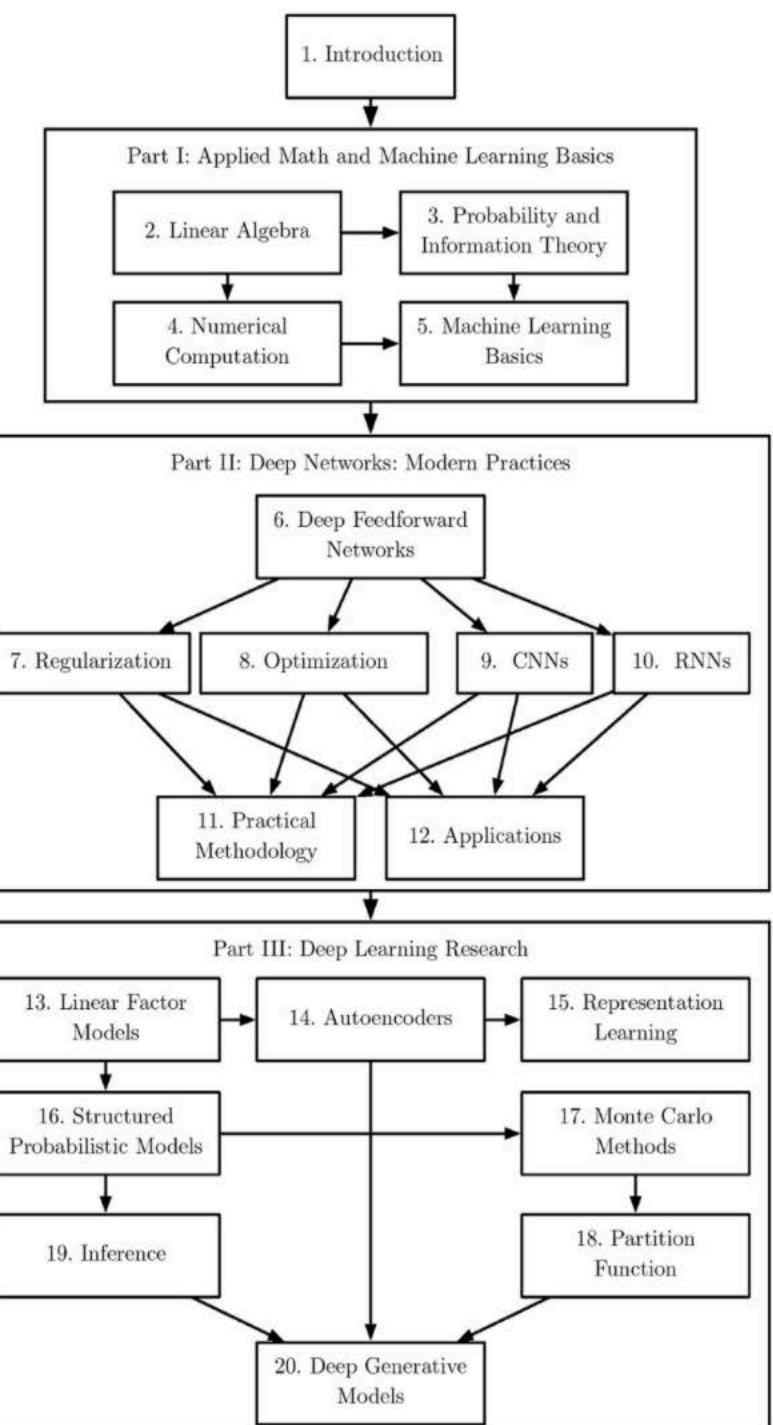


DEEP LEARNING

Ian Goodfellow, Yoshua Bengio,
and Aaron Courville

"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P , if its performance at tasks in T , as measured by P , improves with experience E ."



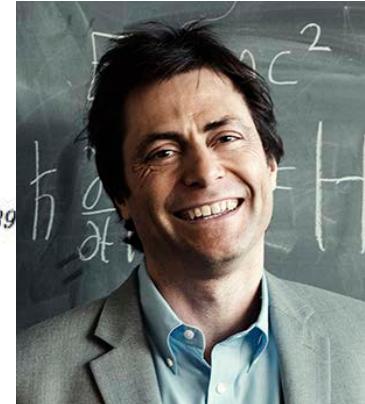
Why does deep and cheap learning work so well?

Henry W. Lin and Max Tegmark

*Dept. of Physics, Harvard University, Cambridge, MA 02138 and
Dept. of Physics & MIT Kavli Institute, Massachusetts Institute of Technology, Cambridge, MA 02139*

(Dated: September 29, 2016)

We show how the success of deep learning depends not only on mathematics but also on physics: although well-known mathematical theorems guarantee that neural networks can approximate arbitrary functions well, the class of functions of practical interest can be approximated through “cheap learning” with exponentially fewer parameters than generic ones, because they have simplifying properties tracing back to the laws of physics. The exceptional simplicity of physics-based functions



“We show how the success of deep learning depends not only on mathematics but also on physics: although well-known mathematical theorems guarantee that neural networks can approximate arbitrary functions well, the class of functions of practical interest can be approximated through “cheap learning” with exponentially fewer parameters than generic ones, because they have simplifying properties tracing back to the laws of physics.”

8.08225v2 [co]

stood *why* deep learning works so well. In contrast to GOFAI (“good old-fashioned AI”) algorithms that are hand-crafted and fully understood analytically, many algorithms using artificial neural networks are understood only at a heuristic level, where we empirically know that certain training protocols employing large data sets will result in excellent performance. This is reminiscent of the situation with human brains: we know that if we train a child according to a certain curriculum, she will learn certain skills — but we lack a deep understanding of how her brain accomplishes this.

