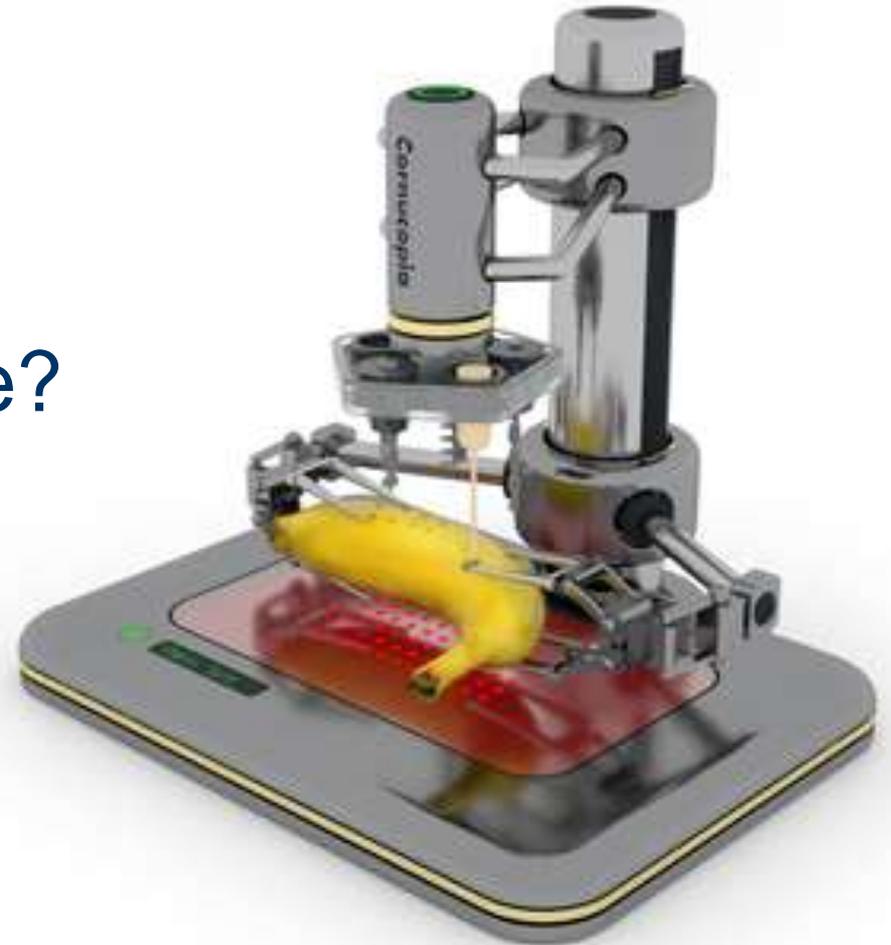
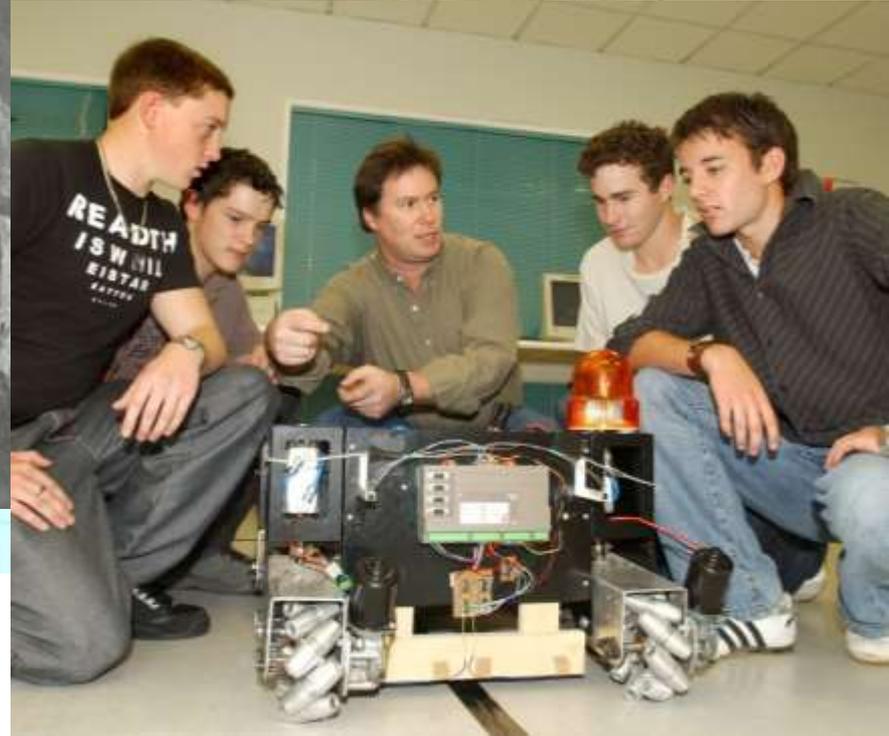


3D Printing the Future?

Olaf Diegel



From A to Z

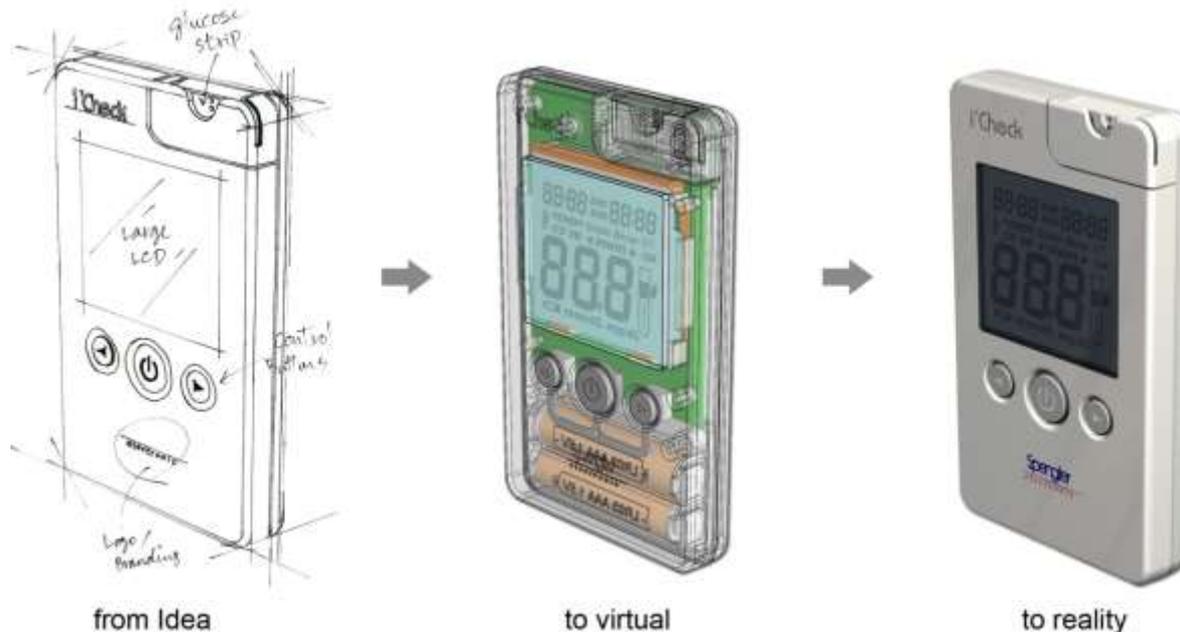


Life before academia



The Past

- For most of its first 2 decades, Additive Manufacturing was known as Rapid Prototyping, and mostly used for prototyping parts.
- In the last decade AM has begun to make appearances in real, commercially available, products, ie. moved beyond prototypes.



