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Problems with Problems: The Changing Frame of Designing in the Context of New Technology

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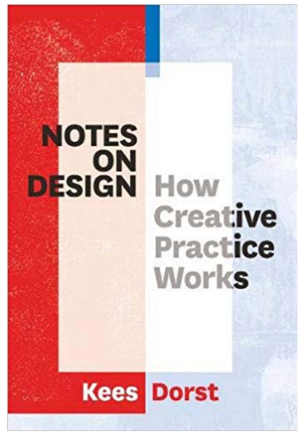
presentations.dubberly.com/Rosenfeld.pdf

PART ONE

The Current Frame

As a first approximation, designers often describe what they do when they design as “problem-solving.”

“When people started trying to understand design … the first model they devised was of design as a problem solving process.”



— **Kees Dorst**, *Notes on Design: How Creative Practice Works*, 2017 [19]

Walter Gropius —

"My intention is … to introduce a method of approach which allows one to tackle a problem according to its peculiar conditions." [1955]

Josef Albers —

Interaction of Color [1963] uses the word "problem" 15 times; Albers writes of "… solving our problems…" and he titles the student exercises "Problems."

Charles Eames —

"Design addresses itself to the need."

"[Constraints are] one of the few effective keys to the design problem." [1972]

Buckminster Fuller —

"When I am working on a problem, I never think about beauty. I only think about how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong."

Paul Rand —

In “Design and the Play Instinct,” he discusses “the kind of problem chosen for study,” and recommends “a problem with well defined limits.” [1965]

Lou Danziger —

“Design is purposeful …”

“… factors of the problem should shape the solution.” [2019]

Armin Hofmann —

In his preface to *Graphic Design Manual,* George Nelson writes that Hofmann believes “that if problems can be correctly stated, they can be solved.” [1965]

Ken Hiebert —

“Problem-solving was embedded in every aspect of learning in the Basel Program.” [2019]

“Unimark designers were the clinicians, diagnosing a client’s problems and then solving them.... Design was scientific and not a messy artistic process. The white lab coat transformed us all into a well-organized team of consistent precise professionals without individuality and quirky intuitions, biases and emotions. Lab coats kept us “clean,” like the “clean” design solutions we sought.”

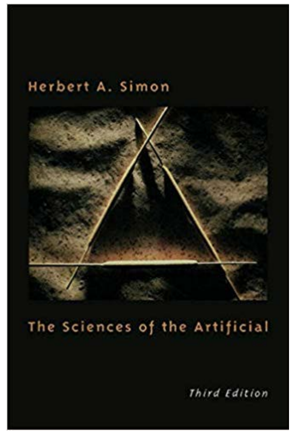
— **Katherine McCoy,** 2019

> *"The new art is founded not on a subjective, but on an objective basis. This, like science, can be described with precision and is by nature constructive. It unites not only pure art, but all those who stand at the frontier of the new culture. The artist is companion to the scholar, the engineer, and the worker."*

— **El Lissitzky and Illya Ehrenberg**, Statement by the editors of the journal *Veshch*, 1922

"The natural sciences are concerned with how things are.... Design, on the other hand, is concerned with how things ought to be, with devising artifacts to attain goals."

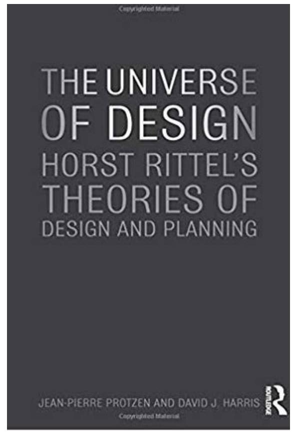
"Everyone designs who devises courses of action aimed at changing existing situations into preferred ones."



— **Herbert Simon**, *Sciences of the Artificial,* 1968 [111]

"Science and design are usually taken as polar contradictions.…What do the words science and design mean and what do they have in common?…

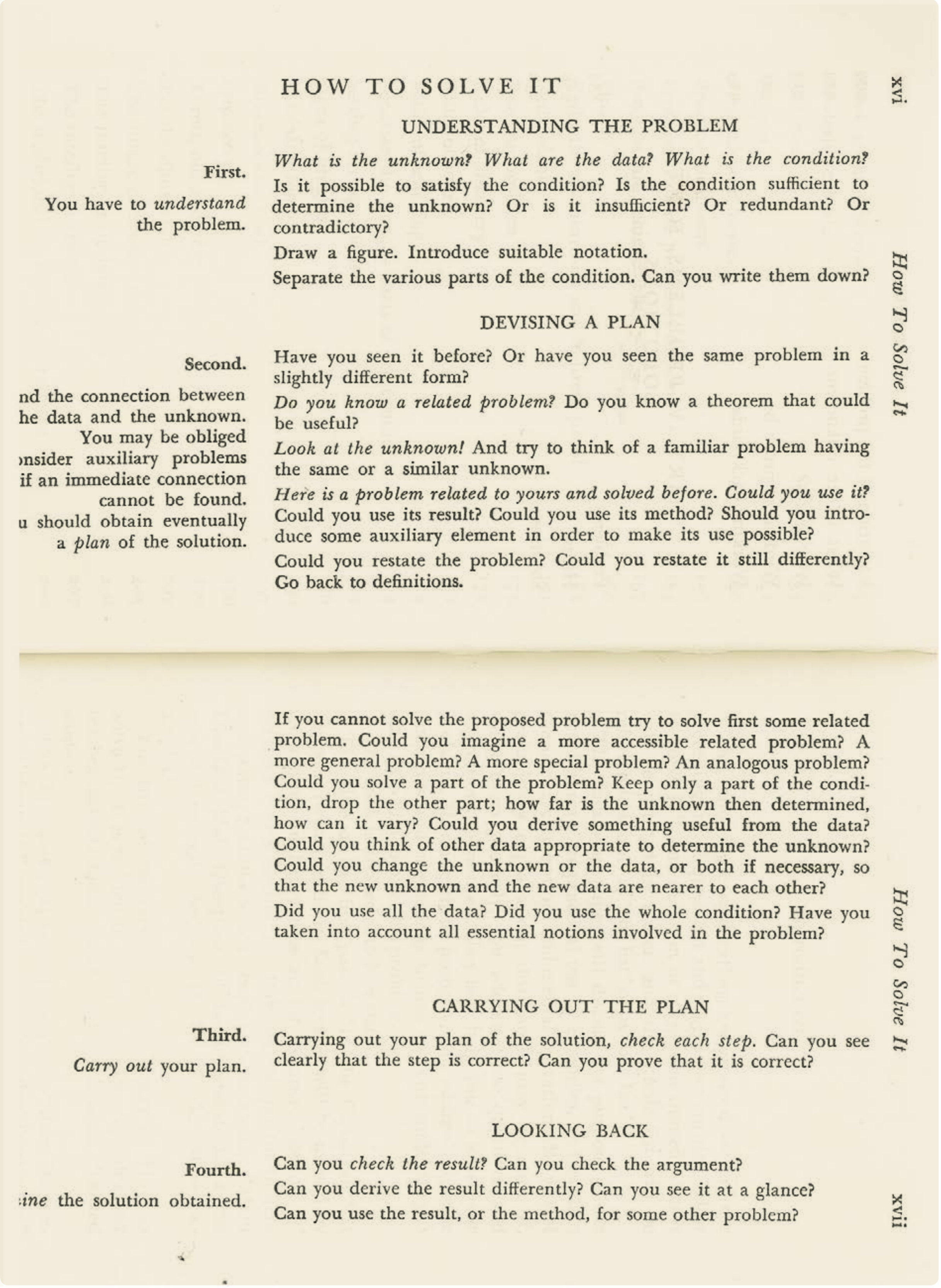
1 activities,
2 names for the results of activities,
3 associated with social institutions…
4 directed to the achievement of new realities…
5 problem-solving activities,
6 … unpredictable results"