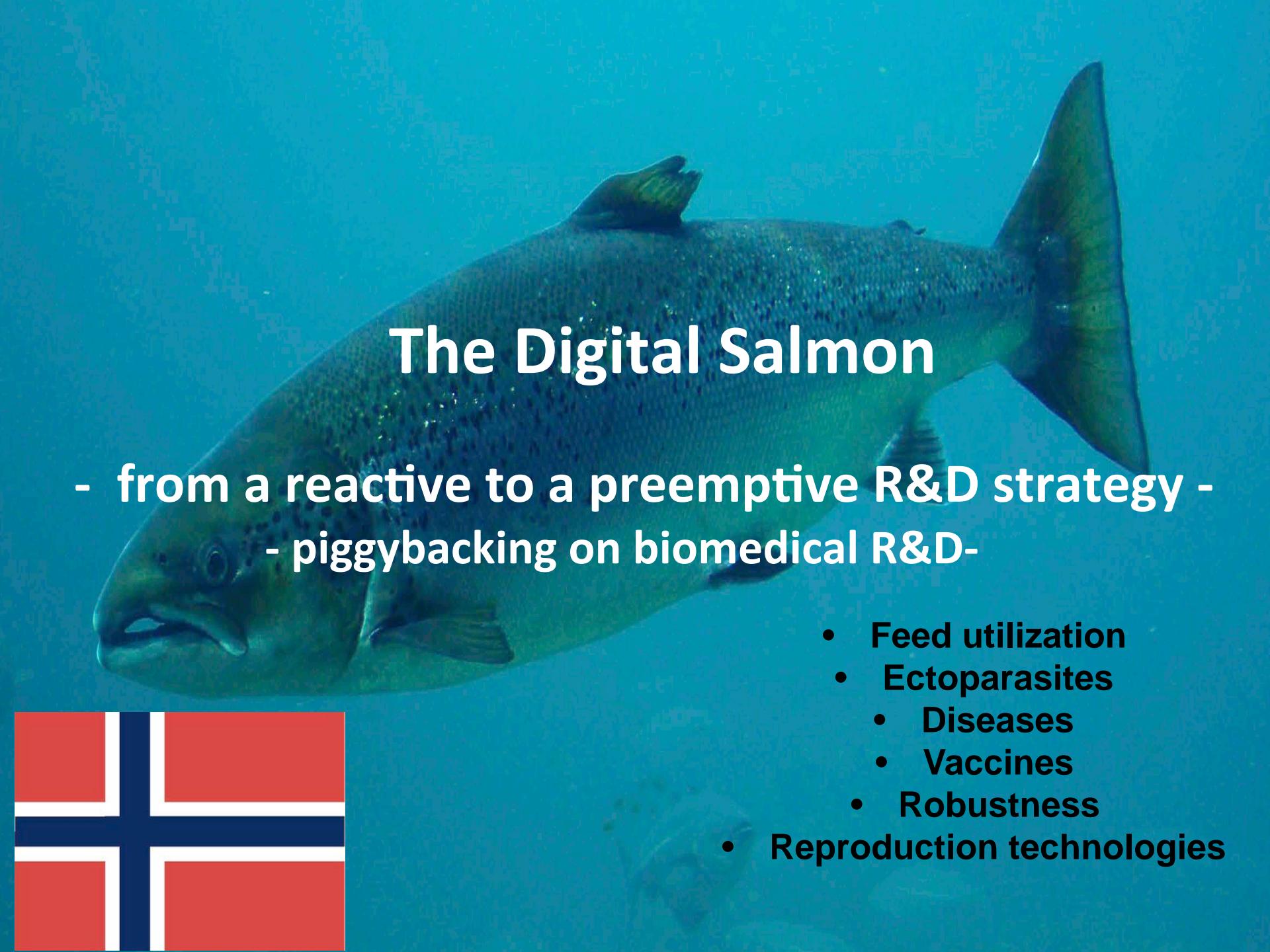
vised learning, classification and prediction. For example, if we are interested in classifying faces, then we may want our neural network to implement a function where we feed in an image represented by a million greyscale pixels and get as output the probability distribution over a set of people that the image might represent.

When investigating the quality of a neural net, there are several important factors to consider:

- **Expressibility:** What class of functions can the neural network express?

Hva åpner en matematisert kausal forståelse for mht rektaangularisering av livskurven?

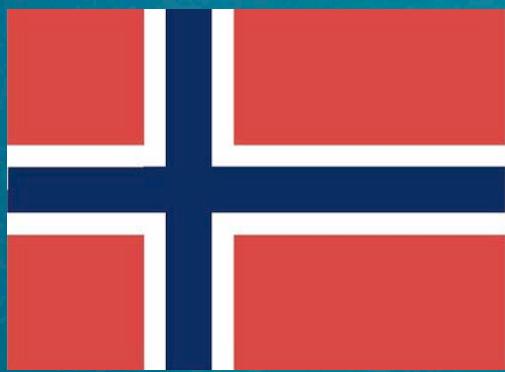
- Kobling av multiskala modeller med kybernetikk
- Langt mer målrettet utvikling av fenotypingsteknologi
- Radikalt forbedret diagnostikk
- Radikalt forbedrede medisineringsregimer
- Radikalt forbedret medisinutvikling (mål-identifisering, utvikling, testing, godkjenning)
- Radikalt forbedrede muligheter for persontilpasning (preventivt og terapeutisk)

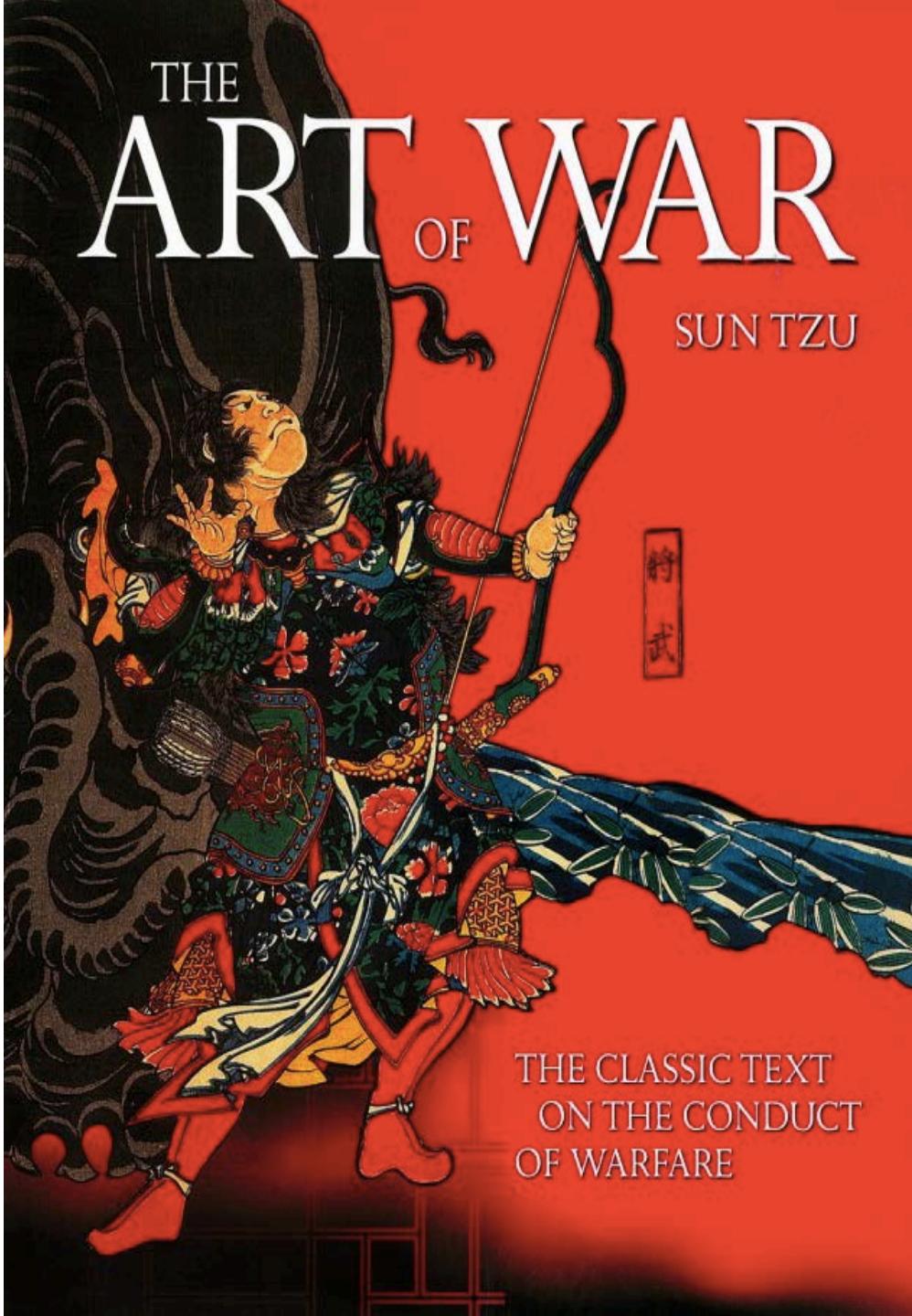
A close-up photograph of a salmon swimming in clear, light blue water. The fish's body is angled towards the left, showing its dark greenish-blue back and silver side. Its fins and scales are clearly visible.