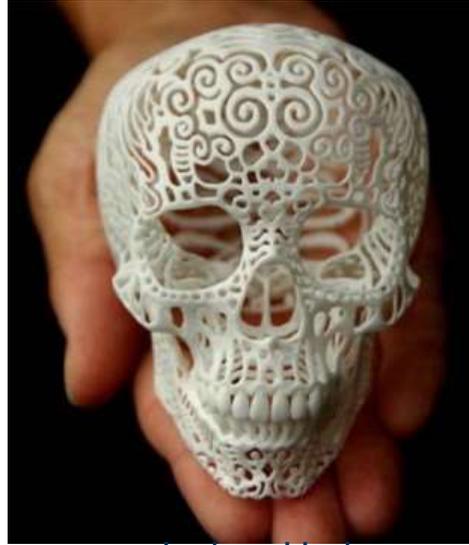
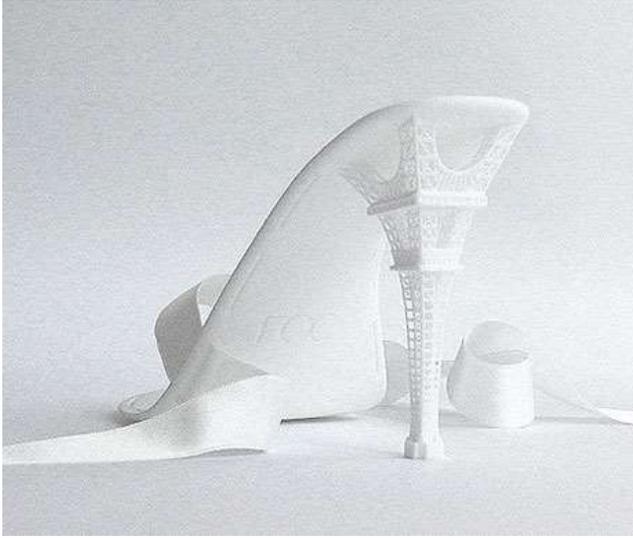
Key Take-Home Message

- 3D Printing will **NOT** replace conventional manufacturing!
- It is a complementary technology that, for **certain products**, and **if used the right way**, gives huge advantages over conventional manufacturing

Advantage: Complexity for Free

- The more complex the part, the better it is suited to Additive Manufacturing (AM).
- If a part is relatively simple, there are, generally, more cost-effective ways of manufacturing it than AM.
- Many simple parts can often be consolidated into one much more complex part as no assembly is required (so less assembly labour).

Art & Design Objects



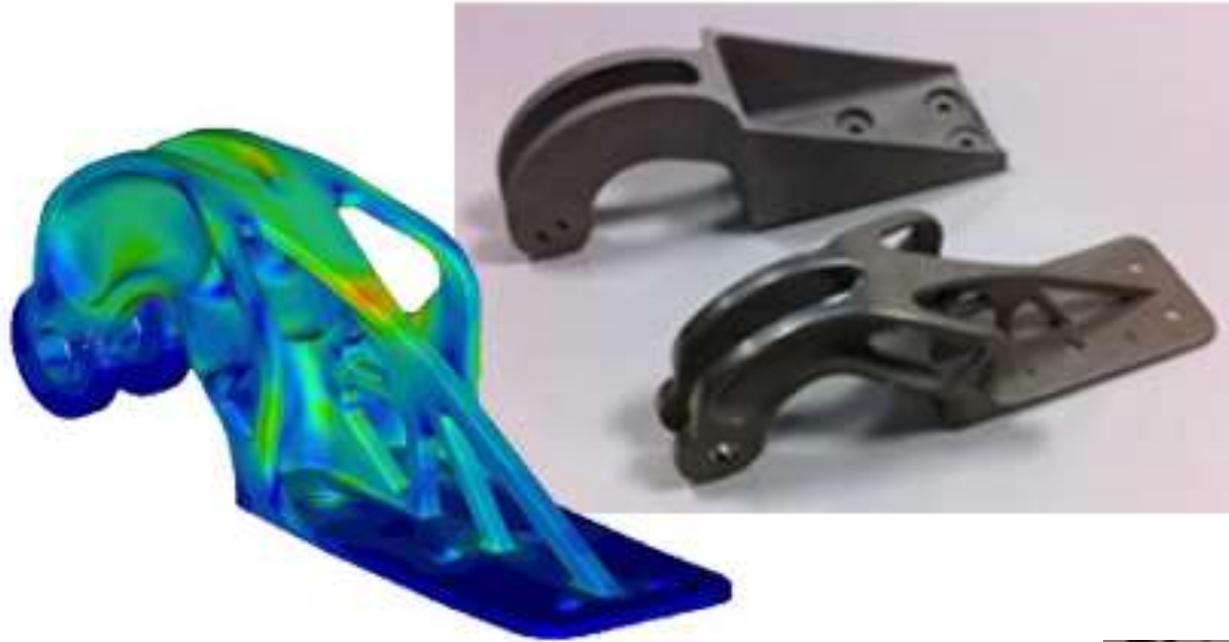
Joshua Harker



Freedom of Creation



Designing for Additive Manufacturing



Most of us are still designing our parts for conventional manufacturing. To take advantage of 3D printing we need to completely rethink how we design parts.