— **Horst Rittel**, *The Universe of Design*, 1964 [48]

“In all of us [at HfG Ulm], especially myself, there was a deep dissatisfaction with a didactics (and a design activity) that had appealed only to intuition. In this context an increasing interest in disciplines … with a heuristic function such as ‘problem-solving’ and ‘decision-making’ [showed up]. We were very curious about anything moving in the world that was concerned with scientific questions.”

— **Tomás Maldonado**, “Looking Back and Forward: Interview,” 2002 [241]



HOW TO SOLVE IT

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UNDERSTANDING THE PROBLEM

First.

You have to *understand* the problem.

What is the unknown? What are the data? What is the condition?

Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory?

Draw a figure. Introduce suitable notation.

Separate the various parts of the condition. Can you write them down?

How To Solve It

DEVISING A PLAN

Second.

nd the connection between he data and the unknown. You may be obliged ɔnsider auxiliary problems if an immediate connection cannot be found. u should obtain eventually a *plan* of the solution.

Have you seen it before? Or have you seen the same problem in a slightly different form?

Do you know a related problem? Do you know a theorem that could be useful?

Look at the unknown! And try to think of a familiar problem having the same or a similar unknown.

Here is a problem related to yours and solved before. Could you use it? Could you use its result? Could you use its method? Should you introduce some auxiliary element in order to make its use possible?

Could you restate the problem? Could you restate it still differently? Go back to definitions.

If you cannot solve the proposed problem try to solve first some related problem. Could you imagine a more accessible related problem? A more general problem? A more special problem? An analogous problem? Could you solve a part of the problem? Keep only a part of the condition, drop the other part; how far is the unknown then determined, how can it vary? Could you derive something useful from the data? Could you think of other data appropriate to determine the unknown? Could you change the unknown or the data, or both if necessary, so that the new unknown and the new data are nearer to each other?

Did you use all the data? Did you use the whole condition? Have you taken into account all essential notions involved in the problem?

How To Solve It

CARRYING OUT THE PLAN

Third.

Carry out your plan.

Carrying out your plan of the solution, *check each step*. Can you see clearly that the step is correct? Can you prove that it is correct?

LOOKING BACK

Fourth.

ine the solution obtained.

Can you *check the result?* Can you check the argument?

Can you derive the result differently? Can you see it at a glance?

Can you use the result, or the method, for some other problem?

