SOFTNET 2021

Mighty Disruptor or Disruptee ?

Reflections on the Future of the Software Industry

HERWIG MANNAERT

Universiteit Antwerpen

About myself …

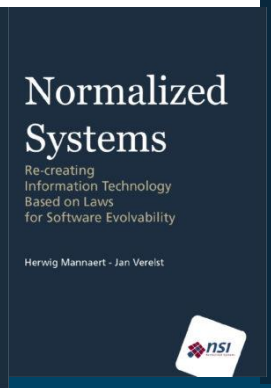
- Electronics engineer
- PhD in image processing
- Full professor UA - FBE
  - Software architecture
  - Normalized Systems Theory
- Co-founder
  - Cast4All nv
  - NSX bv

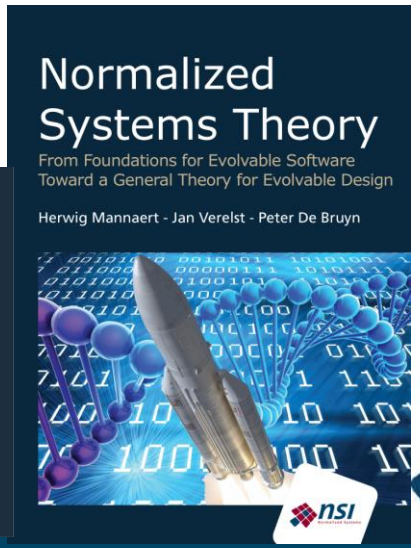
University of Antwerp

ns EXCHANGE

ns FOUNDATION

ns PRIME RADIANT





nsx Normalized Systems

and NS software …

connectingexpertise

nsx Normalized Systems

RESPONSUM

digipolis

fluvius.

zipster

nsx.care

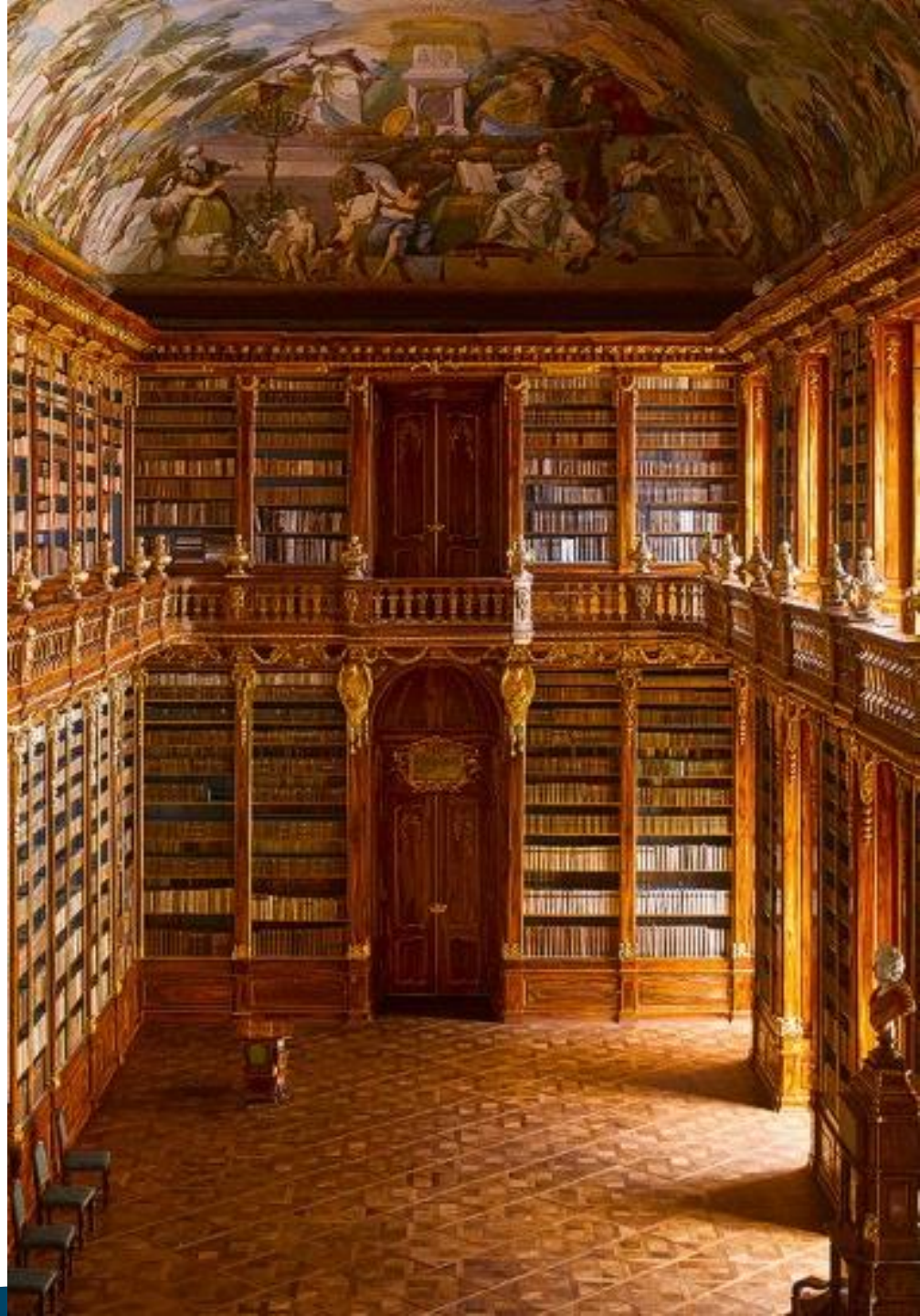
iCAREdata
Improving Care And Research Electronic Data Trust Antwerp

»cast4all
TECHNOLOGIES

B/CAO
Competence Center
Normalized Systems

HELICUS

Innovation and Disruption



On engineering

The engineer, and more generally the designer, is concerned with how things ought to be.