Bottle Opener

Rated at 300KG

1/15th of extruded/cast solid weight

1/30th of machined billet weight



Advantage: Mass customisation

- A small production run of parts can be undertaken in which each part is uniquely customized to suit the user
- It costs no more to do 100 different components than 100 of the same component
- This opens up a whole new area of business for products that are mass-custom-made for the user

Medical Applications



Hip socket, Ala Ortho, Italy, made on Arcam machine



Laser Sintered Hearing Aids, EOS/Materialise



Dental Crowns and Bridges, EOS



Dental aligners, Invisalign

Printing People



Advantage: Complete Products

- Additive manufacturing allows the production of complete products with moving parts. This can greatly reduce the amount of assembly (ergo labour) required to make products.
- AM allows many simple parts to be consolidated into a single more complex part

3D printed airplane

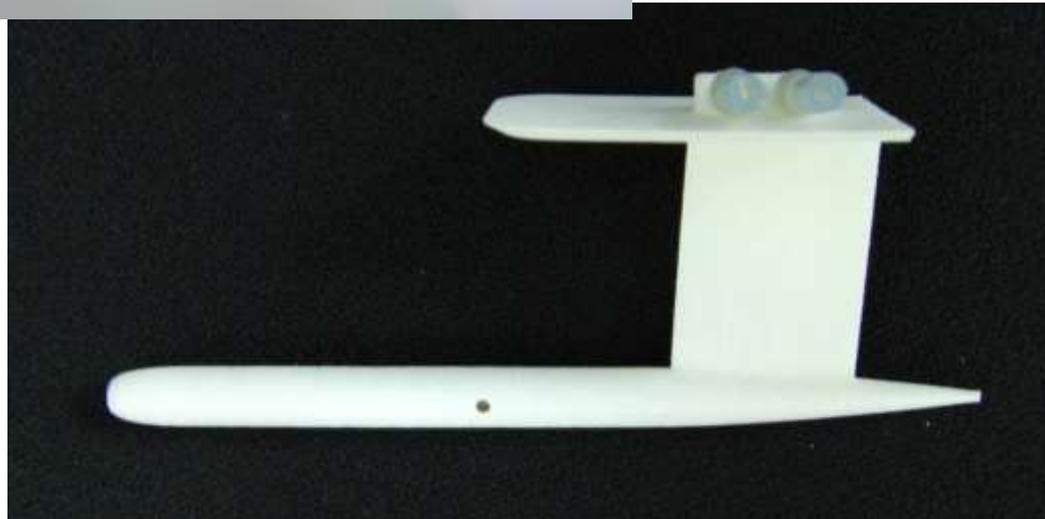


32 piece original

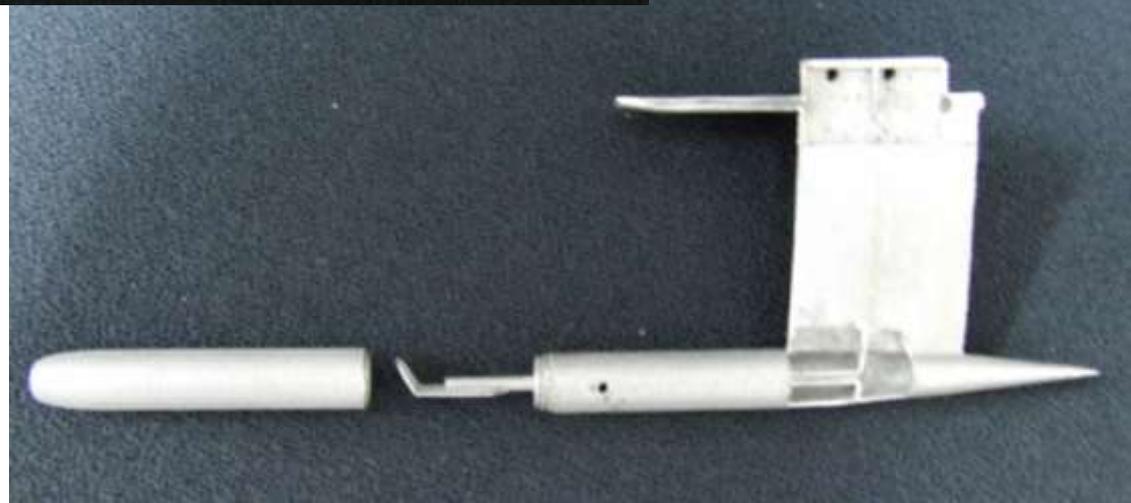


UAV Pitot Tube

1 piece Nylon test part



2 piece titanium final



So how does AM help with Innovation???

- AM is a catalyst that brings together all disciplines in true collaboration
 - AM removes the manufacturing obstacle that can be a barrier to innovation
 - Innovation is about learning to think differently
- 

Innovation vs Engineering vs Design

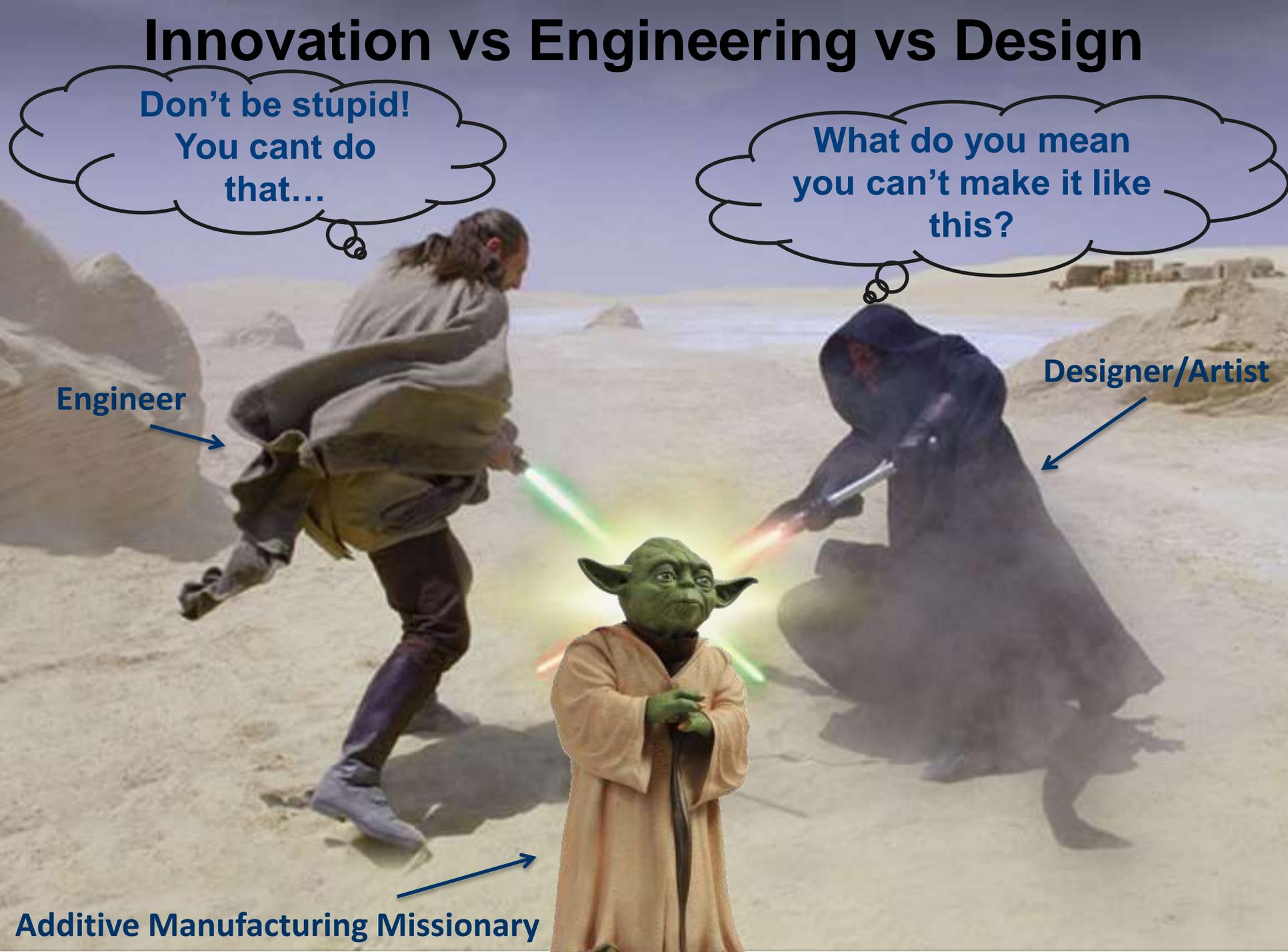
Don't be stupid!
You cant do
that...

