

What is **SYNTHETIC BIOLOGY?**

Engineering Life
and Livelihood



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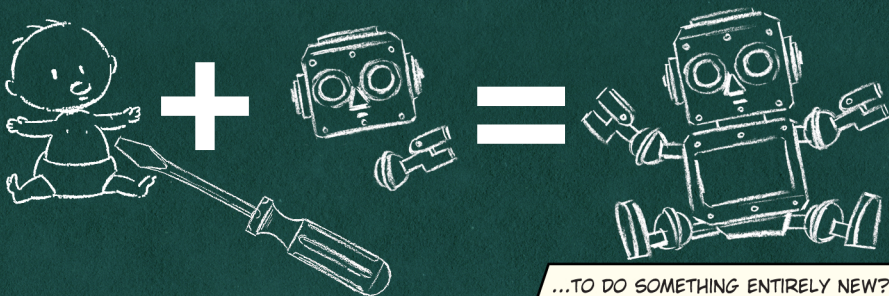
(Engineering Life
and Livelihood)

SO HERE'S A THOUGHT EXPERIMENT.



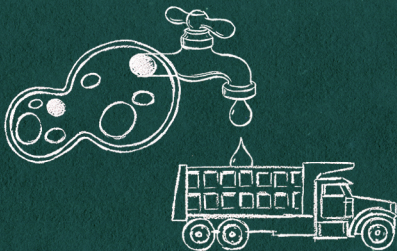
WHAT IF LIVING THINGS WERE
ACTUALLY MACHINES?

THE SORT OF MACHINES THAT YOU COULD TAKE APART, REPROGRAM, AND REWIRE...



...TO DO SOMETHING ENTIRELY NEW?

IF SO, PLANTS COULD JUST BE REWIRED TO GLOW
LIKE LIGHT BULBS...



...OR YEAST TINKERED WITH
TO PRODUCE VANILLA.

THE BIOTECHNOLOGY INDUSTRY HAS ACTUALLY SPENT YEARS TRYING
TO THINK ABOUT LIFE THIS WAY.

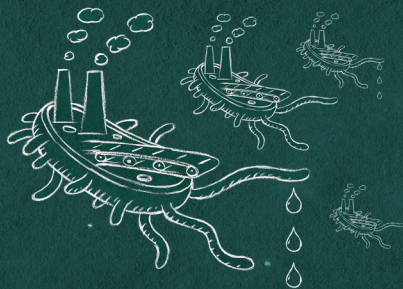


AND THAT IS THE IMPETUS TO A RAPIDLY EXPLODING
NEW INDUSTRY CALLED **SYNTHETIC BIOLOGY**.

NOW IMAGINE - SO THE THINKING GOES - IF YOU COULD JUST 'REPROGRAM' THAT 'CODE' SO THAT THE 'CHASSIS' CELL DOES SOMETHING COMMERCIALY PROFITABLE WITH THESE SO-CALLED 'BIOLOGICAL MACHINES'.

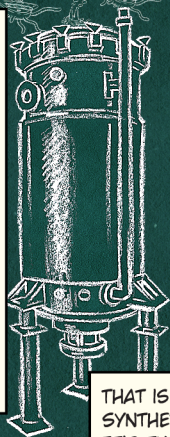


THE CELL CAN BE 'RE-PROGRAMMED' TO ACT AS THOUGH IT WERE A TINY BIOLOGICAL 'FACTORY' THAT WOULD PUMP OUT WHATEVER CHEMICAL YOU DESIRE.

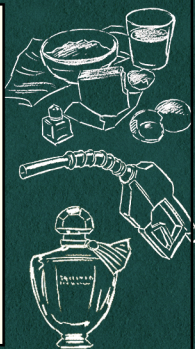


SYNTHETIC BIOLOGY IS IN FACT ALREADY A MULTI-BILLION DOLLAR INDUSTRY.

AND SCALING THAT UP, YOU COULD MAKE MILLIONS OF THOSE 'PROGRAMMED CELL FACTORIES' (BECAUSE THEY ARE SELF-REPLICATING) AND THEN HOLD THEM IN A BIG INDUSTRIAL VAT.