— Herbert Simon

Scientists study the world as it is. Engineers create the world that has never been.

— Theodore von Kármán

Our mission is to contribute to society. It is always about making things better.

— Tim Minshall

People think of me as an investor and a businessman. But I'm an engineer.

— Elon Musk

Some men see things the way they are, and ask 'Why?'

I dream of things that never were, and ask 'Why not?'

— George Bernard Shaw

On technology

- The goal of technology is to contribute to prosperity and well-being of society, by productivity gains or leverages:
  - *Fishing:* manual ➔ spear ➔ fishing net
  - *Transport:* walking ➔ coach ➔ car
  - *Digging:* manual ➔ shovel ➔ excavator
  - *Calculating:* paper ➔ slide rule ➔ computer
  - *Communicating:* courier ➔ letter ➔ online
  - …

On technology

- True realization of these leverages requires:
  - Scalability of production:
    - No enormous efforts
    - No scarce materials
    - No rare skills
    - *Technical complexity manufacturing*
  - Sustainability of production:
    - No depletion of resources
    - No creation of toxic substances
    - No endangering of health
    - *Technical complexity maintenance*

On technology and economy

- Introducing new technologies will in general entail undesired transition effects :
  - Existing labor becomes redundant
  - Existing products become redundant
- Fundamentally technology increases prosperity:
  - Equal efforts – more yields
  - Equal yields – less efforts
  - Or a combination thereof …
- Society needs to compensate transition effects:
  - redistribution wealth
  - conversion workers

On economy

- Studies the production, use, management of resources, the creation and distribution of wealth.

An inquiry into the nature and causes of the wealth of nations.

– Adam Smith

The science of production, distribution, and consumption of wealth.

– Jean-Baptiste Say

- Important concepts involved in this study are *efficiency*, *economies of scale*, and *division of labour*.

On economy and innovation

Joel Mokyr argues that '*a culture of growth*' specific to early modern Europe and the European Enlightenment laid the foundations for the scientific advances and pioneering inventions that would instigate explosive technological and economic development. Bringing together economics, the history of science and technology, and models of cultural evolution, Mokyr demonstrates that culture—the beliefs, values, and preferences in society that are capable of changing behavior—was a deciding factor in societal transformations.

Yvan Van De Cloot states that our current prosperity is based on a smarter organization of the economic fabric embedding innovations. Scientific breakthroughs and innovations, based on knowledge, research and development, are the true origins of prosperity. It is crucial however to realize that a new technology may need decades to realize its full potential.

On innovation

Where does lasting prosperity come from? The answer: Market-Creating Innovations.

— Clayton Christensen

It takes 30 years for a new idea to seep into the culture. Technology does not drive change. It is our collective response to the options and opportunities presented by technology that drives change.

— Paul Saffo

Invention requires a long-term willingness to be misunderstood. You do something that you genuinely believe in, that you have conviction about, but for a long period of time, well-meaning people may criticize that effort … if you really have conviction that they're not right, you need to have that long-term willingness to be misunderstood. It's a key part of invention.

— Jeff Bezos

On innovation

People sometimes think technology just automatically gets better every year, but it actually doesn't. It only gets better if smart people work like crazy to make it better.
— Elon Musk

Before the financial crisis, people thought that we could have a stable thriving economy based on financial services.
— Tim Minshall

The best minds of my generation are thinking about how to make people click ads. That sucks.
— Jeff Hammerbacher

On innovation and disruption

Creative destruction is a concept in economics popularized in the 1950s by ***Joseph Schumpeter*** as a theory of economic innovation and the business cycle. The *gale of creative destruction* "describes the process of industrial mutation that continuously revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one".

Disruptive innovation is a concept in business theory defined in 1995 by ***Clayton Christensen*** and his collaborators. A *disruptive innovation* is an innovation that creates a new market and value network and eventually displaces established market-leading firms, products, and alliances. It has been called the most influential business idea of the early 21st century.

On innovation and disruption

Film staat aan vooravond van digitale revolutie

Barco, EVS en Cast4All leveren technologie voor satelliettransmissie

'Digitale film? Voorlopig pompen we er geen geld in!'