What do you mean
you can't make it like
this?

Engineer

Designer/Artist

Additive Manufacturing Missionary



Innovation is not magic

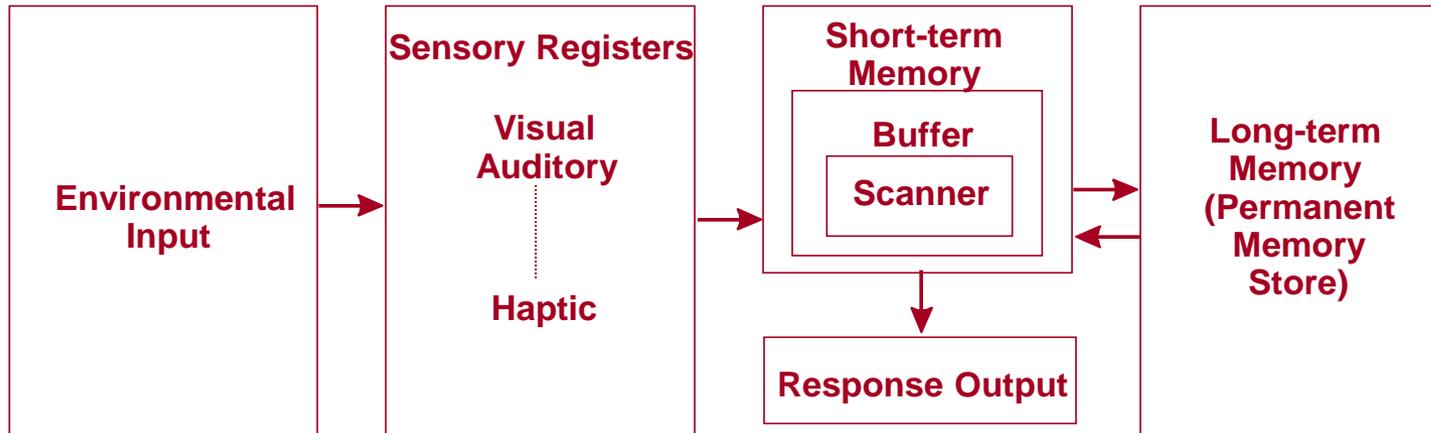
Though the results of innovation may be about the new, the processes involved in innovation are about the old

“We cannot imagine anything whatsoever, only things constructed out of existing knowledge. I cannot imagine a colour beyond my visual experience” (G Smith, 1998)

- All innovation is based on knowledge
- An innovative idea consists in finding a novel use for an existing object or concept
- The method for arriving at a solution can be analysed in hindsight.

