DESIGN THINKING FOR A CLEAN TECH FUTURE

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WHAT IS "DESIGN THINKING"?

SCIENCE TELLS US WHAT IS.
DESIGN TELLS US WHAT COULD BE.

"EVERYONE DESIGNS WHO DEVISES COURSE OF ACTION AIMED AT CHANGING EXISTING SITUATIONS INTO PREFERRED ONES."

HERBERT SIMON

WHAT IS "DESIGN THINKING"?

ESTABLISH PARAMETERS

GENERATE ALTERNATIVES *(NO JUDGMENT)*

EVALUATE, ITERATE, REFINE *(MULTI-FACTORIAL JUDGMENT, INCLUDING AESTHETIC JUDGEMENT)*

AH-HA MOMENTS

CONCLUDE PROJECT

.....

OVER TIME, EVALUATE PROJECT

WHEN APPROPRIATE, REPEAT *(VERNACULAR, CONVENTIONAL WISDOM)*

WHAT IS "DESIGN THINKING"?

ABDUCTIVE THINKING *(PEARCE)*
LATERAL THINKING *(DI BONO)*
CREATIVE THINKING *(PINK)*
ASSOCIATIVE THINKING *(BATESON)*

Men die.
Socrates is a man.
Socrates will die.

The Barbara Syllogism: Subjects address classification.

Grass dies.
Men die.
Men are grass.

Affirming the Consequent: Predicates address relationships. *(Bateson)*

WHAT IS "CLEAN"?

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CO2 EMISSIONS WILL BE REDUCED OR ELIMINATED

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+/OR

OTHER POLLUTANTS GENERATED BY FOSSIL FUELS WILL BE REDUCED OR ELIMINATED

WHAT IS "CLEAN"?

CO2 EMISSIONS WILL BE REDUCED OR ELIMINATED

+/OR

OTHER POLLUTANTS GENERATED BY FOSSIL FUELS WILL BE REDUCED OR ELIMINATED

+/OR

"COLLATERAL DAMAGE" WILL BE REDUCED OR ELIMINATED

WHAT IS "CLEAN"?

"COLLATERAL DAMAGE" WILL BE REDUCED OR ELIMINATED

NO MORE COAL SLUDGE SPILLS IN TENNESSEE

NO MORE MOUNTAIN-TOP REMOVAL IN WEST VIRGINIA

NO MORE OIL SPILLS IN ALASKA

NO MORE THREATS OF POLAR BEAR EXTINCTIONS

NO MORE OIL INDUSTRY INDUCED CIVIL UNREST IN WEST AFRICA

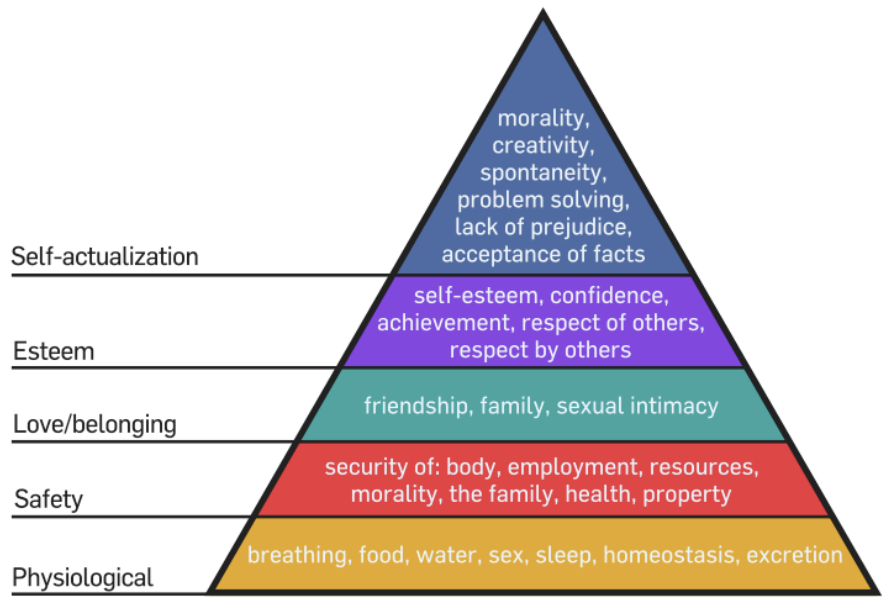
ASSUMPTION 1:

CLEAN TECHNOLOGY WOULD UTILIZE CURRENT SOLAR INCOME

(ELIMINATING THE PROBLEMS OF EXTRACTING FOSSIL FUELS, AND OF THE POLLUTANTS CREATED BURNING THEM)

ASSUMPTION 2:

CLEAN TECHNOLOGY WOULD PROVIDE A HIGH QUALITY OF LIFE FOR ALL PEOPLE ON THE PLANET

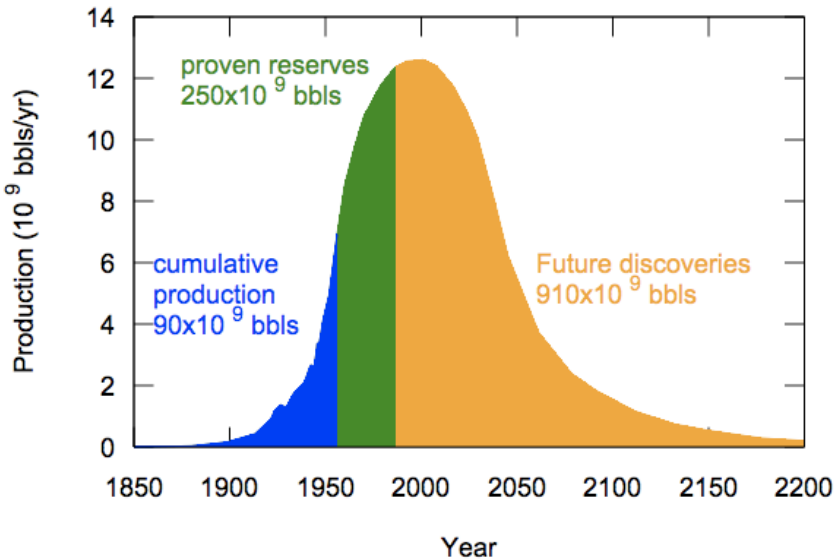


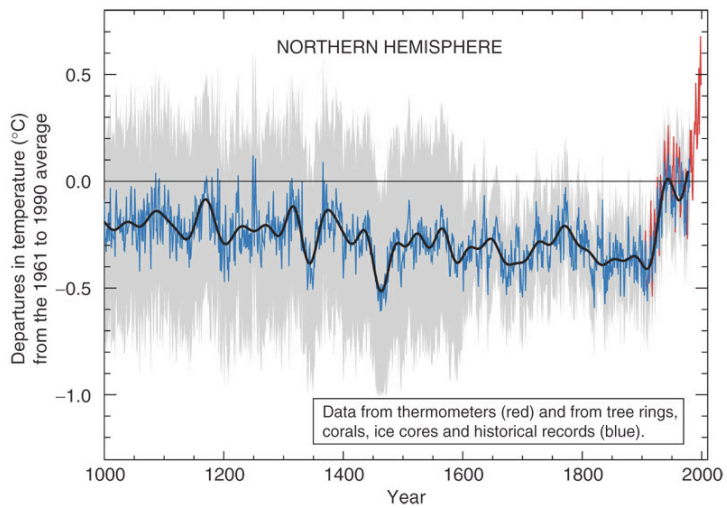
Maslow's Hierarchy of Needs

ASSUMPTION 3:

CLEAN TECHNOLOGY WOULD REPLACE THREATENED SUPPLIES OF FOSSIL FUELS

(EXACERBATED BY THE U.S. REJECTION OF THE KYOTO PROTOCOL, 9/11 AND RESULTING GEOPOLITICAL INSTABILITY, HURRICANE KATRINA, PEAK OIL ASSUMPTIONS, AL GORE'S ADVOCACY ON THE SUBJECT OF CLIMATE CHANGE)





TWO ALTERNATIVES:

INCREMENTAL IMPROVEMENT THROUGH DESIGN

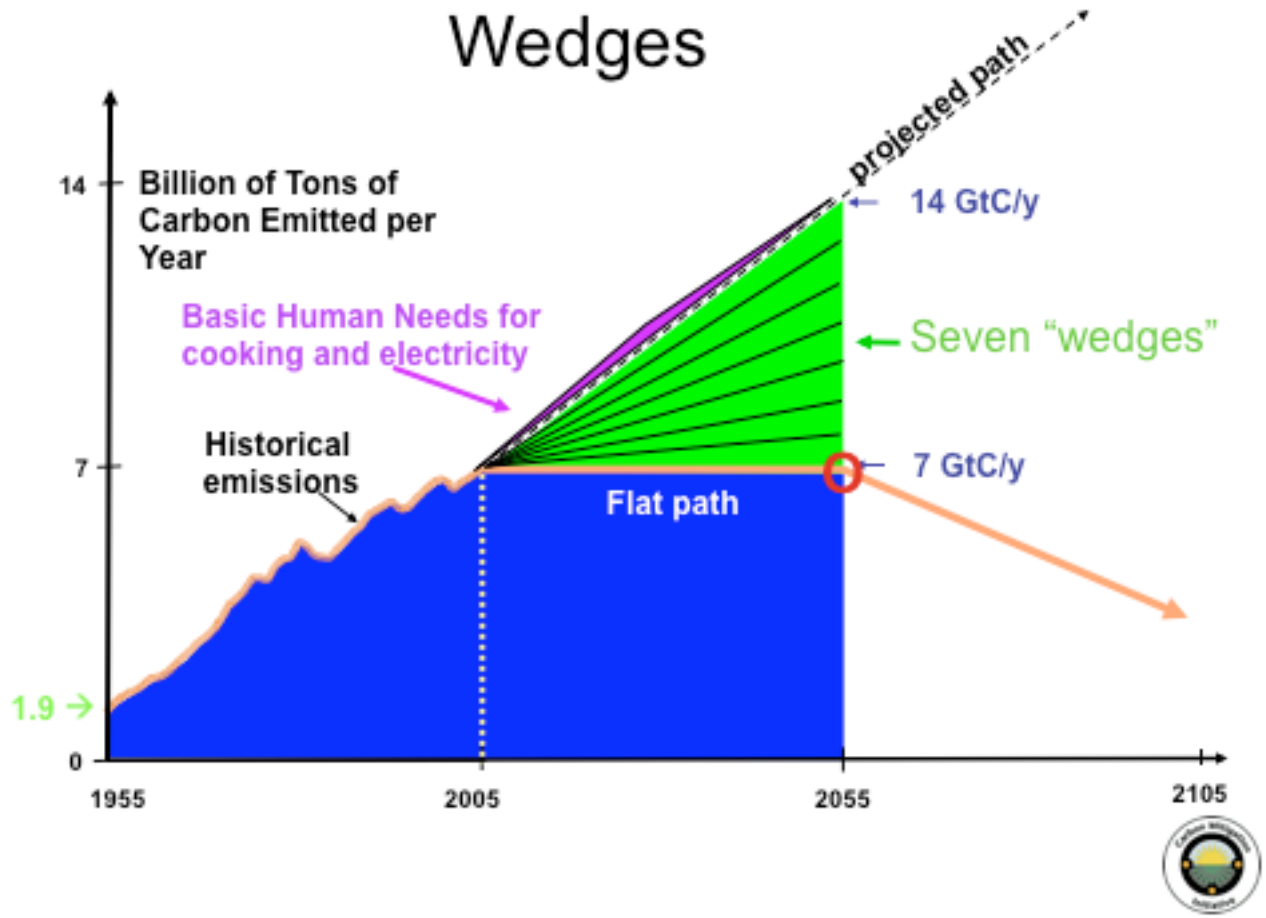
TRANSFORMATIONAL IMPROVEMENT THROUGH DESIGN

GENERATE ALTERNATIVES (NO JUDGMENT)

INCREMENTAL IMPROVEMENT THROUGH DESIGN:

SOCOLOW'S WEDGE AND FRITO LAY

GENERATE ALTERNATIVES (NO JUDGMENT)



From: Stabilization Wedges:
Mitigation Tools for the Next Half-Century

Robert Socolow, Princeton University
Future of Energy Series
Center for the Environment
Harvard University, April 5, 2006