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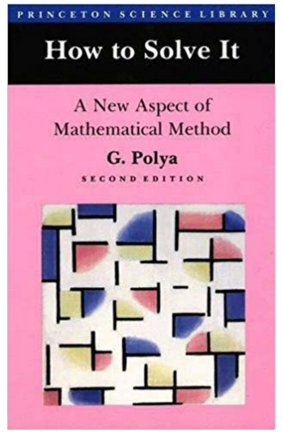
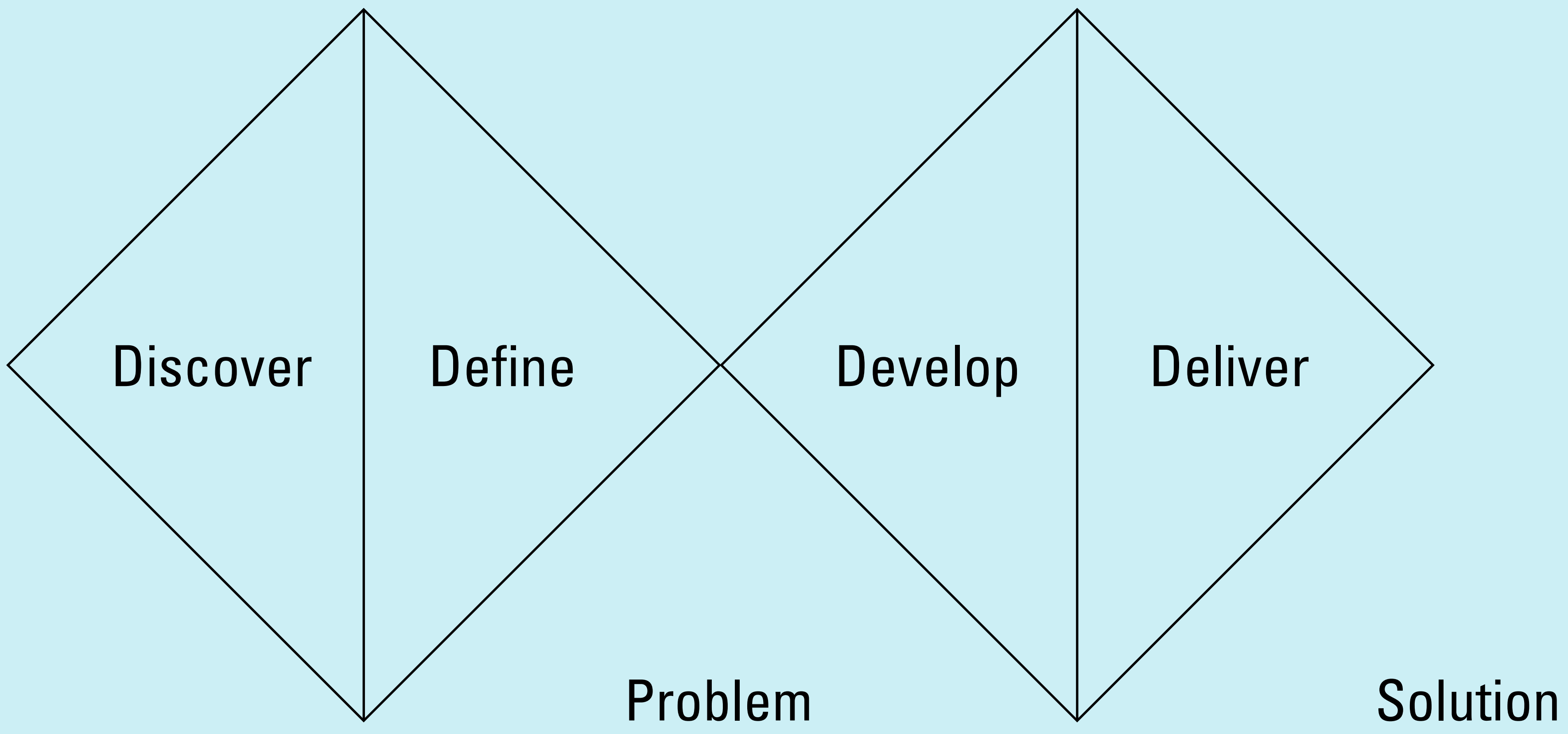


— **George Polya**, *How to Solve It,* 1945 [xvi-xvii]

The concept of designing as "problem-solving" is a foundation for design practice, design education, and writing about design.

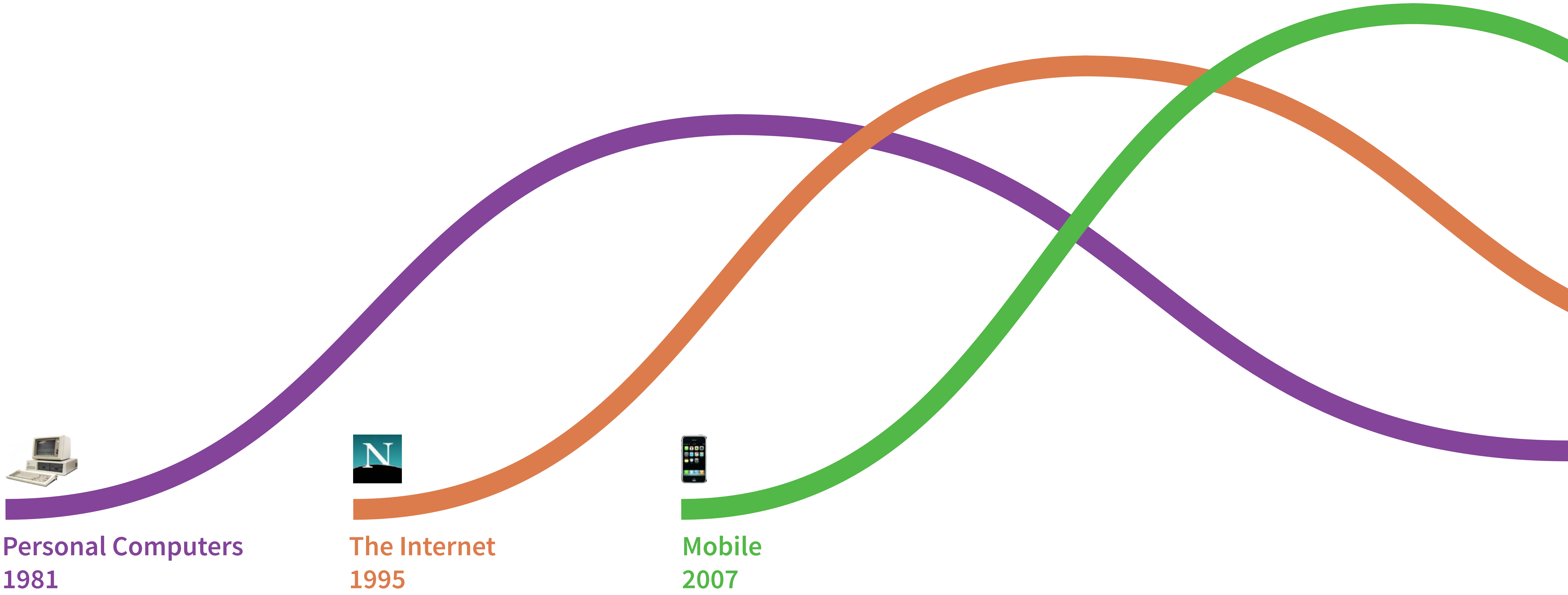
So much so, that the "design problem" is the basic "unit of work." That is, "design project" is almost synonymous with "design problem."