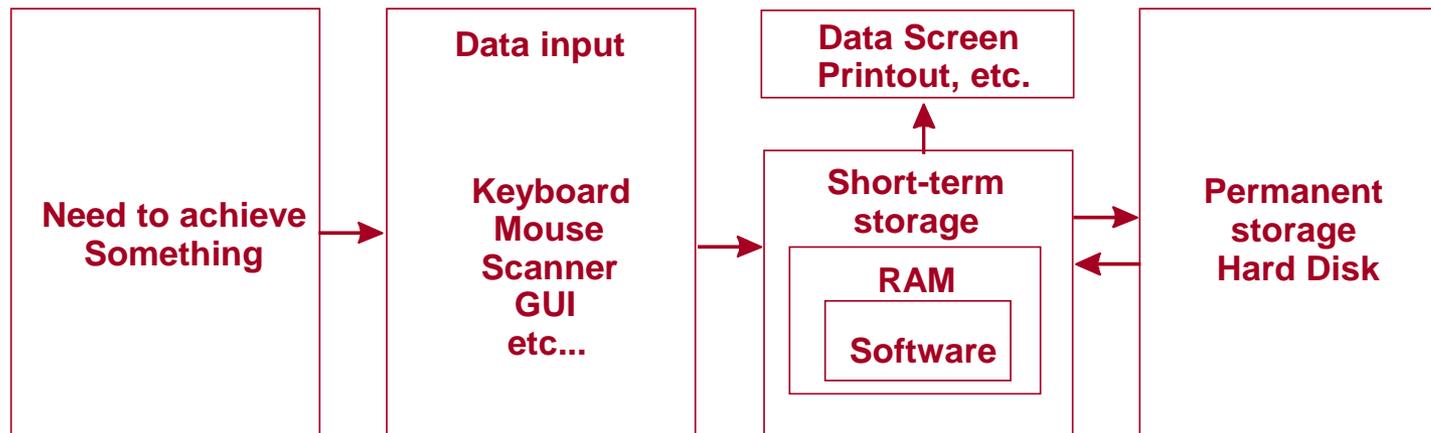
How the mind works

The Brain



Arthur L. Blumenthal, 1977, adapted from
R.C. Atkinson and R.M. Shiffrin, 1971

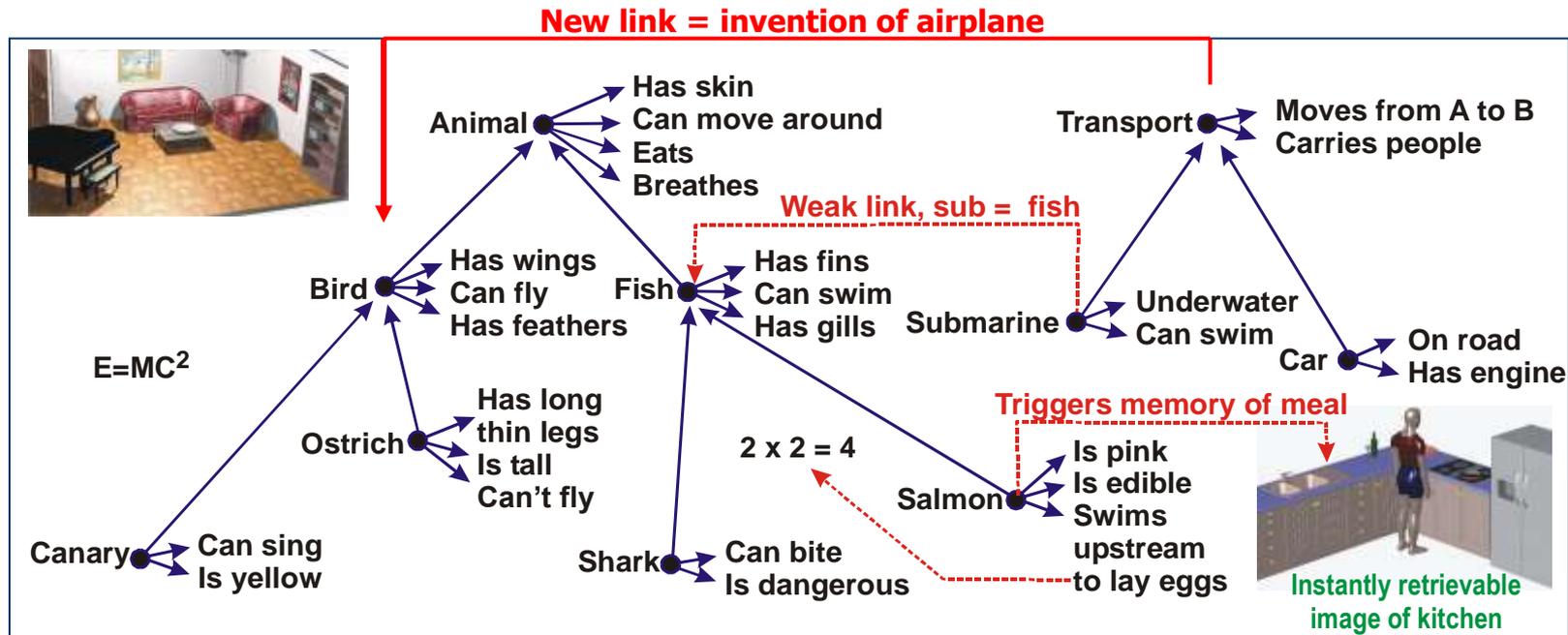
A Computer



Short-Term Memory

- Simultaneous data input limited to 7 events
- The goldfish syndrome: Input remains active for 10 ~ 20 seconds
- 7 elements can be simultaneously retained in STM
- Scanning process recognises validity of data and if required refreshes it, or puts it in long-term memory.
- Data in STM is used to recall data from LTM

Long-term Memory



(Collins and Quillian, 1969, Newell, 1990, Koestler, 1964)

- A dynamic structured hierarchical tree of knowledge
- Each extra node requires an additional 0.75msecs
- Node links can be of greater, or lesser strength and vary with time.
- Nodes can be 'chunked' into memory clusters which are instantaneously retrievable. ($2 \times 2 = 4$, images)

Some fun with numbers



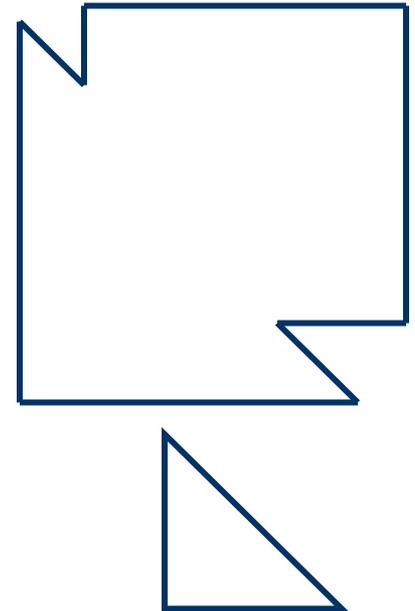
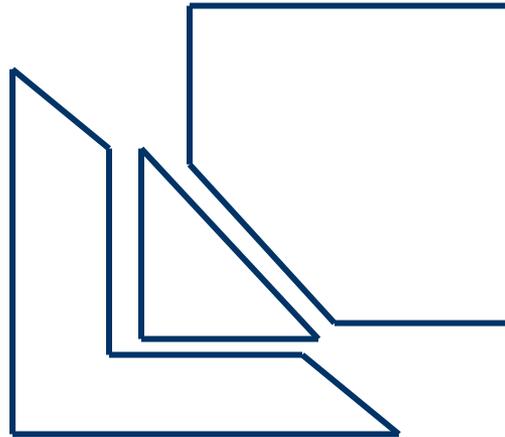
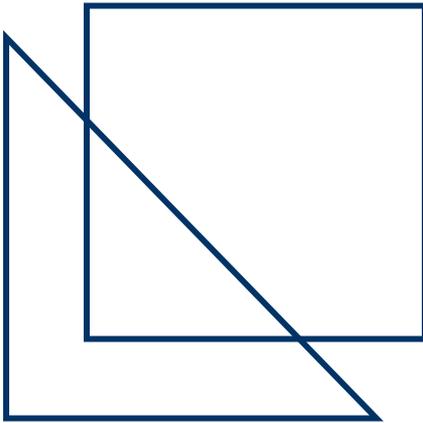
- 7 items in short term memory allows for 127 new combinations (or 5913 if we include permutations)
- In 1 second we can scan 1333 items in LTM and process them in STM
- In 1 second we have the potential for 169,291 innovations (7,882,029 if we include permutations)

So, why isn't it easy?

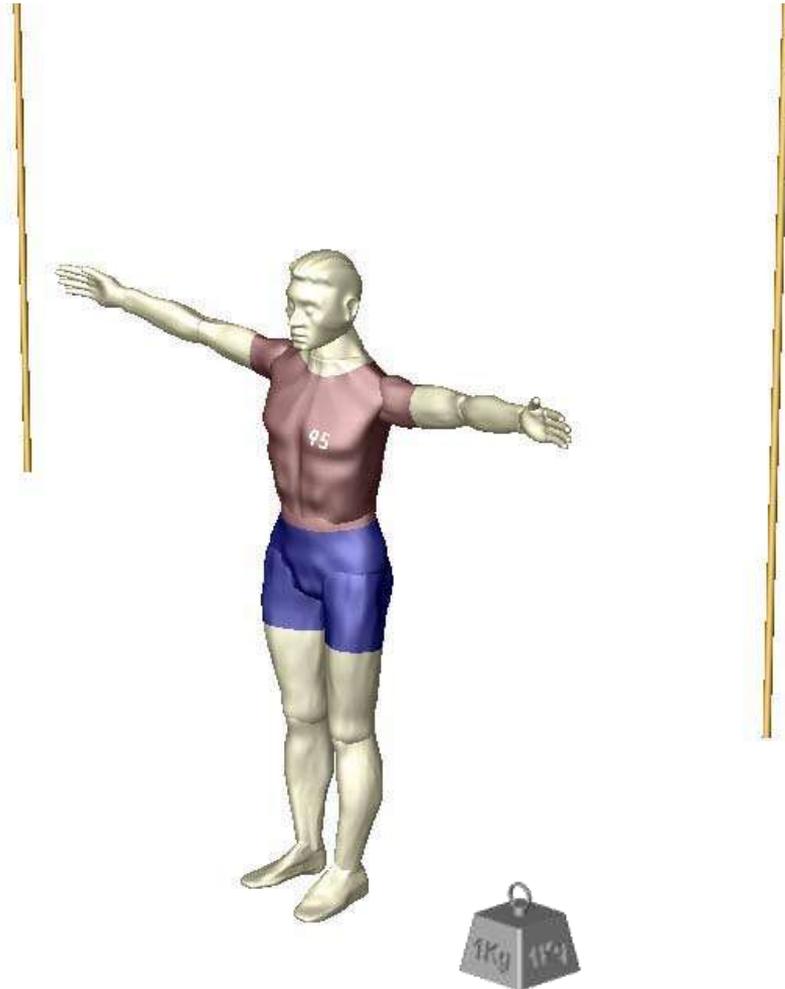
- Gestalt Theory: Law of Prägnanz states that psychological organisation will always be as concise, simple and unified as immediate events permit
- Innovative thinking is hard work!
- Our education acts as a barrier to Innovation