The Digital Salmon

- from a reactive to a preemptive R&D strategy -
 - piggybacking on biomedical R&D-

- Feed utilization
- Ectoparasites
 - Diseases
 - Vaccines
- Robustness
- Reproduction technologies





"If you know the enemy and know yourself, you need not fear the result of a hundred battles.

If you know yourself but not the enemy, for every victory gained you will also suffer a defeat.

If you know neither the enemy nor yourself, you will succumb in every battle."

— Sun Tzu, The Art of War



livestock's long shadow

environmental issues and options



“The livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global.”



A photograph of an industrial biotechnology facility. In the foreground, there's a large stainless steel reactor vessel with a black frame and various pipes and valves attached. Behind it, several control panels are mounted on metal frames. One panel prominently displays the ABB logo. The panels have multiple digital screens and physical buttons. In the background, there are more industrial structures, including what looks like a storage tank and some smaller pieces of equipment. The overall environment is a clean, modern industrial setting.

**Industrial biotechnology:
“the modern use and
application of
biotechnology for the
sustainable processing and
production of chemicals,
materials and fuels”**

REVIEW SUMMARY

BIOENGINEERING

Industrial biomanufacturing: The future of chemical production

James M. Clomburg, Anna M. Crumbley, Ramon Gonzalez*

integration of these with systems biology techniques, such as next-generation sequencing and high-sensitivity “omics” methods, has allowed for the design and potential development of millions of chemical production pathways. The use of genome engineering technologies—such as clustered regulatory interspaced short palindromic repeats (CRISPR)-associated protein Cas9 systems and multiplex automated genomic engineering—and recent advances in screening and selecting for edited organisms using biosensors have re-

ON OUR WEBSITE

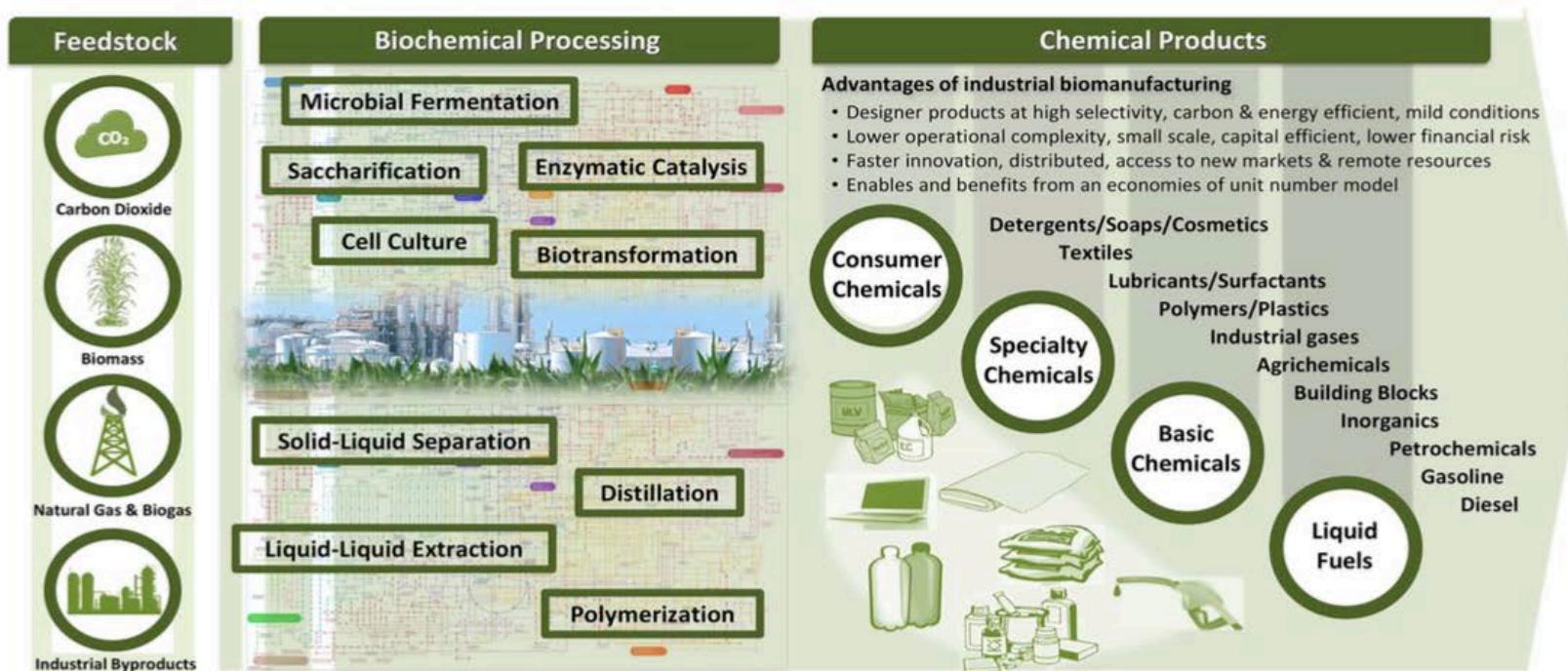
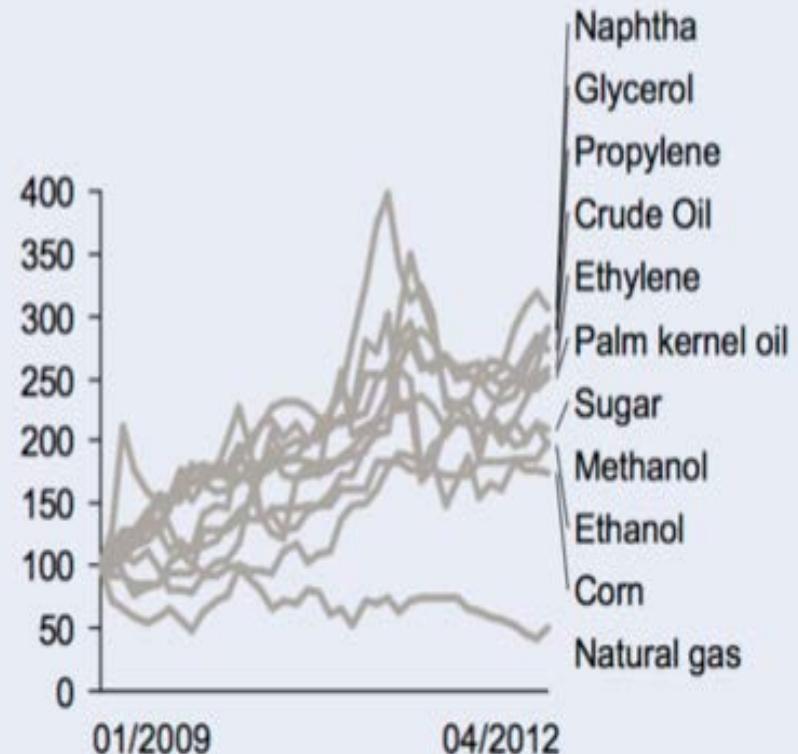
[Read the full article](#)