WELL, THAT WOULD BE A NEW WAY TO MAKE THE STUFF OUR CONSUMER SOCIETIES RELY ON: THE PLASTICS, FRAGRANCES, FOOD INGREDIENTS, AND FUELS.



THAT IS THE INCREDIBLE VISION BEHIND SYNTHETIC BIOLOGY (OR SYN BIO). IT'S THE APPLIED RE-ENGINEERING OF LIFEFORMS TO MAKE STUFF.



THERE ARE PRODUCTS ALREADY IN THE MARKET PLACE.

SYNTHETIC BIOLOGY

THERE'S AROUND A HUNDRED SYN BIO COMPANIES WHO HAVE DEALS WITH THE LARGEST CHEMICAL, FOOD, ENERGY AND COSMETICS COMPANIES ON THE PLANET.



Unilever



ECOVER

Chevron



MONSANTO

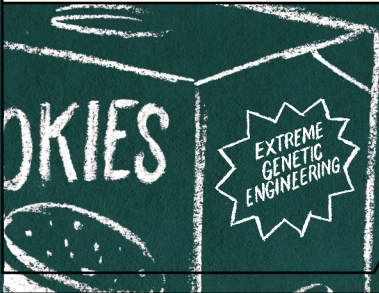


MANY OF THEM ARE HOUSEHOLD NAMES.

ACCORDING TO SYNBIO COMPANIES, THEIR PRODUCTS ARE ALREADY IN SOFT DRINKS, SOAPS, FACE CREAMS AND WASHING DETERGENTS. THEY ARE UNREGULATED, UNLABELLED AND UNDER THE RADAR OF PUBLIC AWARENESS.



TECHNICALLY, SYNTHETIC BIOLOGY IS AN EXTENSION OF GENETIC ENGINEERING: 'EXTREME GENETIC ENGINEERING,' IF YOU LIKE.



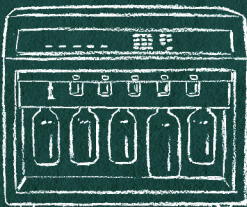
THE DIFFERENCE BEING THAT THE FIELD OF MANIPULATING LIFE HAS COME QUITE A LONG WAY SINCE CORPORATIONS FIRST STARTED SPLICING AND DICING GENES BACK IN THE EARLY 1970S.

BACK THEN, IT USED TO WORK THIS WAY: GENETIC ENGINEERS WOULD SEARCH OUT SECTIONS OF DNA CODE IN NATURE...



... CUT THE DNA OUT OF EXISTING ORGANISMS, AND THEN INSERT IT INTO A NEW HOST ORGANISM IN A 'CUT-AND PASTE' PROCESS.

TODAY, SYNTHETIC BIOLOGISTS USE A DNA PRINTER. IT'S CALLED A DNA SYNTHESISER. IT BUILDS ARTIFICIAL DNA FROM SCRATCH AND SO YOU CAN NOW ARRANGE THE DNA CODE ANY WAY YOU WANT.

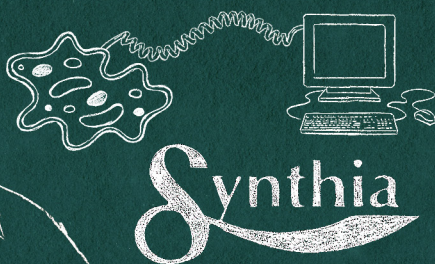
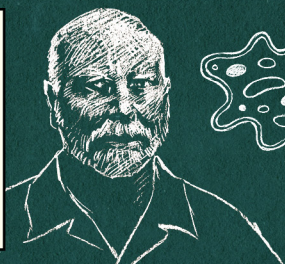


Buy

YOU DON'T NEED TO FIND DNA IN NATURE ANYMORE. YOU JUST BUY IT FROM THE INTERNET.

IT'S EVEN POSSIBLE TO SYNTHETICALLY PRINT OUT FROM SCRATCH ALL OF THE DNA OF A LIVING ORGANISM.