Law of Prägnanz

- What do you see?



The barrier to Innovation

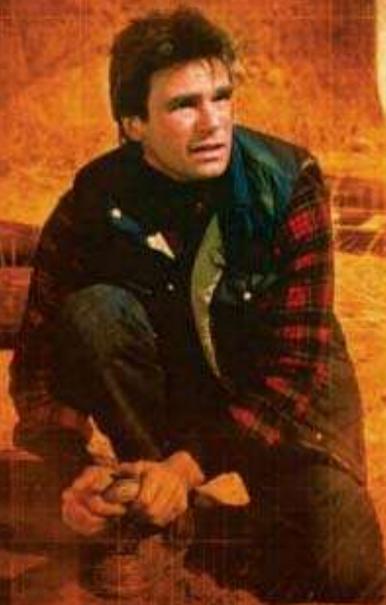


Functional fixedness is the effect of only being able to see something for what we have traditionally been taught it is by our education, environment, culture, etc

(Maier, 1931)

MACGYVER

ALWAYS PREPARED FOR ADVENTURE



Key Take-Home Message

- Most innovation stimulation tools are **mental**. But 3D printing is a **physical** creativity stimulation tool.
- It forces you to **think differently**, and removes the obstacle of 'making'
- Because it crosses **all disciplines**, from hard-core engineering, to art & design, to social sciences, to business, AM gives us an unprecedented opportunity for disciplines to work in much **closer synergy** than ever before. This a great **catalyst for innovation**.

Advantage: Try Ideas at No Risk

- Testing the market with an idea, using traditional manufacturing methods, can often be extremely expensive. AM allows small production runs of product to be taken to market with very little capital risk.
- This allows many more inventors to realize their inventions and test their market validity.

Innovative packaging solutions?



Oceania Defence Rifle Suppressors

- 3D Printed in titanium on EOSM270
- Complex internal baffles and cavities
- Reduces dB to below that required for ear protection

The Economist

FEBRUARY 12TH - 18TH 2011

Economist.com

Europe loses the mobile-phone war

Africa's new wealth

Japan's tea party

How to switch off the internet

The shoe-thrower's index

Print me a Stradivarius

The manufacturing technology that will change the world

This violin was made using an
EOS laser-sintering 3D printer
(and it plays beautifully)



FEBRUARY 12TH - 18TH 2011

Worldwide cover

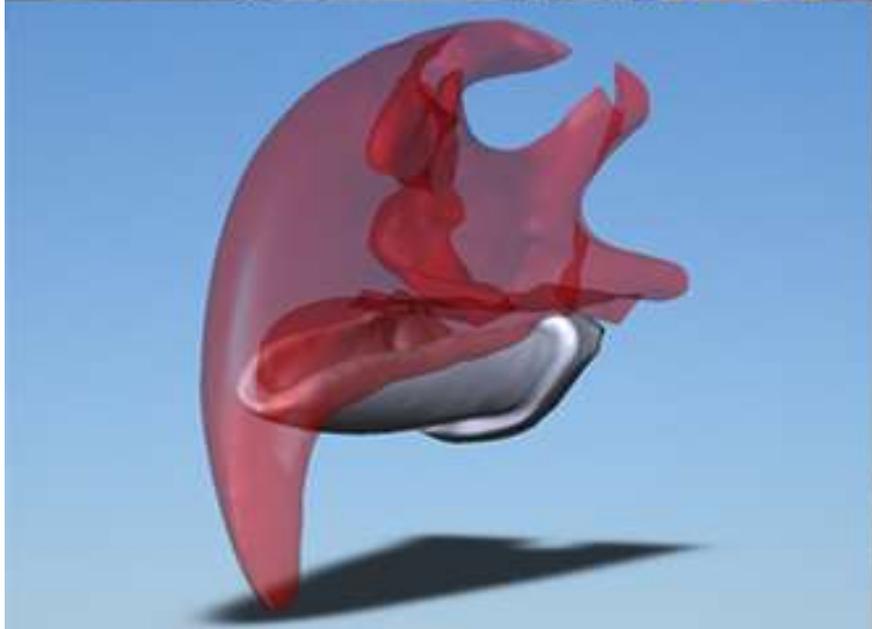
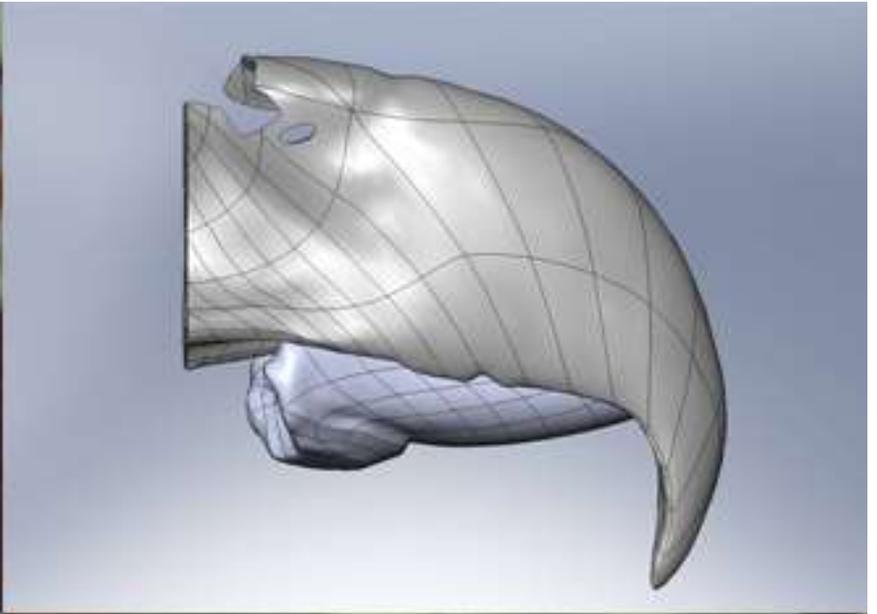
3D Printed Guitars...