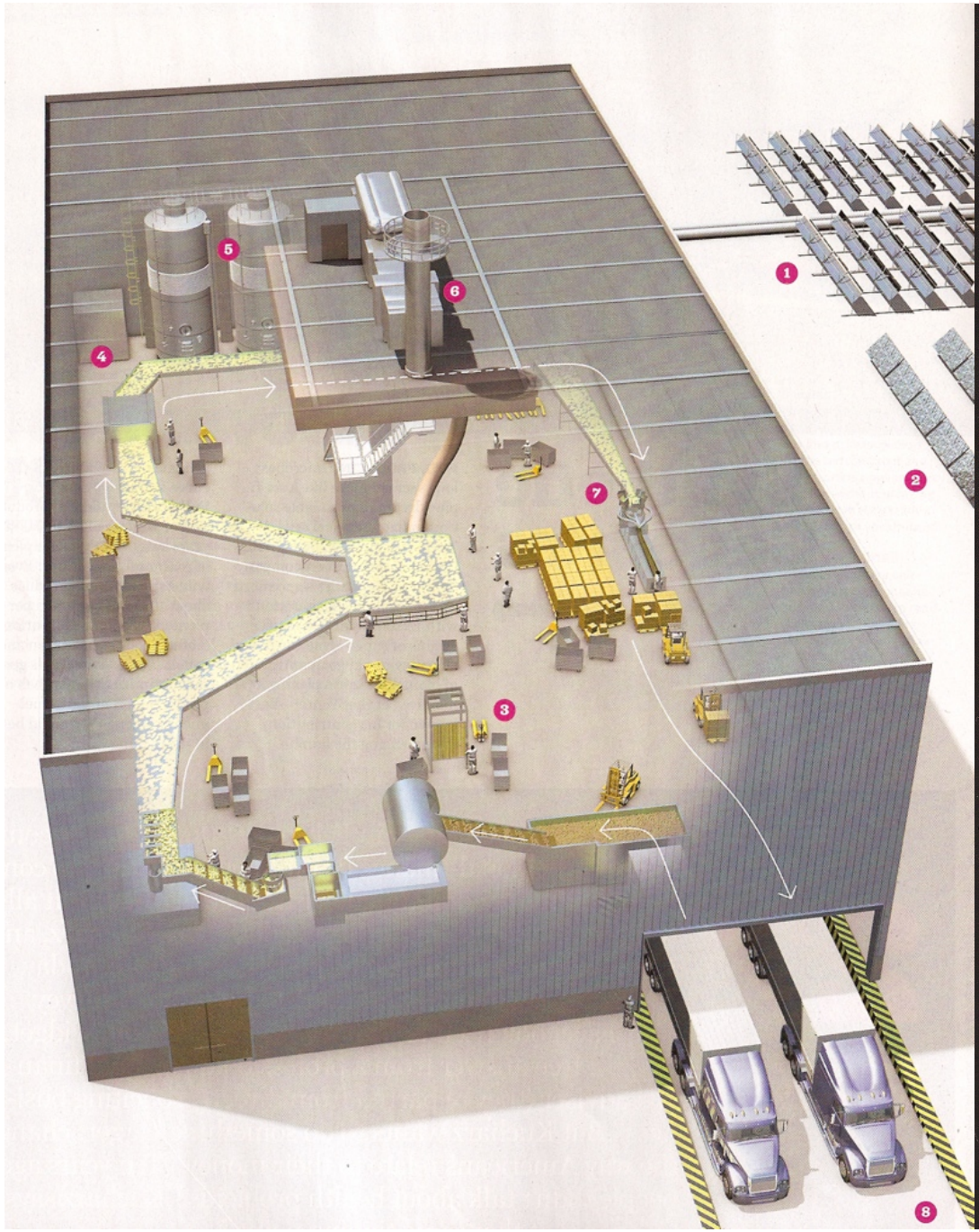
GENERATE ALTERNATIVES (NO JUDGMENT)

Table 1. Potential wedges: Strategies available to reduce the carbon emission rate in 2054 by 1 GtC/year or to reduce carbon emissions from 2004 to 2054 by 25 GtC.

Option	Effort by 2054 for one wedge, relative to 14 GtC/year BAU	Comments, issues
	Energy efficiency and conservation	
Economy-wide carbon-intensity reduction (emissions/$GDP)	Increase reduction by additional 0.15% per year (e.g., increase U.S. goal of 1.96% reduction per year to 2.11% per year)	Can be tuned by carbon policy
1. Efficient vehicles	Increase fuel economy for 2 billion cars from 30 to 60 mpg	Car size, power
2. Reduced use of vehicles	Decrease car travel for 2 billion 30-mpg cars from 10,000 to 5000 miles per year	Urban design, mass transit, telecommuting
3. Efficient buildings	Cut carbon emissions by one-fourth in buildings and appliances projected for 2054	Weak incentives
4. Efficient baseload coal plants	Produce twice today's coal power output at 60% instead of 40% efficiency (compared with 32% today)	Advanced high-temperature materials
	Fuel shift	
5. Gas baseload power for coal baseload power	Replace 1400 GW 50%-efficient coal plants with gas plants (four times the current production of gas-based power)	Competing demands for natural gas
	CO_2 Capture and Storage (CCS)	
6. Capture CO_2 at baseload power plant	Introduce CCS at 800 GW coal or 1600 GW natural gas (compared with 1060 GW coal in 1999)	Technology already in use for H_2 production
7. Capture CO_2 at H_2 plant	Introduce CCS at plants producing 250 MtH_2/year from coal or 500 MtH_2/year from natural gas (compared with 40 MtH_2/year today from all sources)	H_2 safety, infrastructure
8. Capture CO_2 at coal-to-synfuels plant	Introduce CCS at synfuels plants producing 30 million barrels a day from coal (200 times Sasol), if half of feedstock carbon is available for capture	Increased CO_2 emissions, if synfuels are produced without CCS
Geological storage	Create 3500 Sleipners	Durable storage, successful permitting
	Nuclear fission	
9. Nuclear power for coal power	Add 700 GW (twice the current capacity)	Nuclear proliferation, terrorism, waste
	Renewable electricity and fuels	
10. Wind power for coal power	Add 2 million 1-MW-peak windmills (50 times the current capacity) "occupying" 30×10^6 ha, on land or offshore	Multiple uses of land because windmills are widely spaced
11. PV power for coal power	Add 2000 GW-peak PV (700 times the current capacity) on 2×10^6 ha	PV production cost
12. Wind H_2 in fuel-cell car for gasoline in hybrid car	Add 4 million 1-MW-peak windmills (100 times the current capacity)	H_2 safety, infrastructure
13. Biomass fuel for fossil fuel	Add 100 times the current Brazil or U.S. ethanol production, with the use of 250×10^6 ha (one-sixth of world cropland)	Biodiversity, competing land use
	Forests and agricultural soils	
14. Reduced deforestation, plus reforestation, afforestation, and new plantations.	Decrease tropical deforestation to zero instead of 0.5 GtC/year, and establish 300 Mha of new tree plantations (twice the current rate)	Land demands of agriculture, benefits to biodiversity from reduced deforestation
15. Conservation tillage	Apply to all cropland (10 times the current usage)	Reversibility, verification