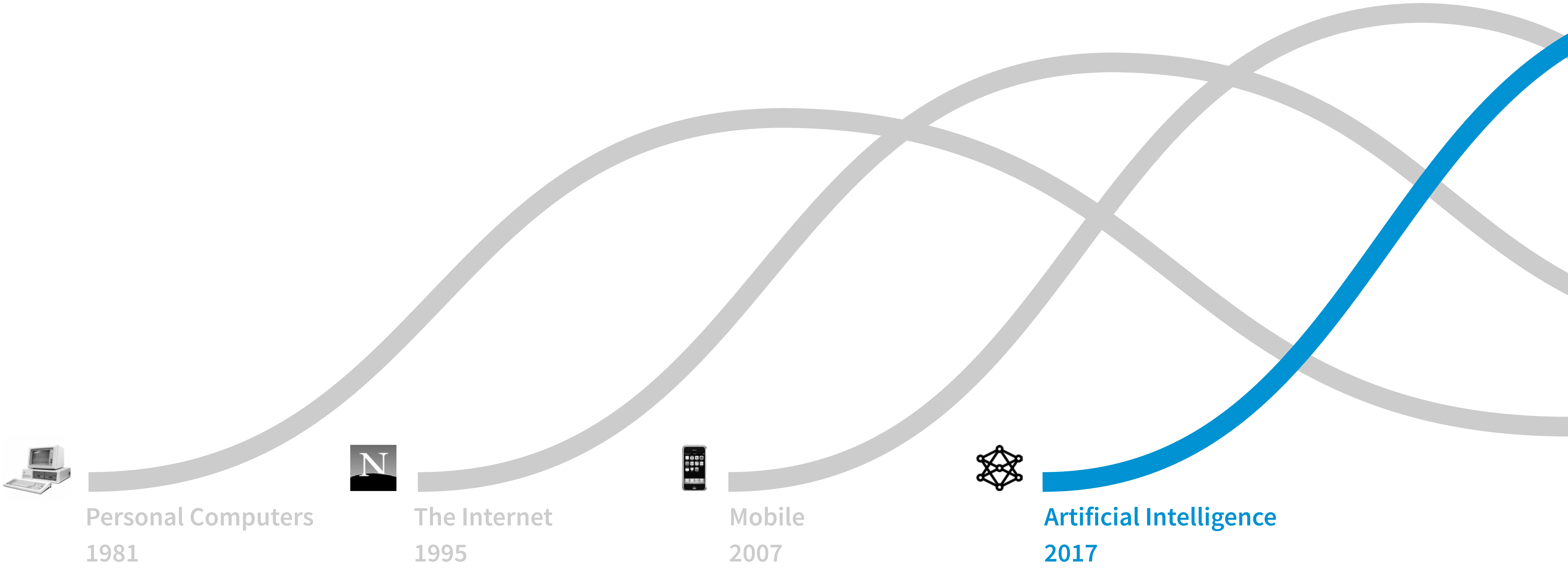
"Double diamond," after Papanek, one of many linear design process models.

How Technology is Changing

Every 10 to 15 years, a new wave of technology changes the way business is done.



The next wave will be Artificial Intelligence (AI) powered by massive amounts of data.



Five core technologies are combining to drive the next wave of change:

1 The sensor revolution
2 Smart, connected products (IoT)
3 Big data
4 On-demand computing (in “the cloud”)
5 Artificial intelligence (machine learning)

1 The sensor revolution

Sensors are printed on chips in the billions, reducing cost and installing measurement capability everywhere.

iPhone includes a dozen of sensors:

- Camera
- Gyroscope
- Barometer
- Proximity sensor
- Ambient light sensor
- Moisture sensor
- Microphone
- Accelerometer

1 The sensor revolution

E.g., today, about 500 satellites orbit the globe;
in less than 5 years, the number will grow to 5,000 or more.

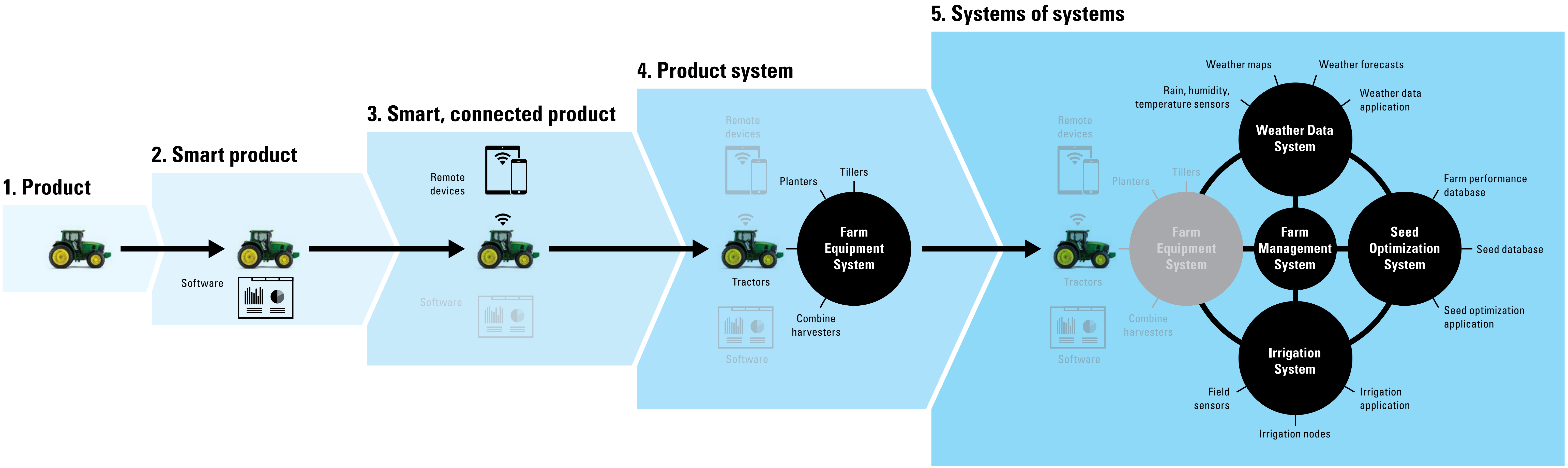
That means more…

- more resolution, thus more detail
- more frequency, then continuous monitoring
- more bands, seeing at night, through clouds (e.g., infrared)

[add satellite era table; landsat vs cubesat: size, weight, cost, numbers]

2 Smart, connected products

Everything will include sensors and built-in computers, connected to internet-based services.