Advantage: Encouraging Innovation

- The relatively low-cost ability to easily try out ideas generates many innovations that would just not have seen the light of day with conventional manufacturing.
- AM has seen children returning to making things. Where, over the past 20 years, they have slowly drifted into a digital entertainment age, 3D printing is now allowing them to move back from digital into reality.

Beauty and the beak



Cortex 3D printed Cast

Victoria University of Wellington graduate Jake Evill



Innovative Applications

MakerBot INDUSTRIES PRODUCTS COMMUNITY SUPPORT BLOG

HOME / BLOG / [Project Shelter: Can the MakerBot Community Save Hermit Crabs?](#)

← 85mm Hobby Clamp by RotoScan 3D Printers Featured on The Street! →

Project Shelter: Can the MakerBot Community Save Hermit Crabs?

POSTED BY BRE PETTIS ON TUESDAY, OCTOBER 18, 2011 IN HERMIT CRAB PROJECT SHELTER

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Top Authors this Month

[Miles Lightwood](#) | [MakerBlock](#) | 20 Posts

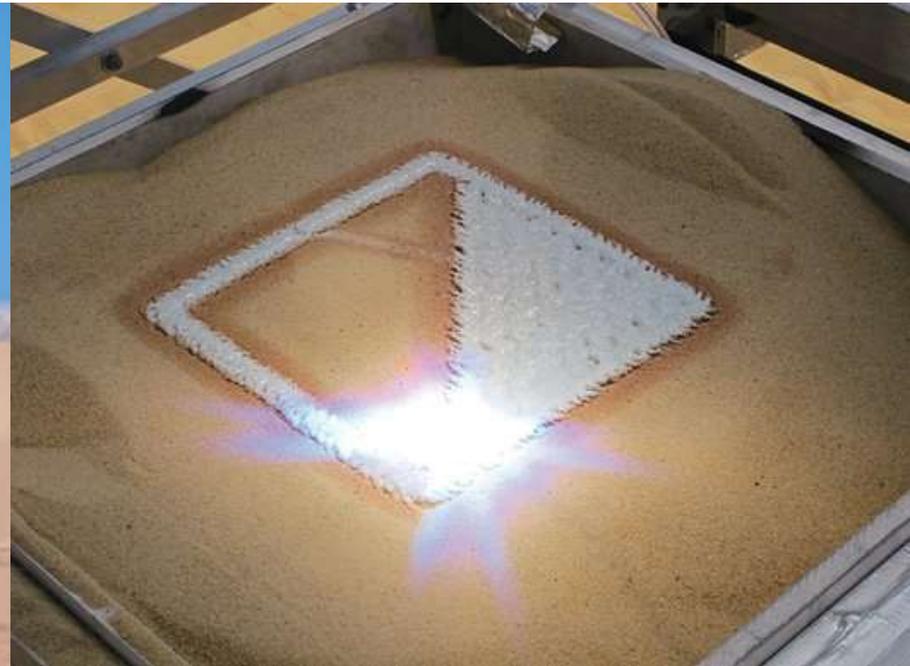


3D printed DB4

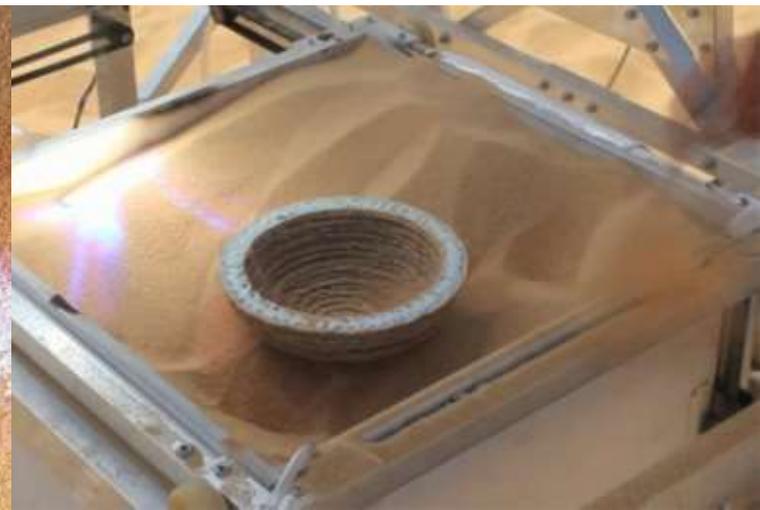
Ivan Sentch, Printed on Solidoodle

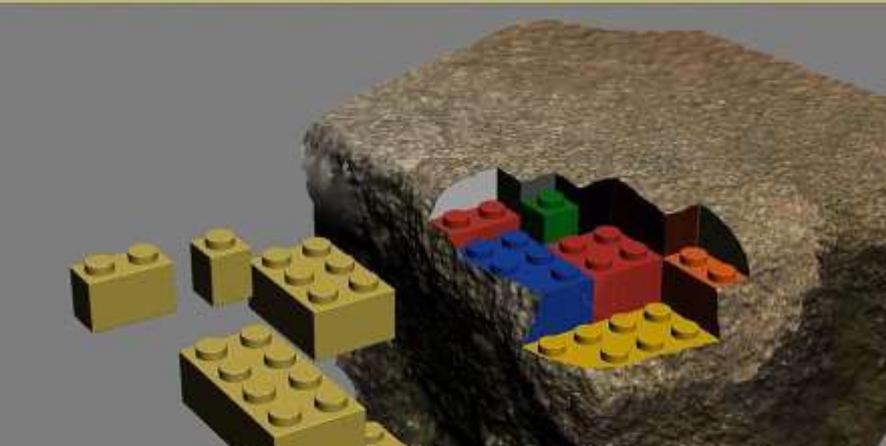
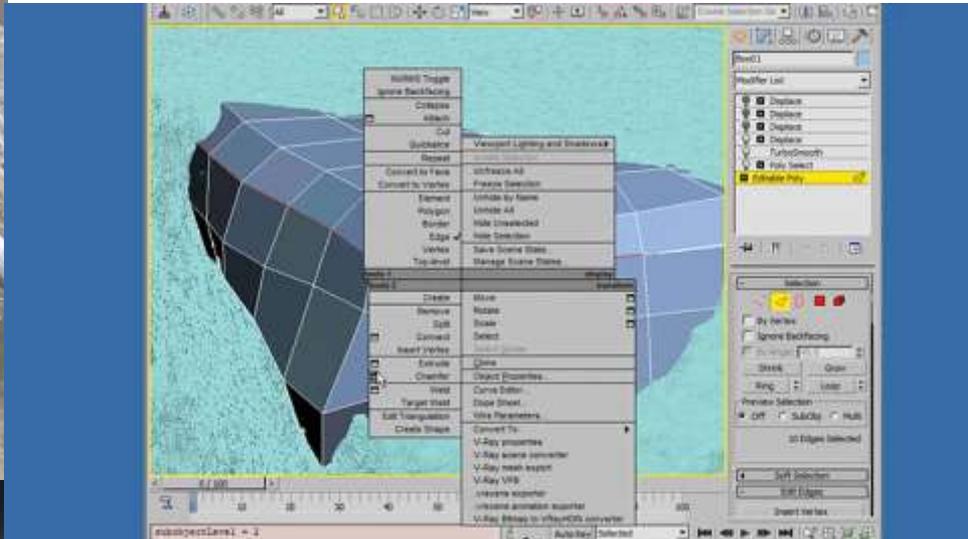


