IDEAS

PROGRAMMABLE MATTER & SYNTHETIC BIOLOGY

NEW PARADIGMS & PROCESSES ENABLE PEOPLE TO TRANSFORM INDUSTRIES

Synthetic Biology and Programmable Matter are two emerging design paradigms that apply computational technologies at the nano scale and beyond. Relatively uncharted and full of promise, these emerging domains of study will inspire designers to rethink the way they approach their work as well as reconsider the nature of the problems they can address. The wildly diverse tools and technologies will have a broad impact on many industries.

NEW

Many of the underlying technologies driving these paradigms are growing at exponential rates, compounding power while lowering cost.

EXPONENTIAL GROWTH
Exponentially growing technologies exhibit compounding development. Generally built on information technologies, their growth accelerates as faster and more powerful computers build faster and more powerful computers, represented as an ever steeper curve.

COST OF PRODUCTION
One consequence of this growth is the shrinking cost of design tools. Most significant is the change of genomic reading and writing, which are changing faster than Moore's Law.

PARADIGMS

These advances in design, computational and biological tools provide designers with new frameworks and approaches to design. One useful framework that generalized design is to identify three fundamental qualities: size, fabrication process and material nature. When mapped on a three dimensional framework these three domains create eight domains or paradigms of design, expanding the designers' toolkit into new areas.

SIZE:
Macro vs Micro
New tools are allowing designers to extend their capability of design from the setting of everyday objects (shoes, cars, furniture) and larger objects (buildings and cities) to smaller objects (medical devices and nanobots).

FABRICATION:
Self-Assembling vs Externally Directed
New fabrication tools are broadening designers' options for physical production. Directed fabrication includes manufacturing processes of additive assembling and subtractive sculpting. In self-assembling systems, the designer is no longer an external director, but creates conditions for complex objects to spontaneously self-assemble from simpler objects.

NATURE:
Non-Living vs Living
New technologies are equipping designers with the capacity to manipulate at the molecular level, using techniques ranging from inanimate chemistry to animated living biology. Advances in synthetic biology equip designers with the ability to read, manipulate and fabricate DNA, introducing the possibility to design biological processes.

1 **MACRO NON-LIVING EXTERNALLY DIRECTED**

The most familiar design paradigm, this domain includes the world of visible objects - from consumer products to buildings and cities.

2 **MICRO NON-LIVING EXTERNALLY DIRECTED**

This domain focuses on the miniature, microscopic and nanosized objects including medical devices, digital processor chips and nano-objects.

3 **MACRO NON-LIVING SELF-ASSEMBLY**

Inspired by the work of Skylar Tibbits, large structures can be assembled by mimicking chemical processes: magnetic shapes snap together into patterns.

4 **MICRO NON-LIVING SELF-ASSEMBLY**

As demonstrated by CADNano, it is possible to build complex nanostructures from a collection of self-assembling smaller structures.

5 **MACRO LIVING EXTERNALLY DIRECTED**

This is the domain of traditional design and management of living creatures from crop to animal management.

6 **MICRO LIVING FABRICATED**

Nature's ecosystems operate at this domain, spontaneously creating and evolving interconnected systems of material and energy exchange.

7 **MICRO LIVING EXTERNALLY DIRECTED**

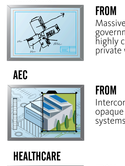
Emerging robotic technologies can directly deposit cells into a lattice creating living tissue, which may be used to regenerate or replace organs.

8 **MICRO LIVING SELF-ASSEMBLY**

All known forms of living creatures are coded by DNA. Genome Compiler provides tools to be able to program DNA at a high level.

PROCESSES

Common to most design methods are a series of activities - methods to promote discovery and insight, techniques to clarify goals and processes, approaches for iteratively prototyping, visualizing, simulating, testing, executing, and measuring. Most design methods strive to discover and implement elegant solutions addressing an entire ecosystem, satisfying multiple objectives simultaneously.



TOOLSET
Most design tools can be put into the categories of scanning or capturing an object or situation, understanding that representation, modifying and improving it, and fabricating the result. The simple version is called scan, modify, print. In the domain of biological science, it is referred to as read, understand and write.

MINDSET
With new tools come new approaches. Design approaches now have become more sophisticated allowing designers the ability to address larger, more holistic issues and strive to reach a wider range of meaningful goals including sustainability, longevity, human experience, social equity, environmental stewardship and profitability.

ENABLE PEOPLE

As design tools continue to be more powerful, simpler to use, more accessible - and driven through social, mobile and cloud-based technologies - more people, from different disciplines, in varying geographies across the world will be engaged in the work of design. Likely, the definition of design will change as design disciplines overlap and merge.

TO TRANSFORM INDUSTRIES

The resulting impact of new technologies, paradigms and processes will equip more people to transform entire industries, from energy production, food, building and healthcare.

MANUFACTURING

FROM
Traditional treat, beat, heat and distribute methods.

TO
Custom 3D printing to serve local and personal needs.

AUTOMOTIVE

FROM
Automotive manufacturing in select urban centers.

TO
3D printing of vehicles and parts in regional centers.

AEROSPACE

FROM
Massive government or highly capitalized private ventures.

TO
Distributed low capitalized centers.

AEC

FROM
Interconnected opaque economic systems.

TO
Interconnected transparent economic systems.

HEALTHCARE

FROM
Disconnected manual systems of data management.

TO
Personalized systems of data-driven healthcare using synthetic biology.

ENERGY

FROM
Fossil-fuel based systems of energy based production.

TO
Glucose based sustainable systems of energy.

Autodesk

IDEAS

This infographic emerged from a two day workshop, conducted on March 27th and 28th, 2012 with thirty leaders in Synthetic Biology, Programmable Matter and Design Technology met at the IDEAS Innovation +Design Summit to discuss tools, trends and implications of these emerging technologies. For more information about IDEAS, visit autodesk.com/ideas or contact ideas@autodesk.com.