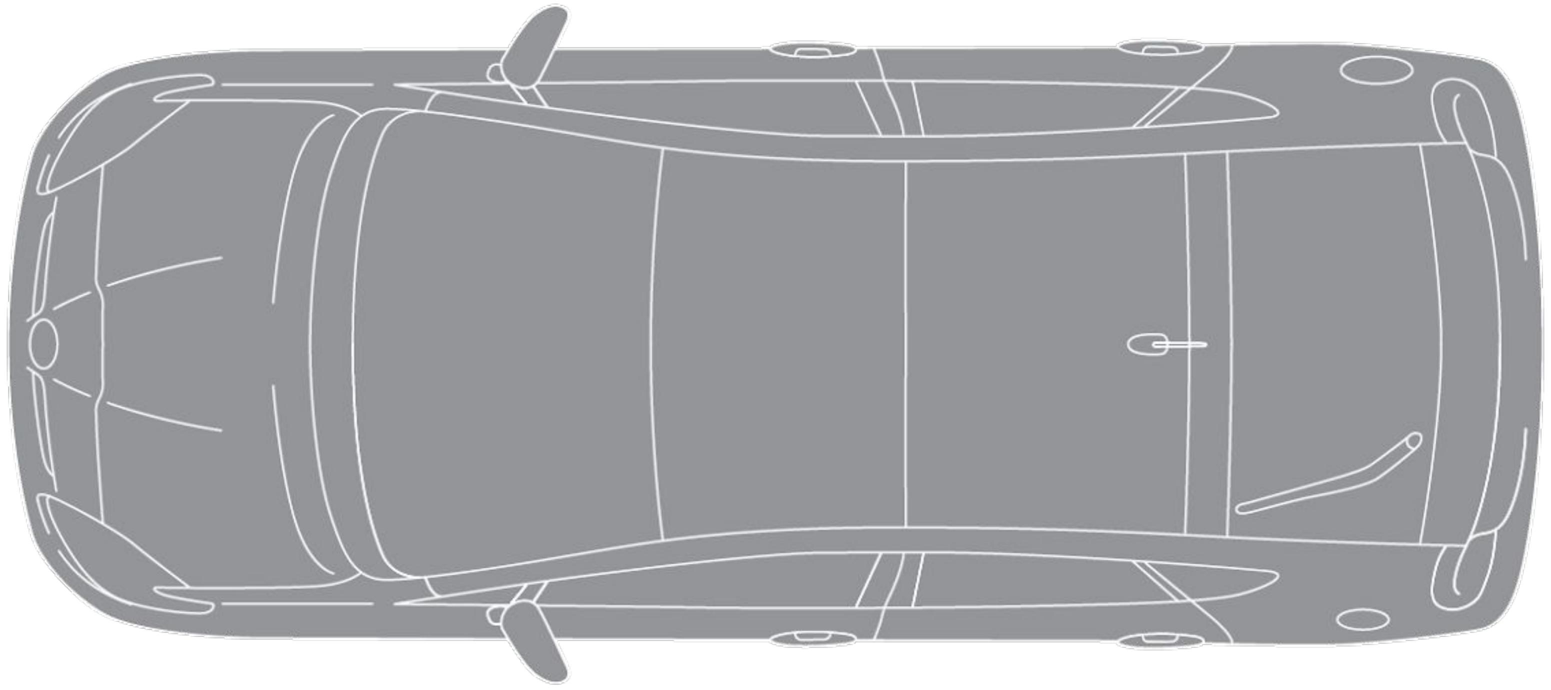
2 Smart, connected products

E.g., today's average car has:

– 60–100 sensors
(growing to 200 by 2020)

– 30 micro processors
(up to 100 for luxury cars)

– 100 million lines of code
(up to 2 million lines in a generation)



3 Big data

Smart products measure and record every change, generating huge amounts of data.

Each car produces about a terabyte of data per day, equivalent to 100 to 200 2-hour movies; soon, that data will be stored in the cloud.

3 Big data

Other examples of the vast amount of data collected; every minute, these services store...

Twitter	473,400 tweets
Snapchat	2,000,000 shares
Instagram	49,380 posts
LinkedIn	120 new users
Google	2,400,000 searches
YouTube	300 hours of video

4 On-demand computing

In the past, internet companies set-up their own computers;
now, we rely on Amazon Web Services, Google Cloud, MS Azure, etc.

- Immediately available
- Scale almost infinitely
- Marginal costs, falling toward zero

4 On-demand computing

E.g., in July, our CTO, Mike Warren, used vanilla Amazon Web Services to earn a spot on the Top-500 super-computer list.