Innovative use of power sources

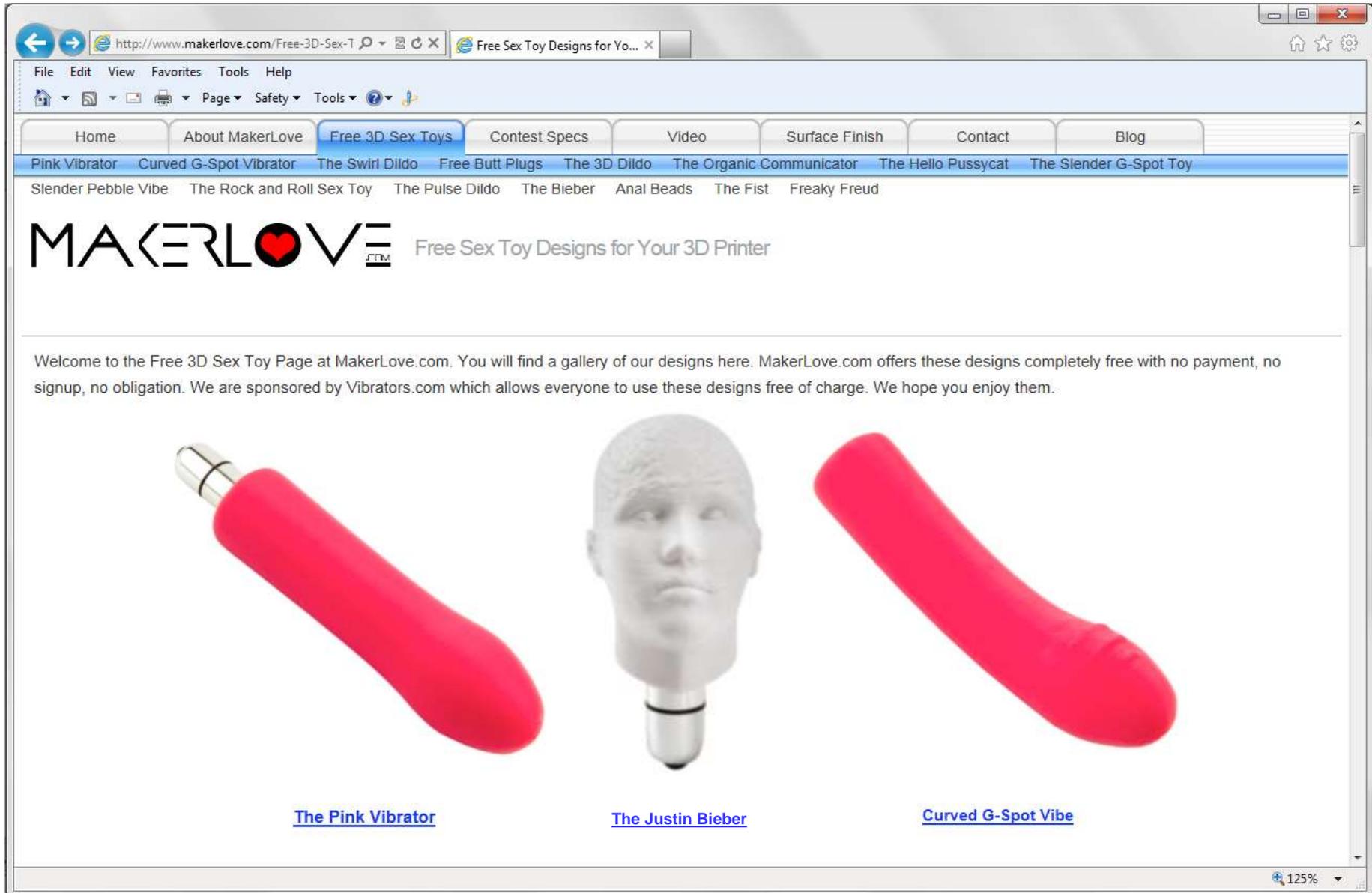


Markus Kayser's "Solar Sinter" 3D printer





And, of course, it was only a matter of time...



The image is a screenshot of a web browser displaying the MakerLove.com website. The browser's address bar shows the URL <http://www.makerlove.com/Free-3D-Sex-T>. The website's navigation menu includes links for Home, About MakerLove, Free 3D Sex Toys (which is the active page), Contest Specs, Video, Surface Finish, Contact, and Blog. Below the navigation menu, there is a horizontal list of product categories: Pink Vibrator, Curved G-Spot Vibrator, The Swirl Dildo, Free Butt Plugs, The 3D Dildo, The Organic Communicator, The Hello Pussycat, The Slender G-Spot Toy, Slender Pebble Vibe, The Rock and Roll Sex Toy, The Pulse Dildo, The Bieber, Anal Beads, The Fist, and Freaky Freud. The main heading of the page reads "MAKERLOVE Free Sex Toy Designs for Your 3D Printer". A welcome message states: "Welcome to the Free 3D Sex Toy Page at MakerLove.com. You will find a gallery of our designs here. MakerLove.com offers these designs completely free with no payment, no signup, no obligation. We are sponsored by Vibrators.com which allows everyone to use these designs free of charge. We hope you enjoy them." Three 3D models of sex toys are displayed: a pink vibrator on the left, a grey 3D-printed head with a vibrator attachment in the center, and a curved pink vibrator on the right. Each model has a corresponding caption below it: "The Pink Vibrator", "The Justin Bieber", and "Curved G-Spot Vibe". The browser's status bar at the bottom right indicates a zoom level of 125%.

[The Pink Vibrator](#)

[The Justin Bieber](#)

[Curved G-Spot Vibe](#)

E-nable: community for low-cost prosthetics



e-nable hand, Volunteer organisation founded by Jon Schull,
www.enablingthefuture.org

Inspired by RoboHand work of Ivan Owen and Richard Van As in 2012



day 2 at Therapy

WWW.ENABLEINGTHEFUTURE.ORG



More 3d printed prosthetics



Emma Lavelle and her “magic arms”. Tariq Rahman and Whitney Sample, Nemours/Alfred I DuPont Hospital for Children (Wilmington, DE)

Key Take-Home Message



≠



≠



Final Take-Home Message

3D Printing is Great!

Use it!!!