From: Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies *Science* S. Pacala, et. al. 968 (2004); 305

EVALUATE, ITERATE, REFINE (MULTI-FACTORIAL JUDGMENT, INCLUDING AESTHETIC JUDGEMENT)



28 NEW!

Frito-Lay

The snack giant moved one-third of its 32 plants to "zero landfill" last year—the rest will achieve that goal by the end of 2011. We put together a composite of the production line that makes deliciously green chips.

1) Solar Concentration
Long rows of reflective troughs focus sunlight on liquid-filled tubes, which can reach up to 500 degrees. The hot fluid is then converted to steam, which heats oil for cooking. The steam is then returned to the solar troughs, in a closed-loop system.

2) Photovoltaics
These solar-cell panels convert sunlight directly into electricity.

3) Water-Recovery System
Frito-Lay captures wastewater from manufacturing lines and cleans it to drinking-water quality by removing bits of corn and potato, passing it through a bioreactor to remove broken-down starches and sugars, then filtering and disinfecting it using ultraviolet light and reverse osmosis. The clean water is then used again to wash potatoes, cook corn, and make snacks.

4) Co-Generation System
Frito-Lay's Killingly, Connecticut, and Kern, California, plants operate independently of the electricity grid, thanks to a natural-gas-powered turbine that creates electricity and high-temperature heat converted to steam.

5) Biomass Boilers
Frito-Lay uses by-products from nearby industries (for example, pecan shells, cottonseed, and wood waste such as sawdust and broken pallets in its Topeka, Kansas, and Arizona plants) as fuel for its biomass boilers, which generate heat and electric power.

6) Stack Heat Recovery
When potatoes, which are 80% water, are sliced and fried, the water escapes as steam. Equipment captures the steam to preheat wash water and warm the building in the winter. When the water condenses, it's used to clean other spuds.

7) Packaging
Over the past five years, Frito-Lay has eliminated 150 square miles of packaging by reducing the materials by 10%. This year, it's introducing the first fully compostable chip bag with its SunChips line.

8) Food-Scrap Recycling
Almost every piece of waste generated at the plant is reused or recycled. The 20 million pounds of potato peelings and corn husks are sent to livestock farms for use as feed, and Frito-Lay consumes 150,000 tons less paperboard each year simply by reusing its shipping cartons five or six times each.