Fig. 2. Industrial biomanufacturing for fuel and chemical production. Exploiting biological processes can enable the conversion of numerous industrially relevant feedstocks to the array of chemical products currently produced through industrial chemical manufacturing with considerable economic, environmental, and societal advantages.

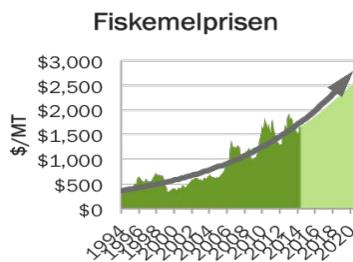
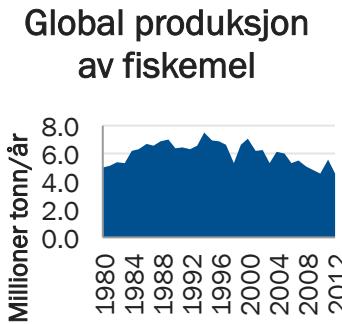


Karbonkilder:



- Ekspansjon
- Robusthet
- Bærekraft/omdømme
- Arbeidsplasser
- Utvikling av norsk bioteknologisk industri

Bioprotein-teknologien virker i industriell skala



- Resultat av 10 års F&U, engineering og drift ledet av Statoil og DuPont
- 40% reduksjon av CO₂ sammenliknet med forbrenning
- Bioprotein som før ble EU-godkjent i 2008 (også for svin + kylling) (fullverdig erstatning for fiskemel)
- Norferm AS sitt anlegg på Tjeldbergodden leverte til produksjon av laksefôr
- Driften ble avviklet i 2006, etter 6 års drift
- I 2008 inngikk Statoil avtale med IRIS, UiB og NMBU om overføring av teknologirettigheter

Kilde: Torkell Gjerstad, IRIS

News

[All Press Releases](#)[Our Stories](#)[On the Issues](#)[Speeches](#)[Company Statements](#)[Media Contacts](#)[Logos, Images & Video](#)[HOME](#) // [NEWS](#) // NEW VENTURE SELECTS CARGILL'S TENNESSEE SITE TO PRODUCE CALYSTA FEEDKIND PROTEIN

New venture selects Cargill's Tennessee site to produce Calysta FeedKind Protein

Site will house one of the largest gas fermentation facilities to produce sustainable fish feed ingredient

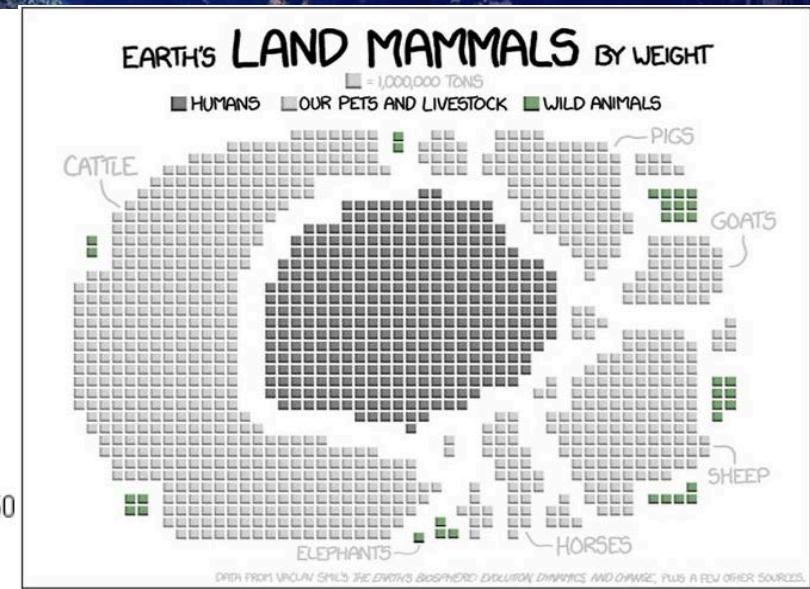
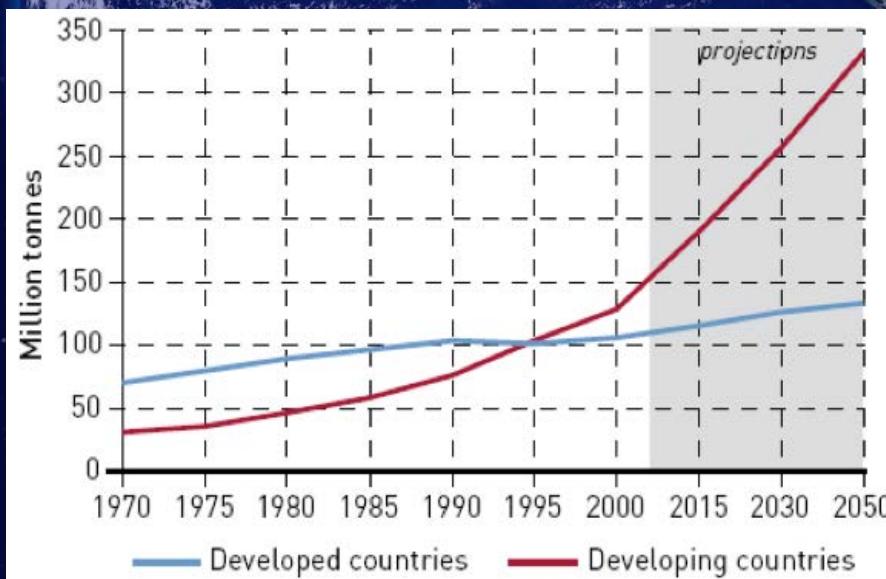
[Fact Sheets](#)

Calysta Inc., along with several third-party institutions, plan to invest in the

- Står på skuldrene av norskutviklet teknologi og betydelig norsk FoU-virksomhet over 20 år, > 1 milliard NOK
- Kan effektivt lukke et stort mulighetsvindu for utvikling av norsk bioteknologisk industri generelt
- Er det slik vi ønsker fruktene av norsk FoU-arbeid skal høstes?
- I fall ikke → behov for mer politisk entrepenørskap og nasjonal samordning



- Dyrket mark: 1500 MH
 - Forproduksjon til husdyr: 470 MH
- Permanent beiteland: 3460 MH
- Skoger: 3870 MH
 - Tropisk og subtropisk areal: 56 %
- Resterende areal for matproduksjon: 2800 MH
 - Skogkledde områder utgjør 50% av dette arealet



Kan vi endre denne utviklingen?