Volgens Kinepolis-directeur Bob Claeys spinnen alleen filmproducenten en -verdelers garen bij digitalisering

Vrijdag wordt wereldwijd 'Star Wars II: Attack of the Clones' uitgebracht. De film zorgt in twee opzichten voor een hype. Een: het is een nieuw Wars-film. Twee: George Lucas heeft de film volledig digitaal opgenomen. De Belgische bioscoopgroep Kinepolis beschikt in Brussel over e de 100 digitale projectiezalen die wereldwijd bestaan. 'Star Wars II' zal er digitaal te zien zijn. Het begin van een nieuwe digitaal tijdperk? Ja zegt Kinepolis. 'Zolang er wereldwijd geen standaard is, pompen we geen cent in de digitalisering.' De uitbaters hebben hun lesje geleerd.

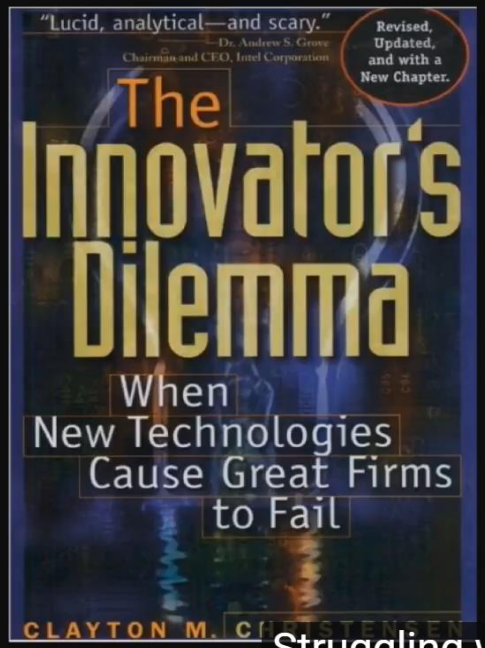
'De digitale film is niet nieuw voor ons', zegt Bob Claeys, bij Kinepolis internationaal verantwoordelijk voor ojectie en geluid. 'Enkele jaren terug atsen Texas Instruments en Buena- ta op 30 plaatsen in de wereld digi- e projectie-apparatuur als testcases. waren geïnteresseerd omdat we den weten wat die digitale techno- e waard was en plaatsten een pro- pe in Brussel en een in Madrid. Disney en Pixar leverden digitale . We projecteerden films als 'Toy ', '101 Dalmatiërs' en andere Dis- ekenfilms digitaal. Het verschil lat de films die toen digitaal wer- ertoond of animatiefilms, zonder eelden, waren of films die op- f analoog werden gefilmd en arna werden gedigitaliseerd. 'ars' daarentegen is gefilmd met e camera's en toont zowel leven- nimatiebeelden.'

s: 'Voor de filmproducenten gitale film enorme voordelen le torenhoge distributiekosten erminderen. Een digitale film der noemenswaardige kosten er kwaliteitsverlies ettelijke orden gekopieerd op cassette kan nadien wereldwijd via f morgen via satelliet of het

De nieuwe Star Wars-film met een volledig digitale Yoda, vroeger een bewegende pop, komt vrijdag wereldwijd in duizenden zalen uit. Verwacht enkel in de VS en Canada in vier dagen 100 miljoen dollar opbrengt.

On innovation and disruption

The Innovators Dilemma



Key Message: *There are two essential types of developments.*

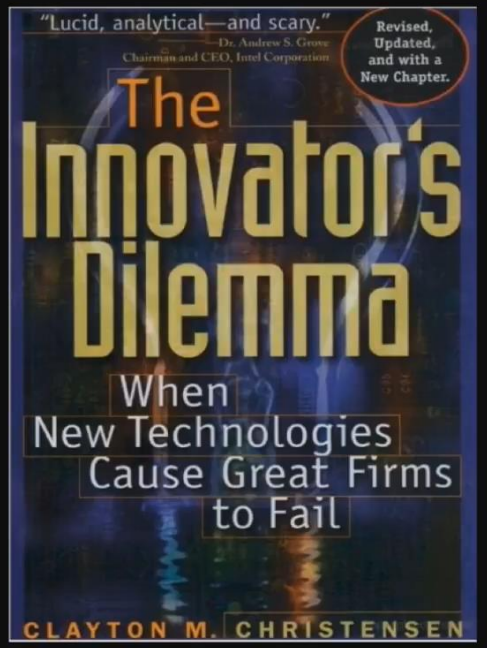
- *Sustaining developments that maintain existing value chains and incumbents*
- *Disruptive developments that overturn existing value chains and incumbents*

Struggling with this, that's what a disruptor is.

33

On innovation and disruption

The Innovators Dilemma (Cont.)



Essentials of Disruption:

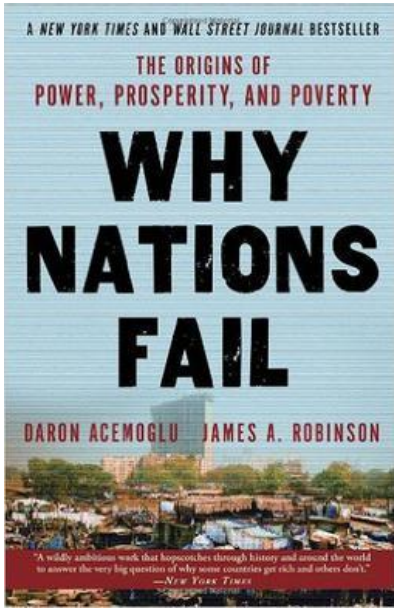
- *Disruptive developments initially are underperforming technologies or capabilities, that have inherent advantages*
- *If they can find a niche market and execute product cycles, they eventually overtake and overwhelm incumbents*

advantages.