CRAIG VENTER DID HIS IN 2011. HE CREATED A MICROBE, NICKNAMED **SYNTHIA**, WHOSE FULL SET OF DNA HAD BEEN PRINTED OUT BY MACHINE. HE CALLED IT "THE FIRST SELF-REPLICATING SPECIES ON THE PLANET WHOSE PARENT IS A COMPUTER".



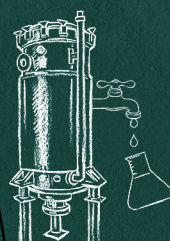
MOST SYNTHETIC BIOLOGY COMPANIES ARE COMING UP WITH ARTIFICIAL DNA CODES THAT FORCES MICROBES TO MAKE INDUSTRIALLY USEFUL COMPOUNDS.



SAFFRON



EVOLVA, A SWISS-AMERICAN SYNBIO COMPANY, HAS RE-ENGINEERED YEAST TO MAKE THE COMPOUNDS FOUND IN THE SPICE SAFFRON.



SAFFRON IS USUALLY PICKED FROM CROCUS FLOWERS IN IRAN, BUT EVOLVA CAN NOW BREW THEIR SYNTHETIC SAFFRON IN A LARGE VAT OF ENGINEERED YEAST - MUCH THE SAME WAY BEER OR WINE IS MADE.

ANOTHER SYNBIO YEAST PRODUCES VANILLIN - THAT'S VANILLA FLAVOUR, BUT WITHOUT A VANILLA PLANT BEING NEEDED.



"NATURAL"

BECAUSE THE INGREDIENTS ARE MADE IN A KIND OF 'BREWING' PROCESS, THE COMPANIES BELIEVE THEY CAN LABEL THEM AS 'NATURAL.' THAT PITS THE TRULY NATURAL COMPOUNDS DIRECTLY AGAINST THE NEW SYNBIO INVENTIONS.

THIS PROSPECT OF LAB-GROWN FOOD AND CONSUMER INGREDIENTS IS EXCITING TO THE 22 BILLION DOLLAR FLAVOUR AND FRAGRANCE INDUSTRY.



BUT, ESPECIALLY WITH THOSE 'NATURAL' CLAIMS, IT'S REASON ENOUGH FOR TROPICAL FARMERS TO BECOME ALARMED.

EVERY HECTARE OF NATURAL SAFFRON GROWING IN IRAN PROVIDES JOBS FOR UP TO 270 PEOPLE PER DAY, AND REPLACING THAT WITH SYN BIO SAFFRON NOW THREATENS THOSE JOBS.

AN ESTIMATED 200,000 PEOPLE GROW, TEND AND CURE VANILLA BEANS IN MADAGASCAR, UGANDA, MEXICO, AND ELSEWHERE.



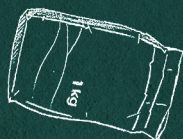
THOSE FARMERS ALREADY HAVE PRECARIOUS LIVELIHOODS BECAUSE OF CHEMICALLY SYNTHETIC VANILLA. BUT NOW SYN BIO VANILLIN FURTHER UNDERMINES THEM.

IT ALSO THREATENS THE ECOSYSTEMS THEY LIVE IN, BECAUSE VANILLA FARMING IS CLOSELY TIED TO RAINFOREST PROTECTION. THE NATURAL VINES REQUIRE INTACT FORESTS TO THRIVE.



BUT IF THE PRICE OF NATURAL VANILLA CRASHES BECAUSE OF SYN BIO VANILLA, FARMERS MAY INSTEAD RESORT TO HACKING AWAY THE FOREST TO PLANT RICE TO SURVIVE.

OF COURSE, THE SYNTHETIC BIOLOGY INDUSTRY CAN'T DO AWAY WITH FARMERS ALTOGETHER. VATS OF ENGINEERED YEAST OR ALGAE REQUIRE VAST QUANTITIES OF SUGAR SOURCED FROM CORN OR SUGARCANE PLANTATIONS.