THE CULTURE OF ORGANS

by

ALEXIS CARREL

and

CHARLES A. LINDBERGH

WITH 111 ILLUSTRATIONS



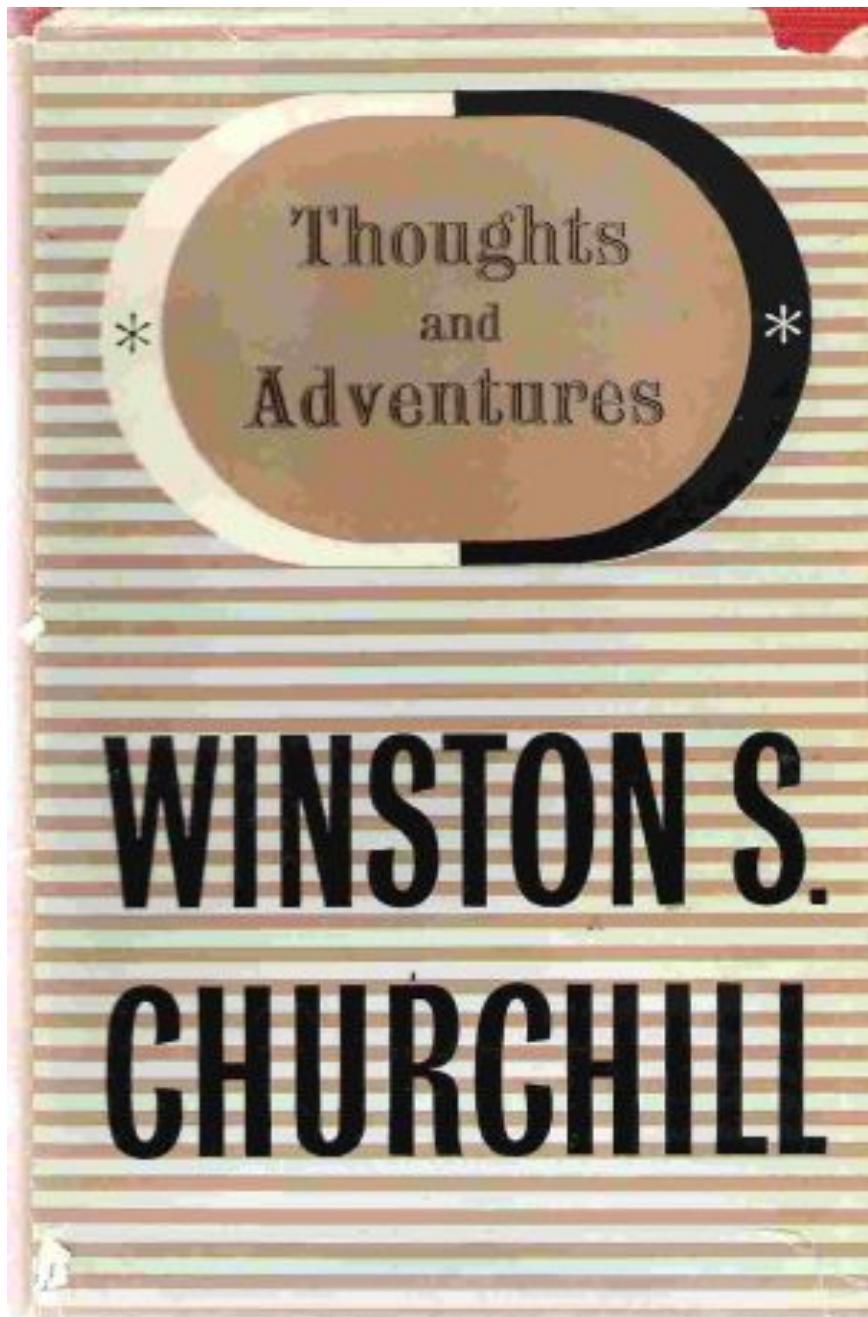
PAUL B. HOEBER, INC.