34

On innovation and disruption

Acemoglu and ***Robinson's*** major thesis is that economic prosperity depends above all on the **inclusiveness** of economic and political institutions. Institutions are "**inclusive**" when many people have a say in political decision-making, as opposed to cases where a small group of people control political institutions and are unwilling to change. They argue that a functioning democratic and pluralistic state guarantees the rule of law. The authors also argue that inclusive institutions promote economic prosperity because they provide an incentive structure that allows talents and creative ideas to be rewarded.

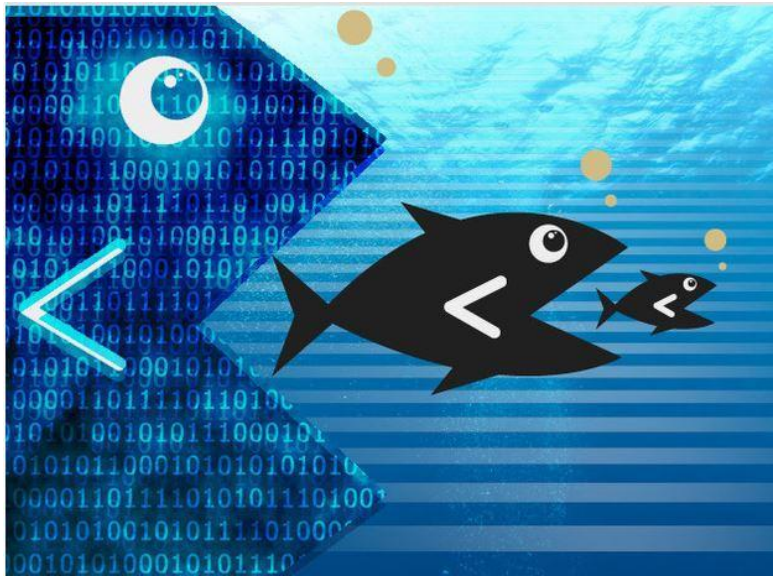


In contrast, the authors describe "**extractive**" institutions as ones that permit the elite to rule over and exploit others, extracting wealth from those who are not in the elite. Nations with a history of extractive institutions have not prospered, they argue, because entrepreneurs and citizens have less incentive to invest and innovate. One reason is that ***ruling elites are afraid of creative destruction*** —a term coined by Austrian economist Joseph Schumpeter—the ongoing process of annihilating old and bad institutions while generating new and good ones. Creative destruction would fabricate new groups which compete for power against ruling elites, who would lose their exclusive access to a country's economic and financial resources.

On disruption and software

When attractive profits disappear at one stage in the value chain because a product becomes modular and commoditized, the opportunity to earn attractive profits with proprietary products will usually emerge at an adjacent stage.