THIS IS WHY SO FAR, ALL THE LARGEST SYN BIO COMPANIES HAVE SET UP MANUFACTURING PLANTS IN BRAZIL.



CANE SUGAR FROM BRAZIL MAY BE SWEET TO EAT, BUT IT HAS A VERY BITTER SIDE TOO. IT'S WATER-HUNGRY, CHEMICAL-LADEN, AND IS OFTEN HARVESTED BY WORKERS IN SLAVE CONDITIONS.

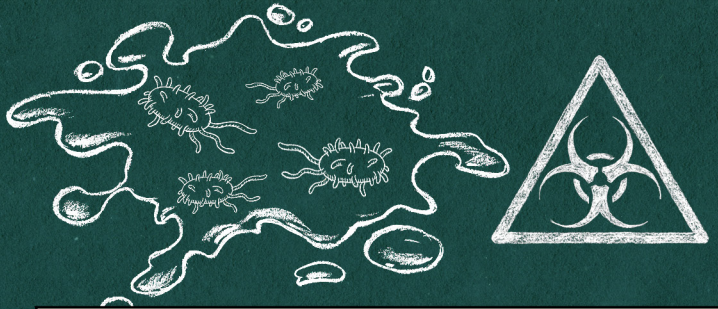


THE EXPANSION OF SUGAR CANE IS DRIVING DESTRUCTION OF BRAZIL'S ECOLOGICALLY PRECIOUS CERRADO REGION AND IT'S DISPLACING OTHER AGRICULTURE DEEPER INTO THE AMAZON.



IN THE FUTURE, SYN BIO COMPANIES HOPE TO ALSO FEED THEIR MICROBES ON WOOD CHIPS AND SAWDUST AND EVEN NATURAL GAS, AND SO THE EXTREME GENETIC ENGINEERING FOLKS ARE NOW BUDDING UP WITH THE EXTREME ENERGY INDUSTRY OF FRACKING.

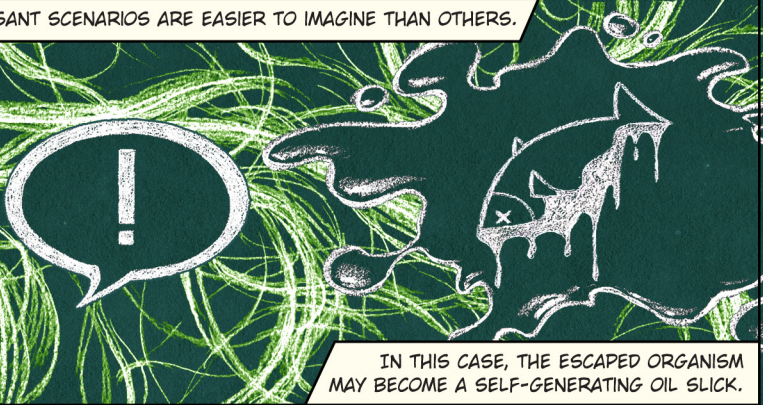
AND THEN THERE'S THE HOT BUTTON QUESTION OF SAFETY. GENETIC ENGINEERING HAS ALREADY FACED 40 YEARS OF GLOBAL CONTROVERSY BECAUSE OF THE UNPREDICTABLE SIDE EFFECTS OF MUCKING AROUND WITH GENETIC CODE.



EXTREME GENETIC ENGINEERING ONLY INTENSIFIES THOSE UNCERTAINTIES. HOW A SYNTHETIC BIOLOGY ORGANISM WILL GROW, ADAPT, BEHAVE AND CHANGE IS AT BEST SPECULATION.

SOME UNPLEASANT SCENARIOS ARE EASIER TO IMAGINE THAN OTHERS.

WHAT IF AN ALGAE ENGINEERED TO PRODUCE GASOLINE (WHICH HAS BEEN DONE) ESCAPES AND IT STARTS TO REPRODUCE IN RIVERS, STREAMS AND OCEANS?



IN THIS CASE, THE ESCAPED ORGANISM MAY BECOME A SELF-GENERATING OIL SLICK.