MEDICAL BOOK DEPARTMENT OF HARPER & BROTHERS

NEW YORK

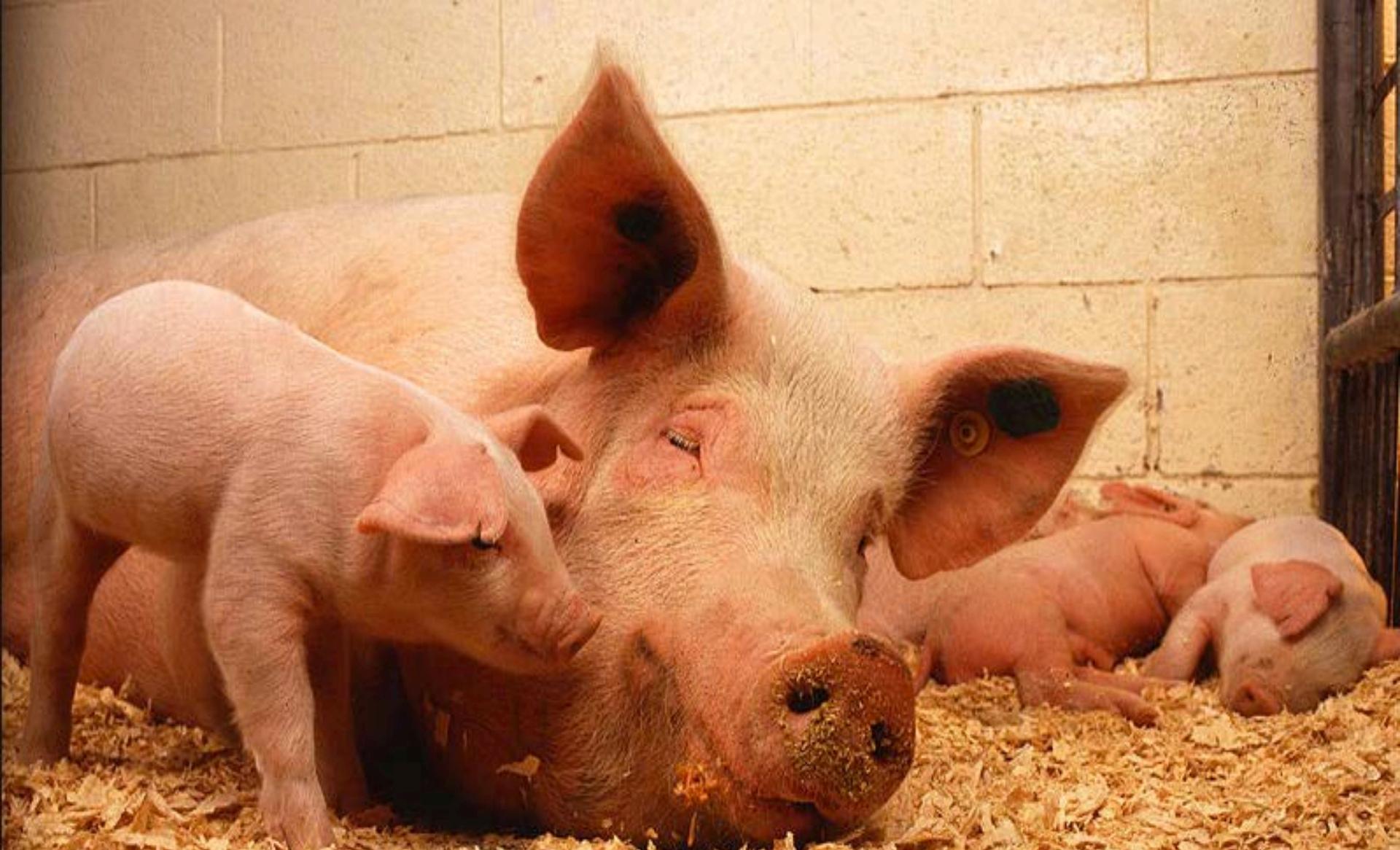
MCMLXVIII





I 1982 vil vi ha avsluttet
tullet med å fore opp en
kylling for å spise kun
brystet og vingene. Da vil vi
dyrke disse delene i et
egnet medium.

But equally startling developments lie already just beyond our finger-tips in the breeding of human beings, and the shaping of human nature. It used to be said, 'Though you have



Navlestrengene fra noen få grisekull gir kjøtt nok til å fore hele verden

Meat without brain and pain - teknologi

Industrisegment 1:

Metan --> metanotrofer --> (genom-editering)--> storskala produksjonsteknologi --> storskala fraksjoneringssteknologi --> avanserte cellekulturblandinger (aminosyrer, vitaminer, vekstfaktorer)

Industrisegment 2:

Satelittceller (myoblaster) --> myotuber --> muskelfibre --> organogenese --> muskler

Industrisegment 3:

Muskelfiberstrukturer/kjøttdeig/muskler --> prosessering --> variert produktspesletter for menneskelig konsum

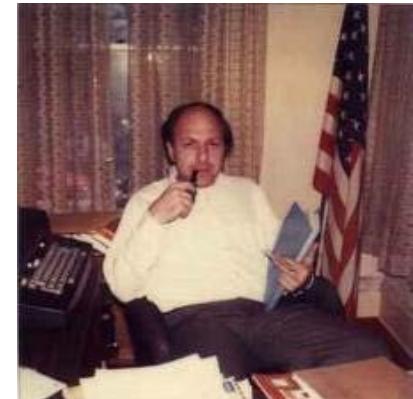
En rekke muligheter for norsk industriutvikling!

Robert Rosen

Life Itself

A COMPREHENSIVE INQUIRY INTO THE NATURE, ORIGIN,
AND FABRICATION OF LIFE

What is life?

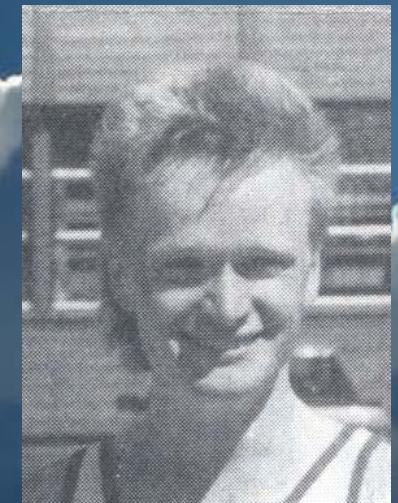
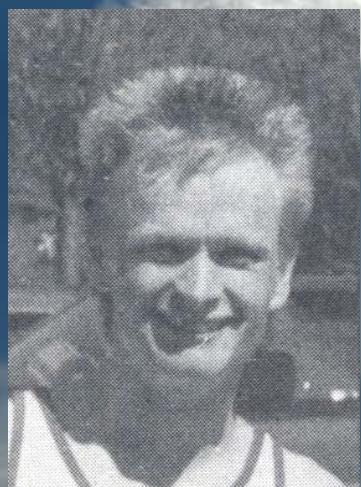


What is it that enables living things, apparently so moist, fragile and evanescent, to persist while towering mountains dissolve into dust, and the very continents and oceans dance into oblivion and back?