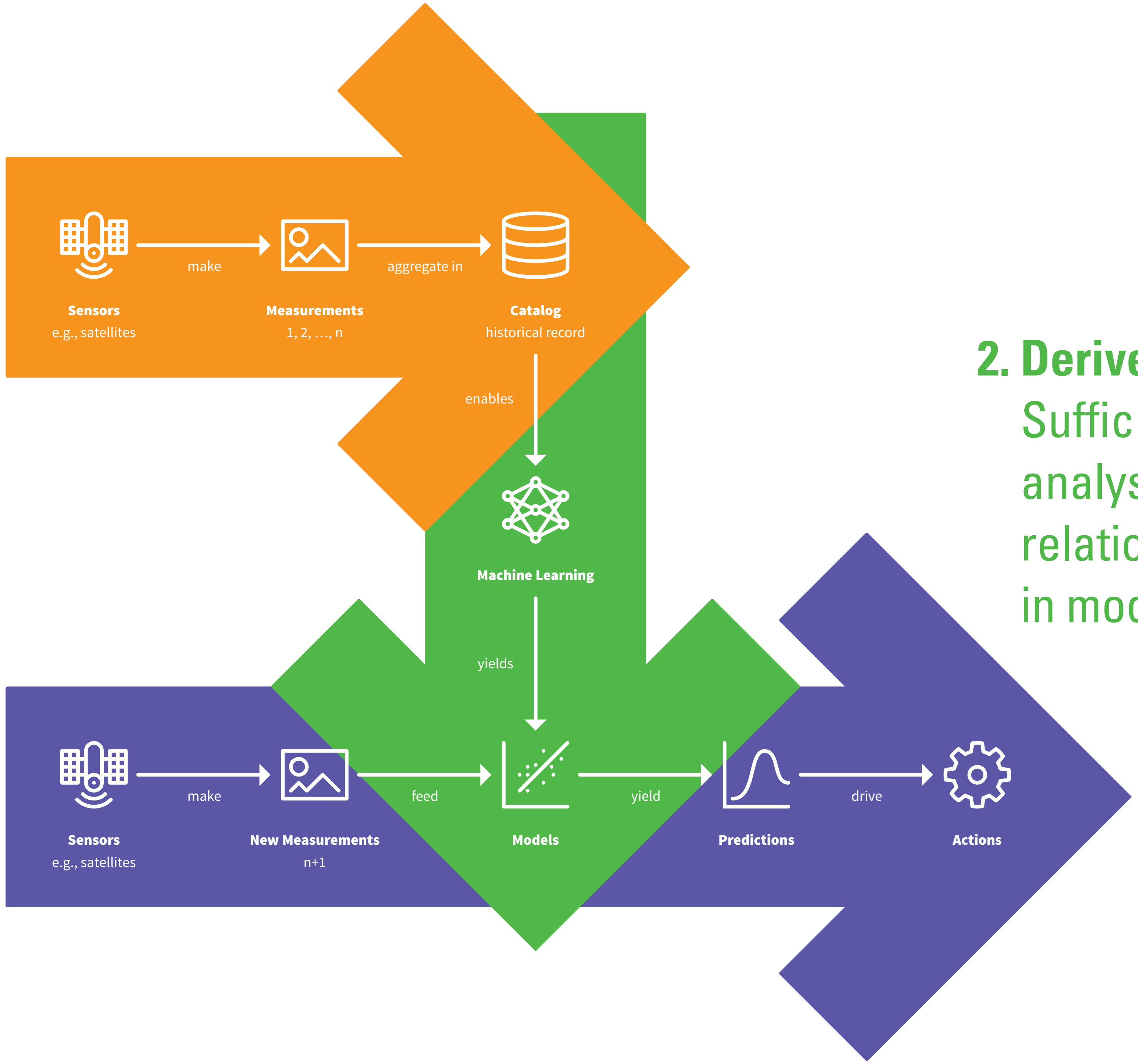
135	Telecom Company China	**CTcluster** - Sugon TC6000, Xeon Gold 6140 18C 2.3GHz, 10G Ethernet Sugon	54,000	1,928.0	3,974.4	520
136	Descartes Labs United States	**Amazon EC2 C5 Instance cluster us-east-1a** - Amazon EC2 Instance Cluster C5, Xeon Platinum 8124M 18C 3GHz, 25G Ethernet Amazon Web Services	41,472	1,926.4	3,981.3	
137	Energy Company China	Huawei 2288H V5, Xeon Gold 6150 18C 2.7GHz, 10G Ethernet Huawei Technologies Co., Ltd.	49,680	1,914.4	4,292.4	733

5 Artificial intelligence

In order to make sense out of big data, we need algorithms that can find patterns.

1. Gather histories

Sensors make a series of point in time measurements. As measurements accumulate, a historical record emerges.



2. Derive models

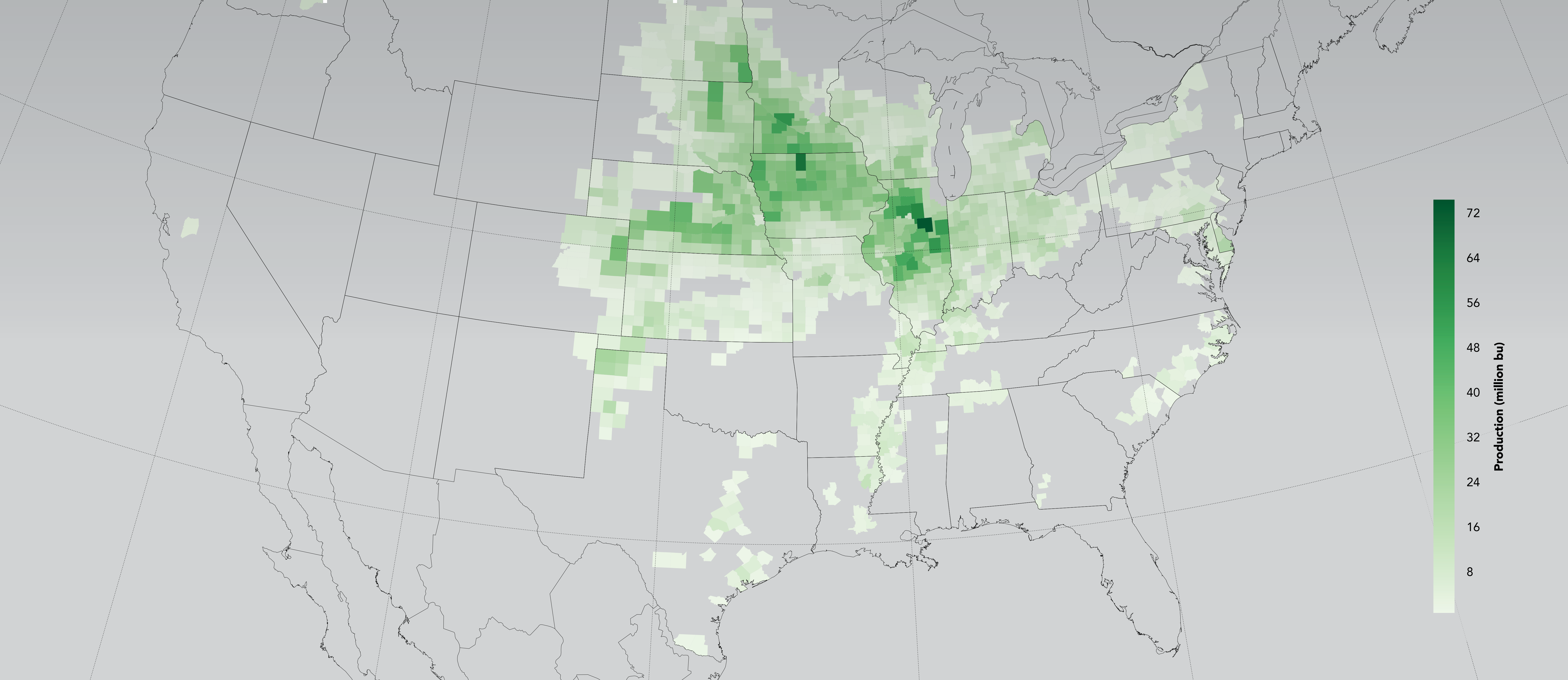
Sufficient historical data enables analysts to discover patterns and relationships—these are codified in models.