— Clayton Christensen

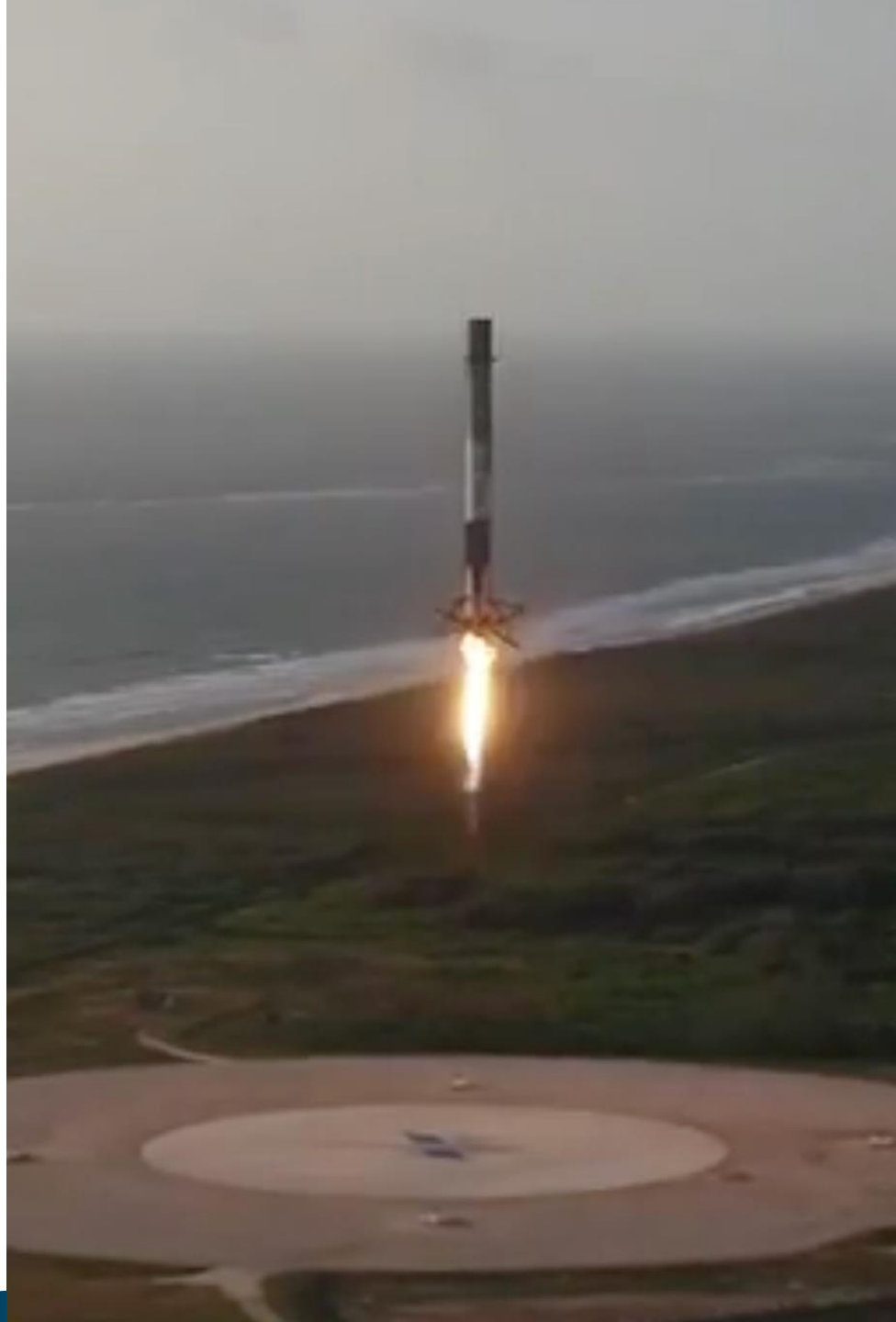


Software is eating the world.

In the future every company will become a software company.

— Marc Andreessen

Looking at Disruptors



The age of disruption

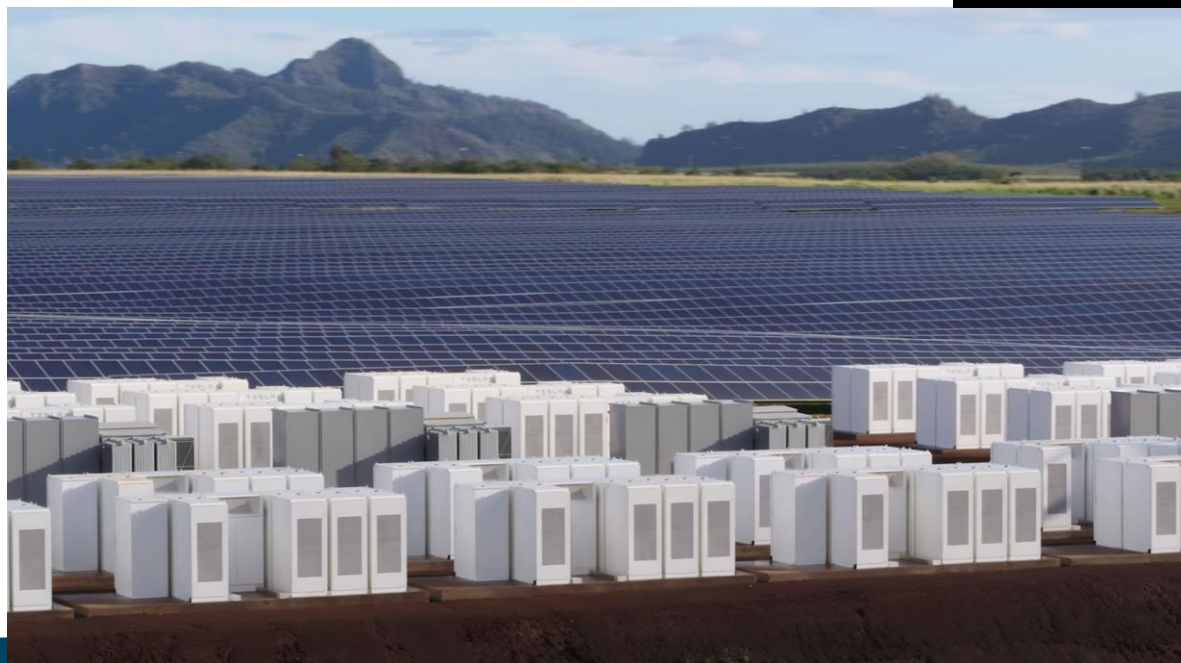
Google

Booking.com

Uber

amazon

airbnb



On disruptors and experts

Fooling around with alternating current (AC) is just a waste of time. Nobody will use it, ever.
— Thomas Edison, Inventor, 1889.

Heavier than air flying machines are physically impossible.
— Lord Kelvin, Mathematician and Physicist, 1897.

The horse is here to stay but the automobile is only a novelty – a fad.
— President of the Michigan Savings Bank, 1903.

A rocket will never be able to leave the Earth's atmosphere.
— The New York Times, 1920.

There is no reason an individual would ever want a computer in their home.
— Ken Olsen, Founder Digital Equipment Corporation, 1977.