GOVERNMENTS DON'T YET KNOW HOW TO ASSESS SYNTHETICALLY MODIFIED ORGANISMS FOR SAFETY AND SO MOST ARE SUPPOSEDLY BEING KEPT CONTAINED, BUT NOW A NEW WAVE OF SYN BIO ORGANISMS ARE BEING DEVELOPED THAT ARE INTENDED FOR ENVIRONMENTAL RELEASE.



IN APRIL 2013, A GROUP OF 'BIO-HACKERS' FROM CALIFORNIA USED THE WEBSITE KICKSTARTER TO RAISE ALMOST HALF A MILLION DOLLARS TO COMMERCIALISE A SYNTHETIC BIOLOGY PLANT THAT GLOWS IN THE DARK.

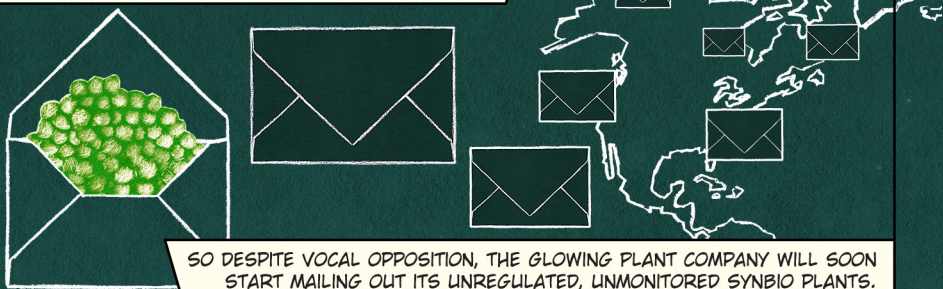


FOR FORTY DOLLARS A POP, THE 'GLOWING PLANT PROJECT' PROMISED TO SEND HUNDREDS OF THOUSANDS OF BIOENGINEERED SEEDS TO OVER 6,000 RANDOM INDIVIDUALS ACROSS NORTH AMERICA.



THAT'S A LARGE UNREGULATED RELEASE OF SYNTHETICALLY MODIFIED ORGANISMS!

CRAZILY, THE US GOVERNMENT DECLARED IT DIDN'T HAVE THE MEANS TO REGULATE THESE EXTREME ORGANISMS.

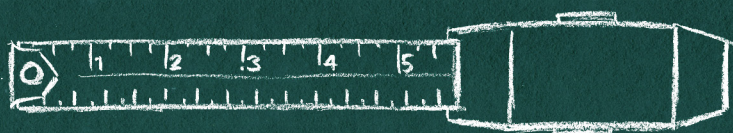


SO DESPITE VOCAL OPPOSITION, THE GLOWING PLANT COMPANY WILL SOON START MAILING OUT ITS UNREGULATED, UNMONITORED SYNBIO PLANTS.

AS THE INDUSTRY OF SYNTHETIC BIOLOGY RACES AHEAD, REGULATORS ARE VERY MUCH LAGGING BEHIND. DELEGATES TO THE 193 COUNTRIES OF THE UN CONVENTION ON BIOLOGICAL DIVERSITY ARE BELATEDLY BEGINNING TO GRAPPLE WITH OVERSIGHT OF SYNTHETIC BIOLOGY.



ALREADY, AN INTERNATIONAL FIGHT IS BREWING BETWEEN A HANDFUL OF RICH COUNTRIES WHO BACK THE SYNBIO INDUSTRY AND THOSE TROPICAL NATIONS WHOSE FARMERS, FIELDS AND FORESTS STAND TO LOSE FROM THE NEW BIOECONOMY THAT SYNTHETIC BIOLOGY IS ABOUT TO UNLEASH.



CREDITS

From the original animation of
MARIE-JOSÉE SAINT-PIERRE

Written by
JIM THOMAS

Drawings by
MARIE-JOSÉE SAINT-PIERRE
CLAUDE CLOUTIER

Layout and Design for Comics by
NEMCY CRUZ

The BIOECONOMIES MEDIA PROJECT
is funded with a grant from
the Social Sciences and Humanities
Research Council of Canada.

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