Infographic by GOLDEN SECTION GRAPHICS

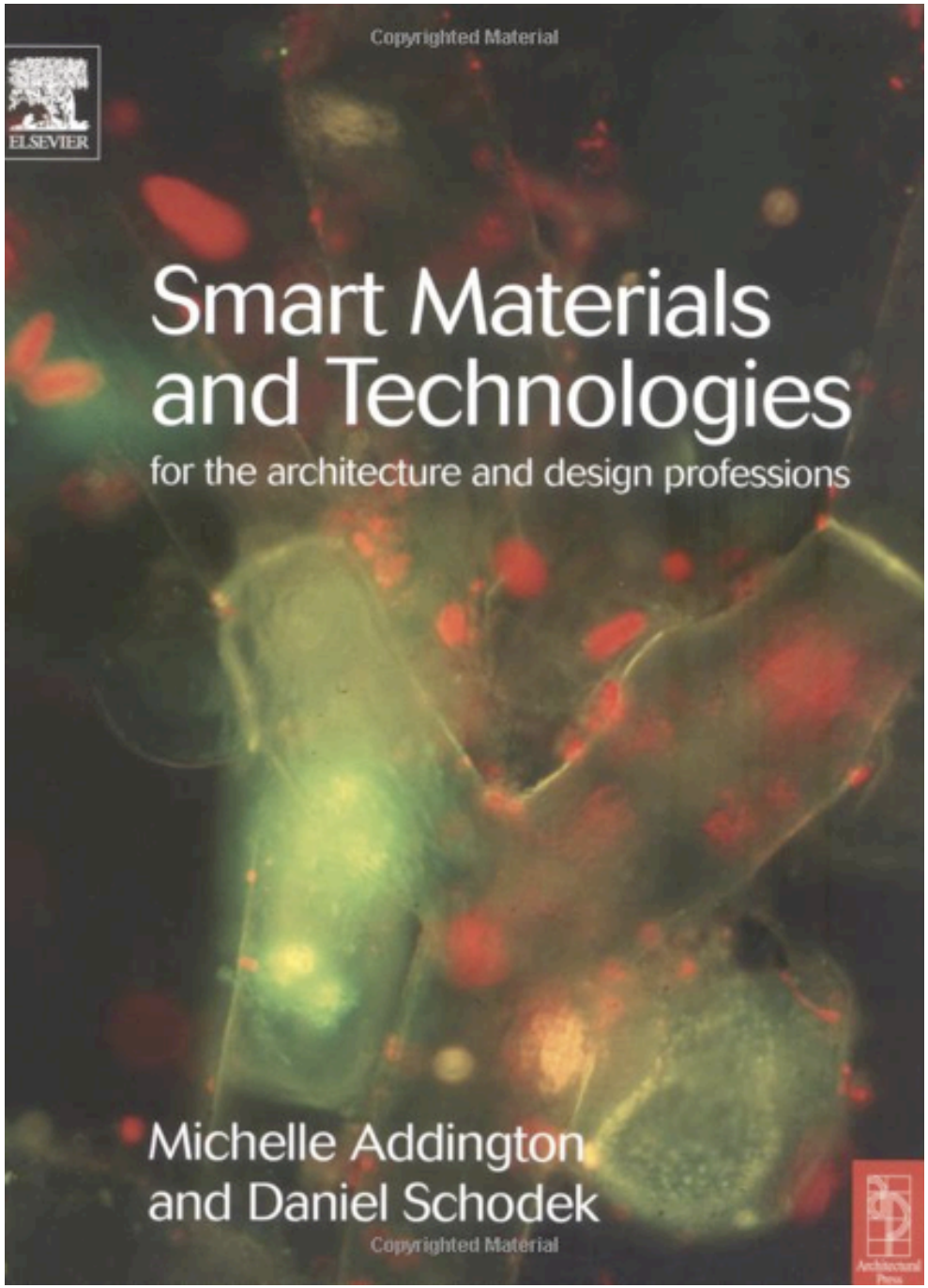
From: *Fast Company Magazine*, March 2010

GENERATE ALTERNATIVES (NO JUDGMENT)

TRANSFORMATIONAL IMPROVEMENT THROUGH DESIGN:

GOOD-BYE, WILLIS CARRIER

EVALUATE, ITERATE, REFINE (MULTI-FACTORIAL JUDGMENT, INCLUDING AESTHETIC JUDGEMENT)