3. Predict futures

Once trained, new measurements are fed through the model to predict the future—enabling us to act today.

5 Artificial intelligence

E.g., in 2015, we used satellite images, weather data, and ML to automate prediction of corn production for the first time.



How Organizations are Adapting

Taking advantage of these trends requires climbing a learning curve, from data-aware to data-animated and beyond.

6 Model animated / self-driving / autonomous

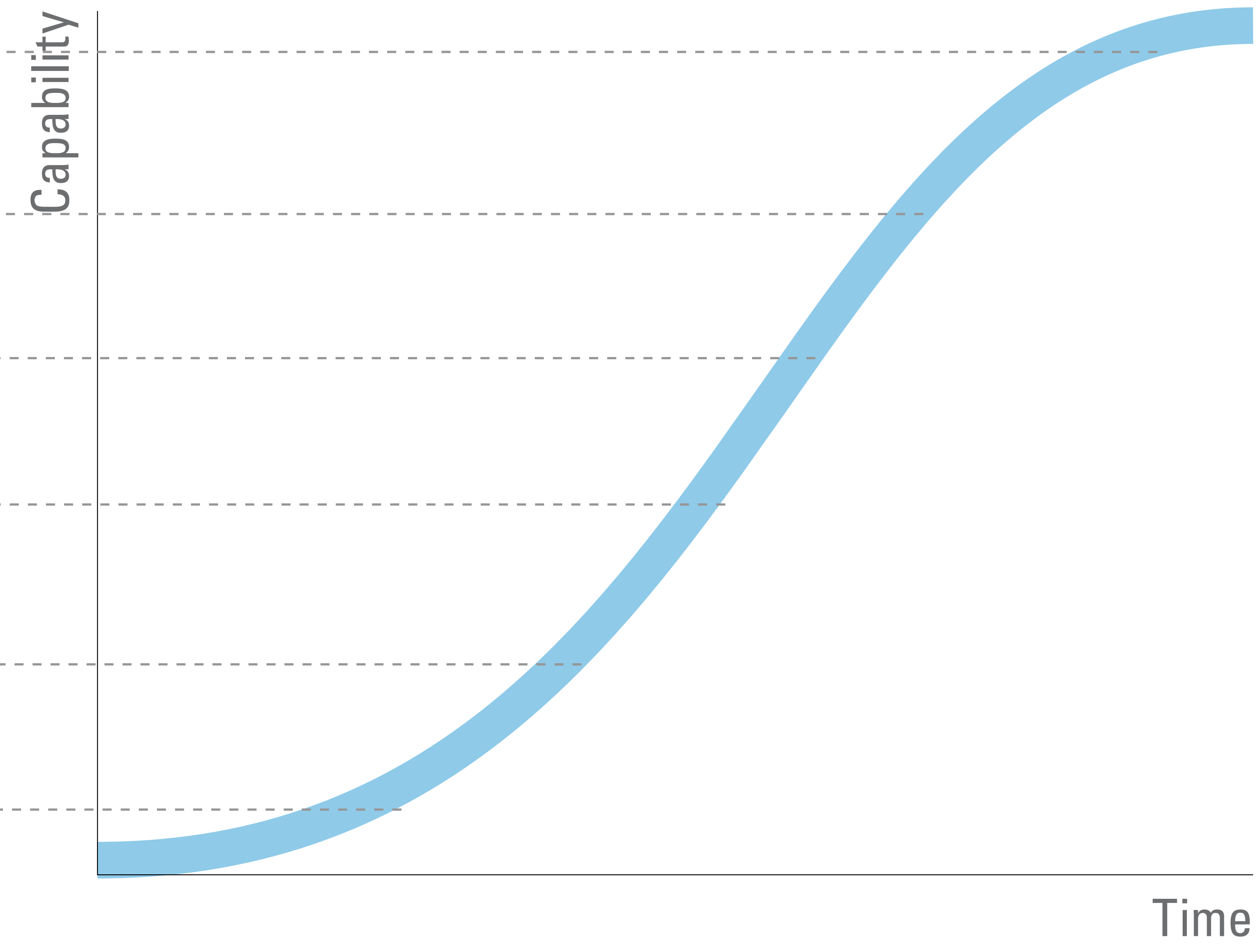
5 Model driven / optimization / semi-autonomous