The Internet will soon go spectacularly supernova and in 1996 catastrophically collapse.
— Robert Metcalfe, Founder of 3Com, Inventor of Ethernet, 1995.

On disruptors and software

- *Software* seems indeed to be eating the world
  - disruptors are to a large extent software companies
- *Software companies* are not eating the world
  - disruptors are developing software in house
  - disruptors enter the computing market
- *Software products* are fading
  - offered as a service
    - search, maps, bookings
  - part of a product
    - cars, phones, rockets

On disruptors and technology

- A disruptive innovation has in general a
  - *Technological* component
    - Creating new technologies
    - Combining existing technologies
    - Realizing existing technologies
  - *Business model* component
    - Disintermediation & reintermediation
      - Amazon *vs. retail*
      - Booking *vs. travel agent*
      - Spotify *vs. music stores*
    - Architecture participation
      - Facebook *doesn't own content*
      - Airbnb *doesn't own venues*
      - Uber *doesn't own cars*

Apple: iPod & iTunes Store

- Technology
  - Use of flash memory *(cfr. SanDisk 1988)*
  - Scroll wheel based on *Synaptics trackpad*
  - iTunes originally for PC's *(SoundJam)*
- Disruptive
  - Podcasts
  - Breakthrough in distribution model
    - Traditional: outdated model
    - Digital: illegal or small scale

    ➔ Agreement with the Big 5

Apple: iPhone & AppStore

- Technology
  - Integration:
    - Phone + Music player + Internet + Camera
  - Intuitive *touch user interface*
  - Gyroscope
- Disruptive
  - Integration with iTunes Store
  - SDK and App Store

Leverage: download vs. producing, packaging, and transporting discs

Tesla: Electric cars

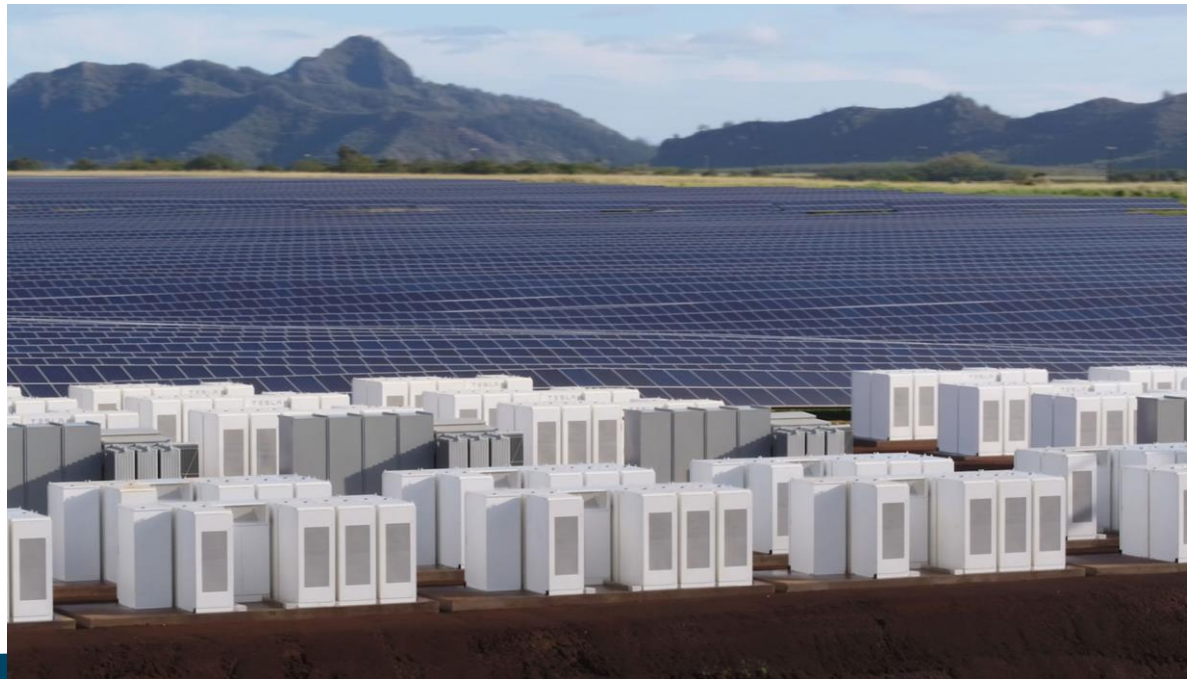
- Technology
  - Advanced battery
  - Futuristic styling
  - Auto-pilot, software updates

- Disruptive
  - Electric car becomes trendy
  - Direct sales, no dealers *(legal battle !)*
  - Free *supercharger* network
  - *Gigafactory*: battery production

Leverage: charging batteries vs. drilling, refining, and transporting oil

Tesla: Sustainable energy

- Technology
  - Solar panels ➔ solar tiles
  - Powerwall / Powerpack
- Disruptive
  - Energy provider:
    - e.g. Hawai, …



SpaceX: Falcon rockets

- Technology
  - Vertical *propulsive landing*

  (cfr. Delta Clipper 1993)
  - *Hypersonic retropulsion*
- Disruptive
  - Agressive HR policy
  - Fighting monopoly ULA *(legal battle !)*
  - ***Total vertical integration***

As long as you use legacy components, you inherit the legacy cost structure.
— Elon Musk

On disruptors and attitude

We wanted flying cars, instead we got 140 characters.