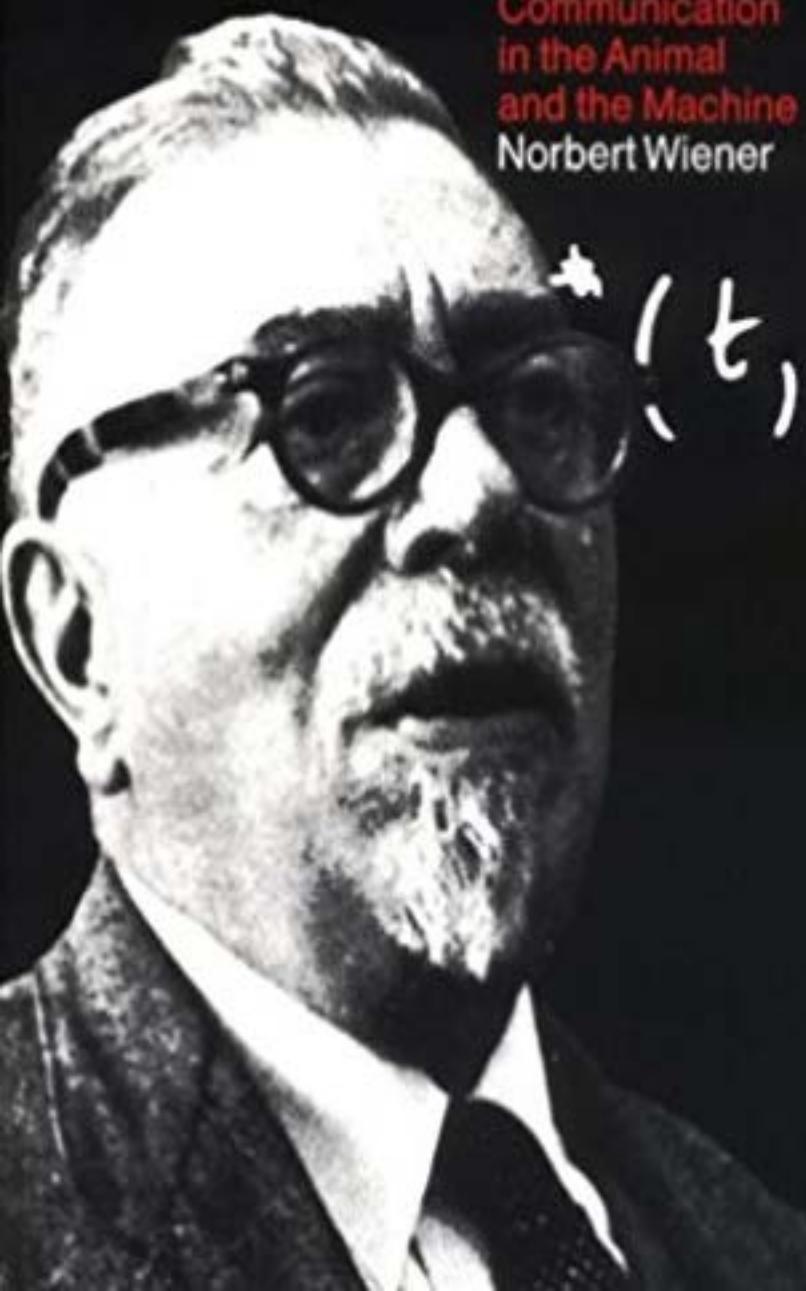




**Genotype-fenotype
avbildningen i et gitt
miljø er usedvanlig
forutsigbar!**



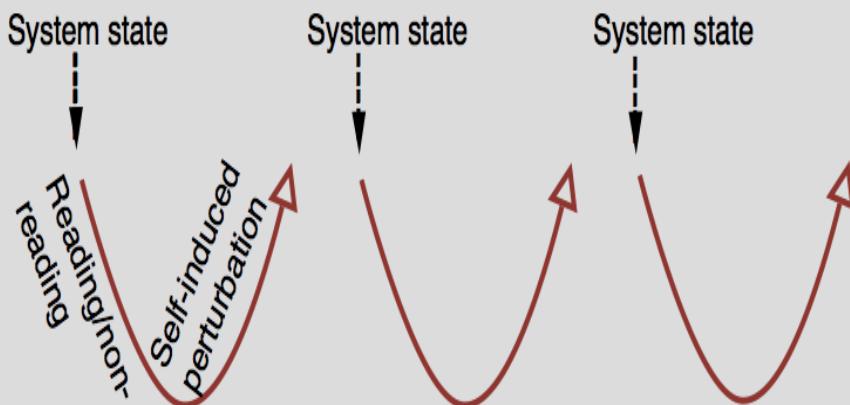
Cybernetics:
or Control and
Communication
in the Animal
and the Machine
Norbert Wiener



Morfogenetisk kybernetikk

Initial conditions and system configuration

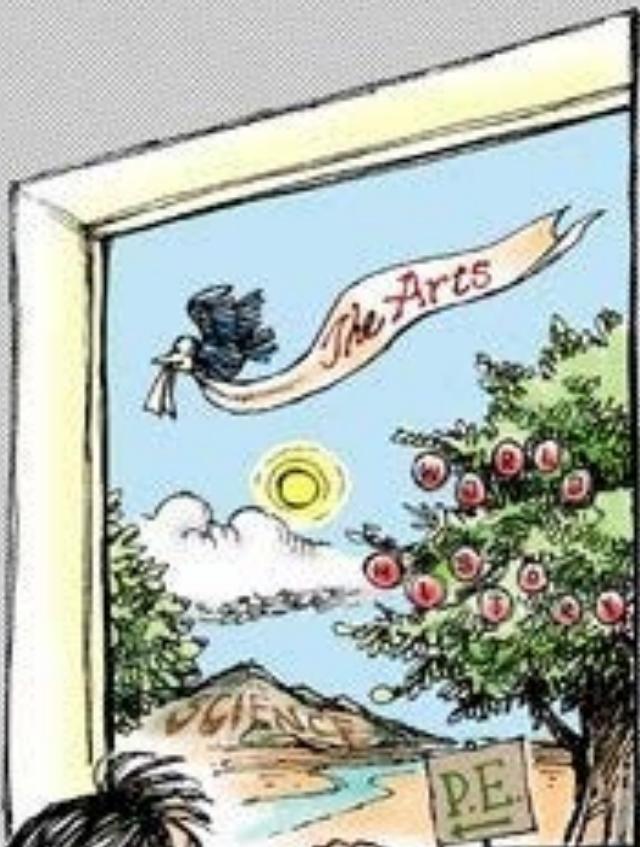
Self-transcendent unfolding of system dynamics
and
movement in morphospace



DNA

Boundary conditions = Environment

COME AWAY FROM
THE WINDOW! YOU DON'T
WANT TO BE A CHILD
LEFT BEHIND, DO YOU?

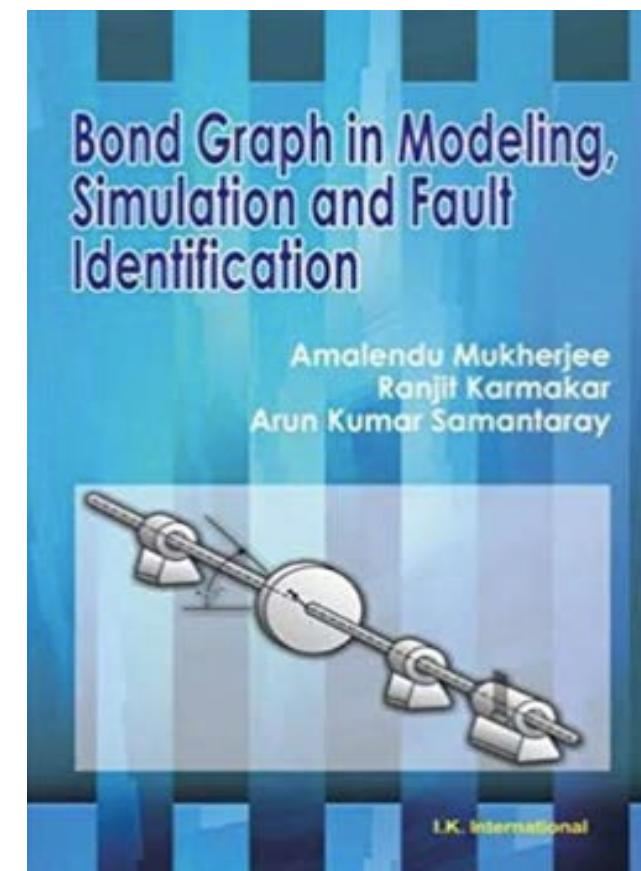
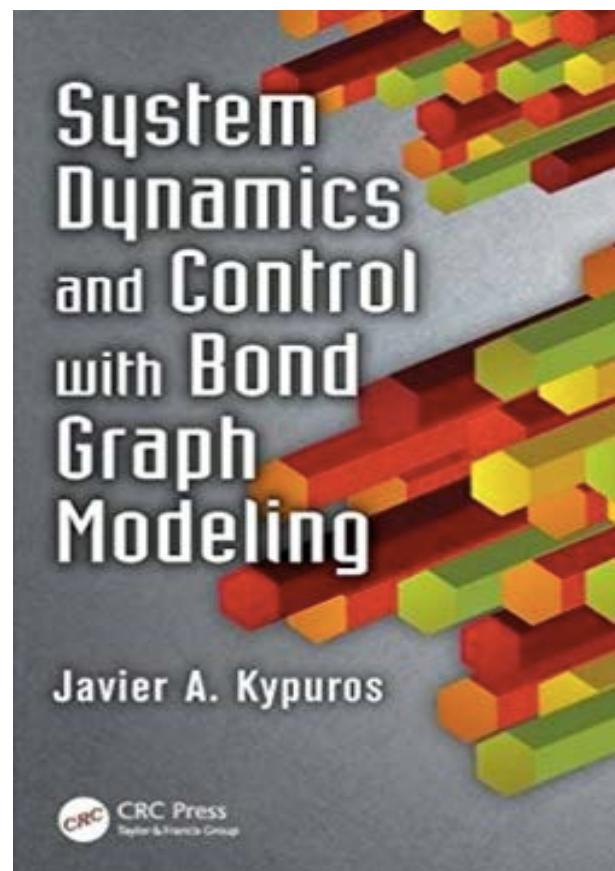
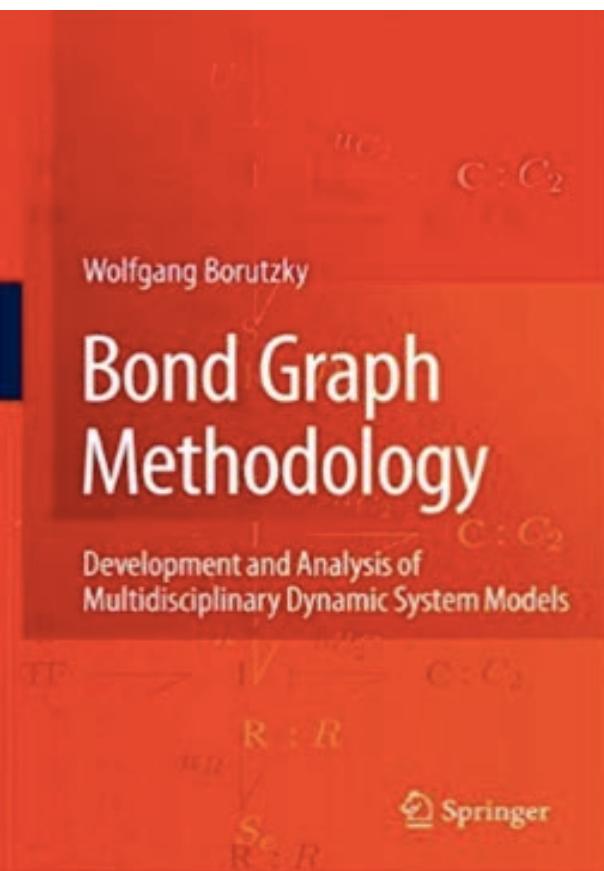