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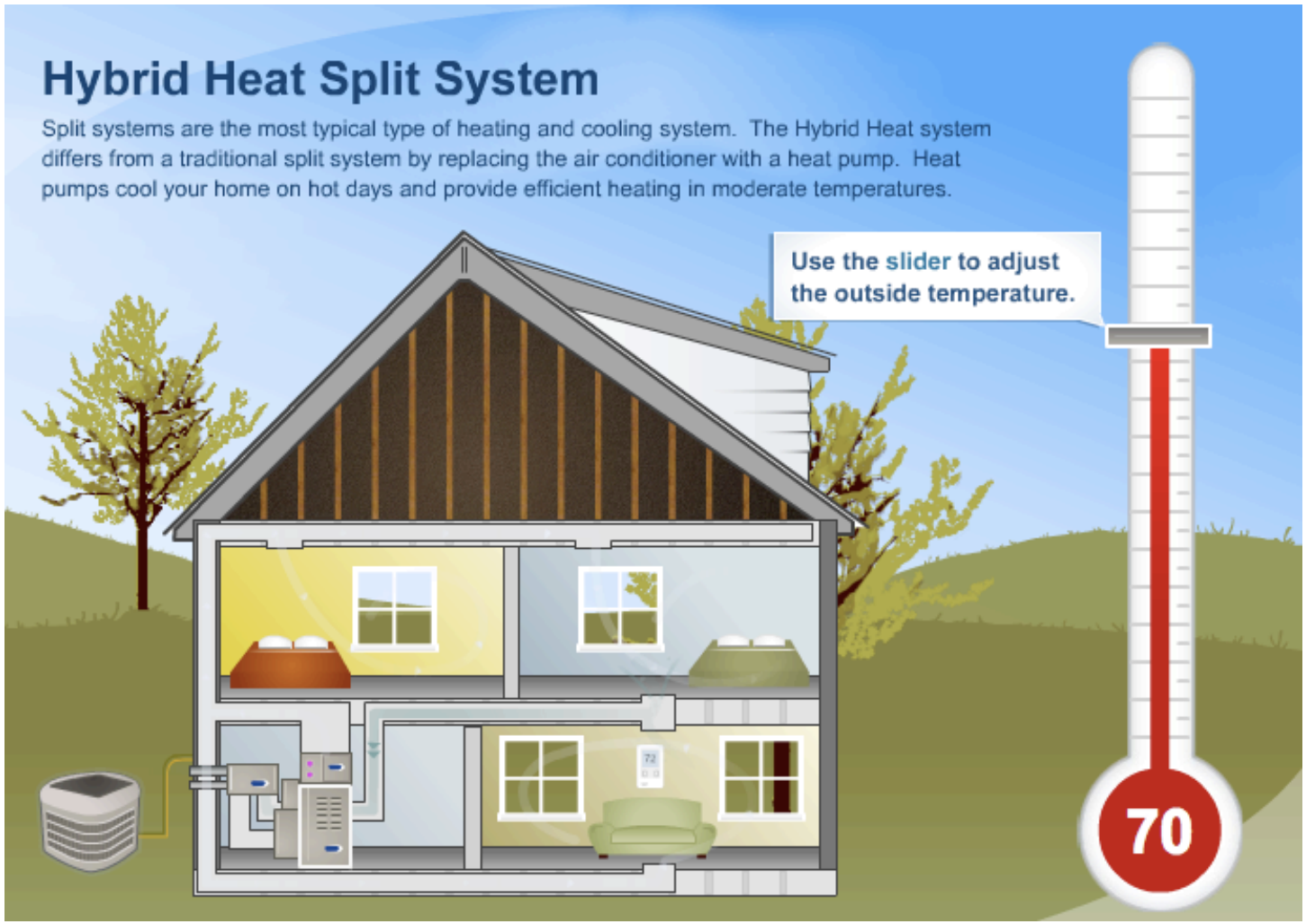
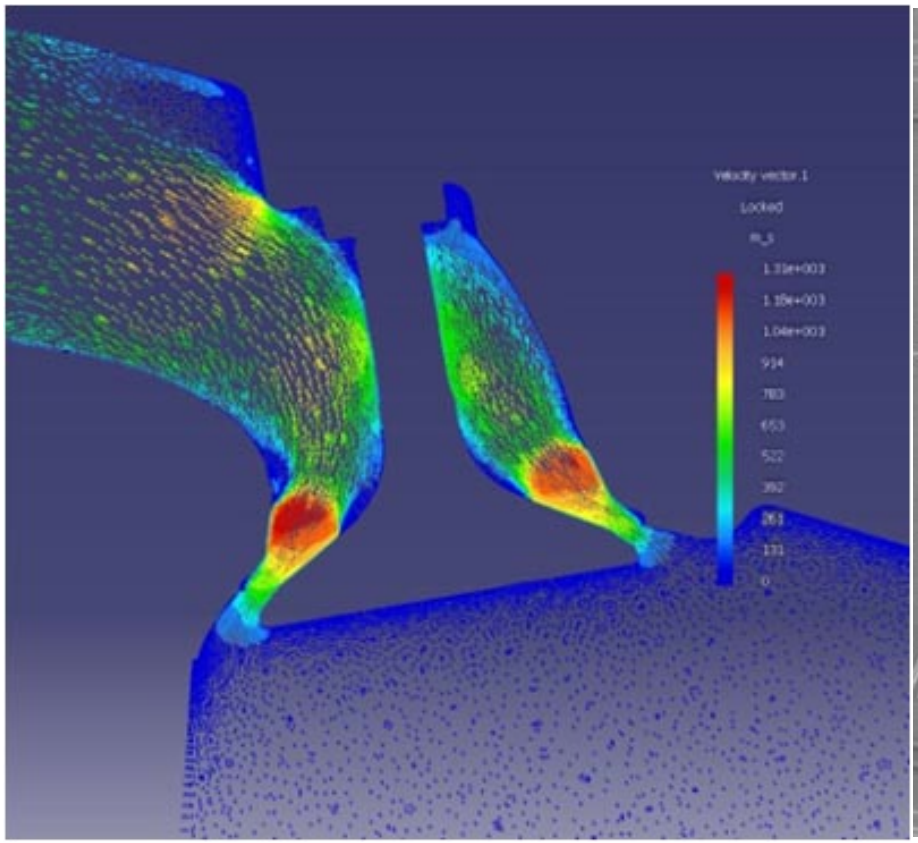