— Peter Thiel

The best minds of my generation are thinking about how to make people click ads.

That sucks.

— Jeff Hammerbacher

Why do I hear millennials say: it would be awesome if you could pass me the salt. When I was growing up, awesome used to apply to walking on the moon, awesome used to apply to curing diseases like cancer.

— Neil de Grasse Tyson

Walk out of a meeting or drop off a call as soon as it is obvious you aren't adding value. It is not rude to leave, it is rude to make someone stay and waste their time.

— Elon Musk

Our mission is to contribute to society. It is always about making things better.

— Tim Minshall

Reflecting on the Future

There are still issues with software

- Errors and crashes
  - *Multi-trillion Lines-of-Code ➔ billions of defects*
    - 2003 US & Canada Blackout for 8M people
    - fatal crashes cars and rockets caused by software
    - high impact software errors in justice and banking
- *Time and budgets*
  - *The Standish Group reports*
  - *Final Report Elias Committee (NL):*
    - huge cost overruns
    - depreciation of IT systems after 7 years

There are still issues with software

- Maintenance costs
  - are an increasing burden on IT departments
  - are *not only caused by old legacy* systems
- Technical or maintenance debt
  - emerges almost inevitable in new systems
  - is being measured but not avoided
- Resource staffing
  - an ever growing need for IT staff
  - extrapolations often indicate that every single human being would need to work in IT in the future …

These issues seem to be systemic

- *Productivity Paradox*
  - Slowdown of productivity growth in 1970s and 1980s
  - Slowdown of productivity growth in 2000s and 2010s – *2.0*
  - Many hypotheses:
    - Measurement, mismanagement, unproductive IT, …
- This is *NOT what technology is supposed to be*:
  - Increasing productivity
  - Decreasing labor efforts
  - Scalable and sustainable

You can see the computer age everywhere but in the productivity statistics.

— Robert Solow

and have been known for a long time

The Dream: Doug Mc Ilroy

"expect families of routines to be constructed on *rational principles* so that families fit together as **building blocks.** In short, [the user] should be able safely to regard components as black boxes.**"**

from: McIlroy, *Mass Produced Software Components*,
1968 NATO Conference on Software Engineering, Garmisch, Germany.

and have been known for a long time

The Reality: Manny Lehman

The Law of Increasing Complexity
Manny Lehman

"As an evolving program is continually changed, its complexity, reflecting deteriorating structure, increases unless work is done to maintain or reduce it."

Proceedings of the IEEE, vol. 68, nr. 9, september 1980, pp. 1068.

but have not been systematically addressed

- Information Systems Methodologies
  - *"An IS methodology is a methodical (systematic) approach to IS planning, analysis, design, construction and evolution."* (Olle, 1988)
  - More than 1000 exist:
    - BON, Booch, BOOM, Catalysis, CBD/e, Coad/Yourdon, COMMA
    - CRC, Convergent Engineering, Demeter, DOORS, DOOS
    - EPA, EROOS, Fusion, Goofee, HOOD, IDEA, ION, KISS
    - MERODE, MOSES, MWOOD, Object COMX, Objecteering
    - Objectory, OEP, Octopus, OMT, OOAD/OOIE, OOA/RD, OOBE
    - OOCL, OOHDM, OOram, OOSC, OOSD, OOSE, OOSP
    - Open, OSA, PAUD, ROAD, ROPES, RUP, Scrum, Skill-Driven Design
    - SDL, Shlaer & Mellor, Softstar, SOMA, SOMT, Syntropy, XP
    - …

but have not been systematically addressed

- No guidance for selecting an IS methodolgy:
  - The *Methodology jungle*
- All methodologies share common issues:
  - Limited adoption
  - Vagueness
  - Unsystematic application
  - Lack of traceability
- Methodologies and frameworks focus on
  - Process view
  - Descriptive aspects

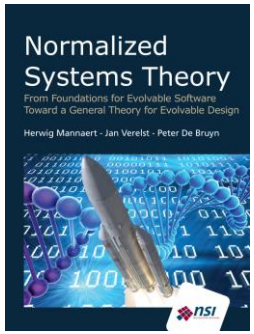
  and *do not provide prescriptive design rules*

On disruptors and software issues

- New disrupting companies limit and encapsulate the software issues to some extent:
  - Companies *offering software as a service (e.g. Google)* manage and operate their own software, limiting to a certain extent the amount of unexpected issues with client installations of their software (versions)
  - Companies *offering software within products (e.g. Tesla)* integrate and *test software on their hardware*, limiting to a certain extent the amount of unexpected issues with client installations on other hardware (versions)
- But:
  - Their *software* related resources, such as *developers and data centers*, seem to be growing and *eating away other types of resources*