SOUNDS
GOOD
TO ME!

"Bond graphs deal with energy transfer between different physical systems and make a distinction between the supply, storage, transmission and dissipation of energy. "



Henry M. Paynter
(1923 –2002)



Bond graphs – nøkkelen til transdisiplinaritet?



Standardised units:

Peter Hunter

		Mechanics			Biochemical reactions	Heat flow	Electrical circuit	Electro-magnetic
		Solid		Fluid				
Potential	name (u)	force J.m ⁻¹ (N)	torque J.rad ⁻¹ (Nm)	pressure J.m ⁻³ (Pa)	chem potential J.mol ⁻¹ (G)	temperature J.e ⁻¹ (K)	elect potential J.C ⁻¹ (V)	J.cd ⁻¹
Quantity	(q)	m	rad	m ³	mol	e	C	cd
Flow	(v) =	m.s ⁻¹	rad.s ⁻¹	m ³ .s ⁻¹	mol.s ⁻¹	e.s ⁻¹	C.s ⁻¹	cd.s ⁻¹
Rate of flow	(a) =	m.s ⁻²	rad.s ⁻²	m ³ .s ⁻²	mol.s ⁻²	e.s ⁻²	C.s ⁻²	cd.s ⁻²
Elastance	E ()	J.m ⁻²	J.rad ⁻²	J.m ⁻⁶	J.mol ⁻²	J.e ⁻²	J.C ⁻²	J.cd ⁻²
Resistance	R ()	J.s.m ⁻²	J.s.rad ⁻²	J.s.m ⁻⁶	J.s.mol ⁻²	J.s.e ⁻²	J.s.C ⁻²	J.s.cd ⁻²
Inductance	L ()	J.s ² .m ⁻²	J.s ² .rad ⁻²	J.s ² .m ⁻⁶	J.s ² .mol ⁻²	J.s ² .e ⁻²	J.s ² .C ⁻²	J.s ² .cd ⁻²

Time	Second	s	Duration of 9,192,6731,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom
Length	Metre	m	Distance for light to travel 1/299,792,458 seconds (1/c) in a vacuum
Mass	Kilogram	kg	Such that Planck constant is 6.6260693x10⁻³⁴ J.s
Temperature	Kelvin	K	Such that Boltzmann constant k_B = 1.3806505x10⁻²³ J.K⁻¹
Current	Ampere	A	Such that 1 C = 1 A.s
Amount of substance	Mole	mol	Such that the Avogadro constant is 6.0221415x10²³ mol⁻¹
Luminous intensity	Candela	cd	The intensity, in a given direction, of a light source at 540x10 ¹² Hz with a radiant intensity in that direction of 1/683 W/steradian



THE ENTREPRENEURIAL STATE



Debunking
Public vs. Private
Sector Myths



MARIANA MAZZUCATO



Behov for en mer systematisk tilnærming?

- Er det grunnlag for å stimulere til utvikling av en oppdrettsorientert bioteknologisk industri i Norge med store følgeeffekter?
- Avklaring av markedsmessige, teknologiske, bærekraftsmessige, økonomiske og industripolitiske forutsetninger
- Harmonert aktivering av virkemiddelapparatet når en vet hva som kreves av tilrettelegging på kort og mellomlang sikt

THE IDEA FACTORY

Bell Labs and the Great Age of American Innovation

Jon Gertner

- Transistoren
 - Laseren
 - Solcellen
 - Unix
 - Kommunikasjonssatellitten
 - Mobiltelefonen
 - Fiber-optiske kabelen
-
- Visjonært lederskap
 - Tvungen interdisiplinaritet
 - Orientert forskningsfrihet
 - Institusjonell tålmodighet
 - Attraksjon av talent



A photograph of a rock climber in silhouette against a vibrant sunset. The climber is positioned on the left side of the frame, scaling a light-colored, textured rock face. The background is filled with large, billowing clouds bathed in warm orange and yellow light from the setting sun. The overall mood is one of determination and achievement.

**The person who
says it cannot
be done should
not interrupt the
person who is
doing it.**

—Chinese Proverb



“Give me the fruitful error any time, full of seeds, bursting with its own corrections. You can keep your sterile truth for yourself.”

Vilfredo Pareto (1848-1923)

Nistepakke:

- Bioteknologi spenner veldig vidt
- Utviklingstrender: L + M + E
- Kan bidra til å løse store utfordringer
- Undervisningsmessig tilrettelegging for transdisiplinaritet
- Skal Norge bli en synlig aktør innen bioteknologi trengs det statlig entrepenørskap.