation, structural strength, protection against mold
growth, resistant to water absorption, and fireproof. The waste material is not only replacing
PU or PS, it is also replacing many of the chemicals. This is one of the core characteristics of
the Blue Economy that makes a product competitive in performance and price. It goes
without saying that there are no synthetic binders, and that it is therefore completely
chemical and VOC free (free of volatile organic compounds).

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… Further information on the 100 innovations at www.theblueeconomy.org

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