On disruption in software from within

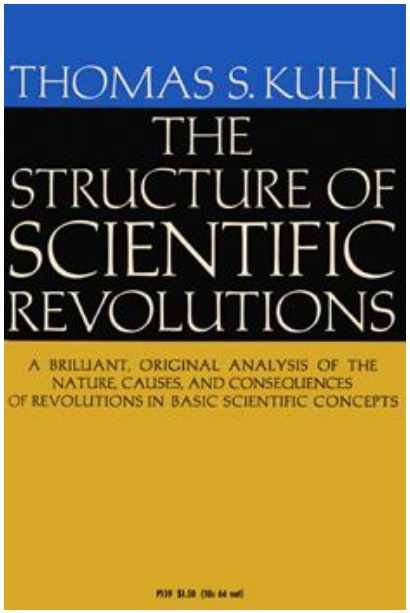
- The various issues in information systems development and software maintenance indicate a *breeding ground for a cycle of creative destruction from within*
- Such a potential disruptive cycle requires a
  - *Technological* component
    - Industrial automated production
    - Evolvability avoiding technical debt
    - Automated testing and quality control
  - *Business model* component
    - Discouraging time and material
    - Rewarding streamlining and quality
    - Capturing the sustainability aspect

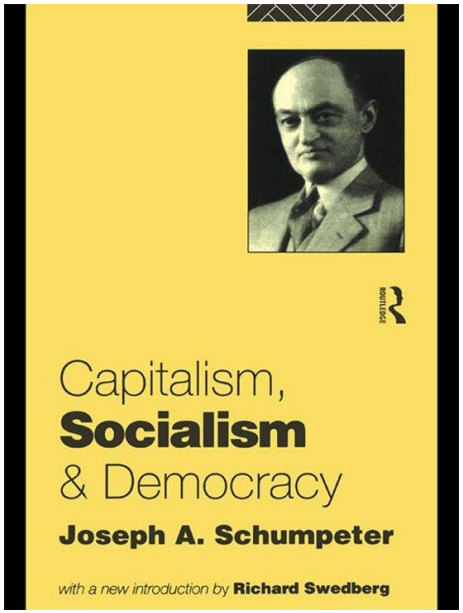


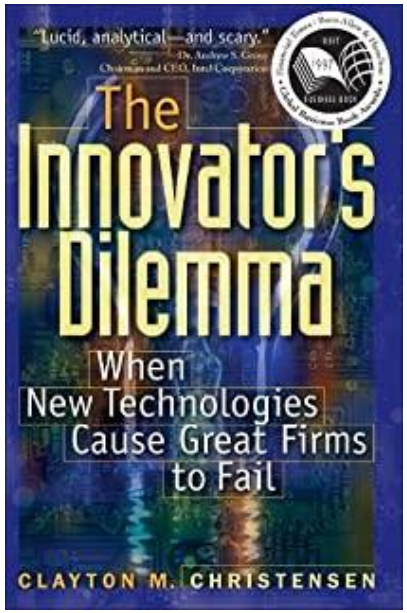
Conclusion

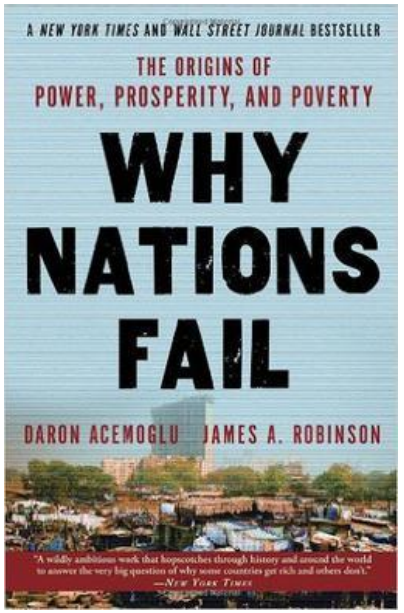
- The purpose of engineering and innovation is to leverage technology and to contribute to prosperity
- Innovations are often disruptive, having a technological and business component, and displacing value networks
- We live in disruptive times, where waves of disruption are often driven by software intensive companies
- The development and maintenance of software is still facing some tough and even systemic issues
- We believe that this is a breeding ground for a potential new cycle of destruction from within

Some traditionale references









Some online references

- Marc Andreessen on *Why software is eating the world*
  - https://a16z.com/2011/08/20/why-software-is-eating-the-world/
- Clayton Christensen on *Building a disruptive business*
  - https://www.youtube.com/watch?v=Zn6-KksdOgE
- Marc Andreessen on *It's time to build*
  - https://a16z.com/2020/04/18/its-time-to-build/
- Cathie Wood on *Innovation in tumultuous times*
  - https://ark-invest.com/market-commentary/coronavirus/

Some inspiring references

We wanted flying cars, instead we got 140 characters.
— Peter Thiel

The best minds of my generation are thinking about how to make people click ads.
That sucks.
— Jeff Hammerbacher

Why do I hear millennials say: it would be awesome if you could pass me the salt. When I was growing up, awesome used to apply to walking on the moon, awesome used to apply to curing diseases like cancer.
— Neil de Grasse Tyson

People sometimes think technology just automatically gets better every year, but it actually doesn't. It only gets better if smart people work like crazy to make it better.
— Elon Musk

Our mission is to contribute to society. It is always about making things better.
— Tim Minshall

I'd argue that everybody wants to do something that matters.
— Linus Torvalds

herwig.mannaert@uantwerpen.be

Universiteit Antwerpen