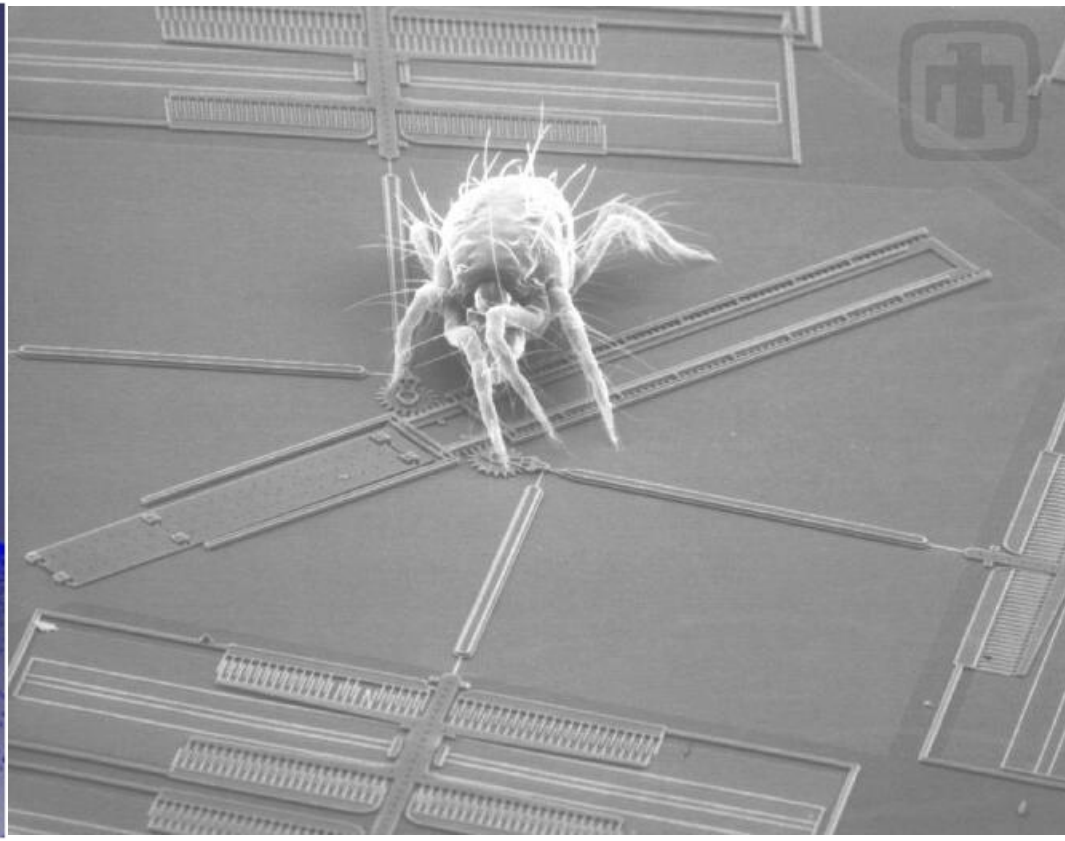
From: http://www.residential.carrier.com/systems/types.shtml

HEAT PEOPLE, NOT AIR.

EVALUATE, ITERATE, REFINE (MULTI-FACTORIAL JUDGMENT, INCLUDING AESTHETIC JUDGEMENT)



From: http://www.ansys.com/products/fluid-dynamics/ffc/



From: http://mems.sandia.gov/gallery/images_bugs_on_mems.html

NON-COINCIDENT PHENOMENOLOGICAL AND PHYSICAL BOUNDARIES USING CFDs AND MEMs

(COMPUTATIONAL FLUID DYNAMICS AND MICROELECTRONMECHANICAL SYSTEMS) (D. Michelle Addington)

GENERATE ALTERNATIVES (NO JUDGMENT)

TRANSFORMATIONAL IMPROVEMENT THROUGH DESIGN:

DESKTOP-PRINTED CURRENT SOLAR INCOME

EVALUATE, ITERATE, REFINE (MULTI-FACTORIAL JUDGMENT, INCLUDING AESTHETIC JUDGEMENT)

SMARTWRAP: PHOTOVOLTAICS WALLS PROTOYPE

(KieranTimberlake at the Cooper Hewitt Museum)

Grass dies.
Men die.
Men are grass.

GRASS USES MORE THAN CURRENT SOLAR INCOME.
IT TURNS WASTE INTO FOOD.

WHAT IS EDIBLE WASTE?

FOR WHOM IS THE WASTE EDIBLE?

FOR WHAT IS THE WASTE EDIBLE?

“If I had asked people what they wanted, they would have said faster horses.”

Henry Ford