4 Data animated / control

3 Data driven / monitoring

2 Data informed

1 Data aware

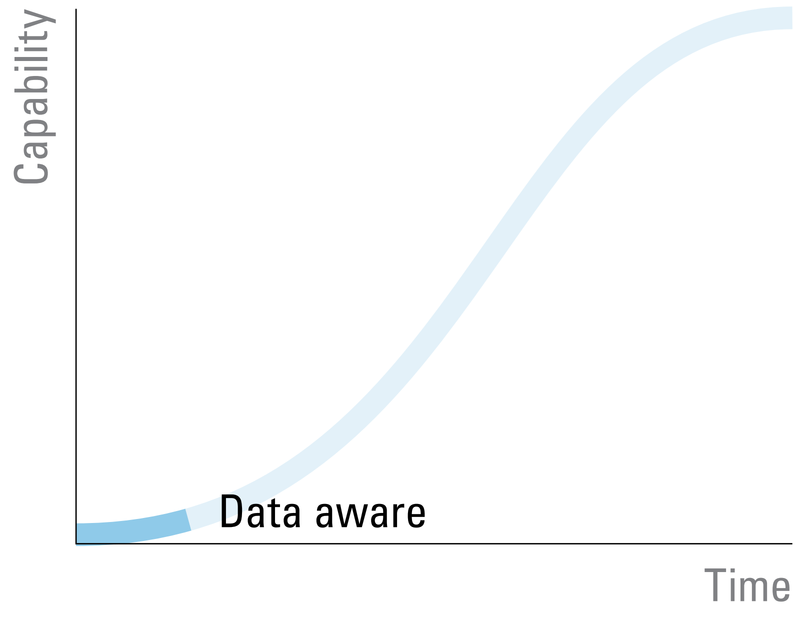


[See also Elizabeth Churchill and Michael Porter]

Step 1: Using data at-hand and creating a data culture

Data-aware organizations realize the value of data
and map goals and plan ways of measuring their progress.

Reviewing and wrangling internal data sources
Gathering and processing public data
Evaluating commercial data
Deploying dedicated sensors

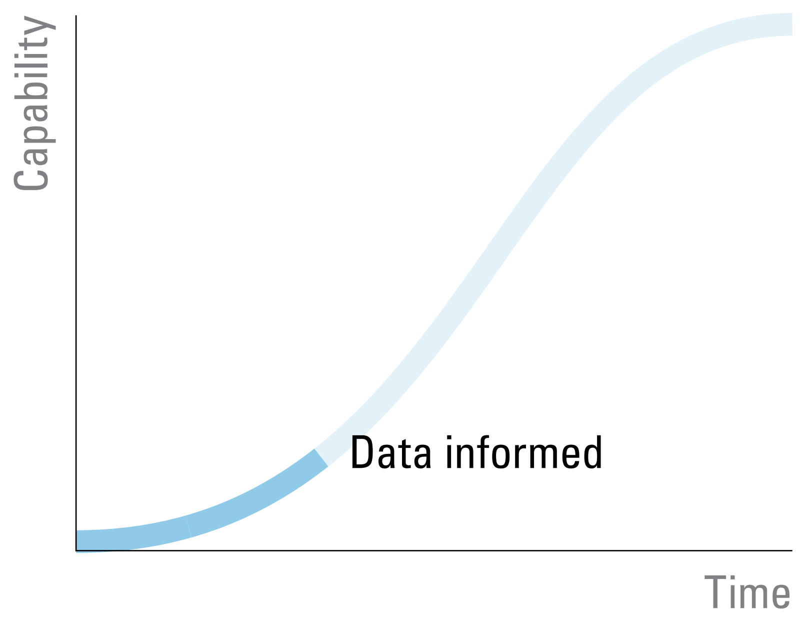


Step 2: Building conceptual and computational foundations

Data-informed organizations begin systematic efforts
to collect, “wrangle,” and store the data they need.

The resulting “reservoir” of “science ready” data becomes a huge asset.
Large volumes of data “attract” more data; they have “gravity.”

Data “wrangling” involves setting up software “pipelines”
to automate intake: collect, tag, register, calibrate, clean, mask
(to remove clouds), (sometimes) turn into vectors, index, and store.



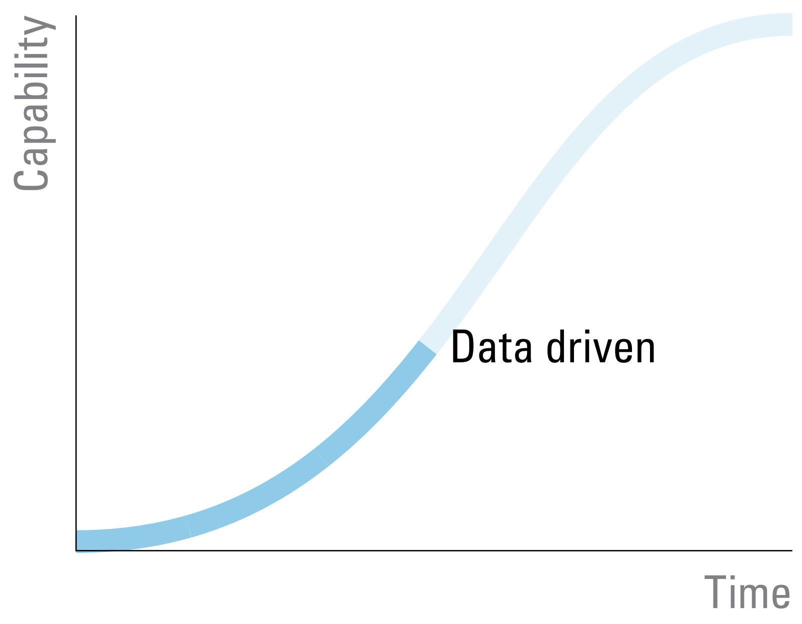
Step 3: Monitoring key thresholds

Data-driven organizations measure their operations and the environment in real-time, using automated software pipelines to identify danger conditions and alert managers to the need for action.

For example:

- Running low on supplies, gas, or blood sugar
- Over-heating a process or over-filling a storage unit
- Changes in price or volume
- Change in ground cover, plant growth, or start of construction
- Movement of vehicles or shipment of materials
- Emissions (e.g., methane) and fire

This is the world of "dashboards."

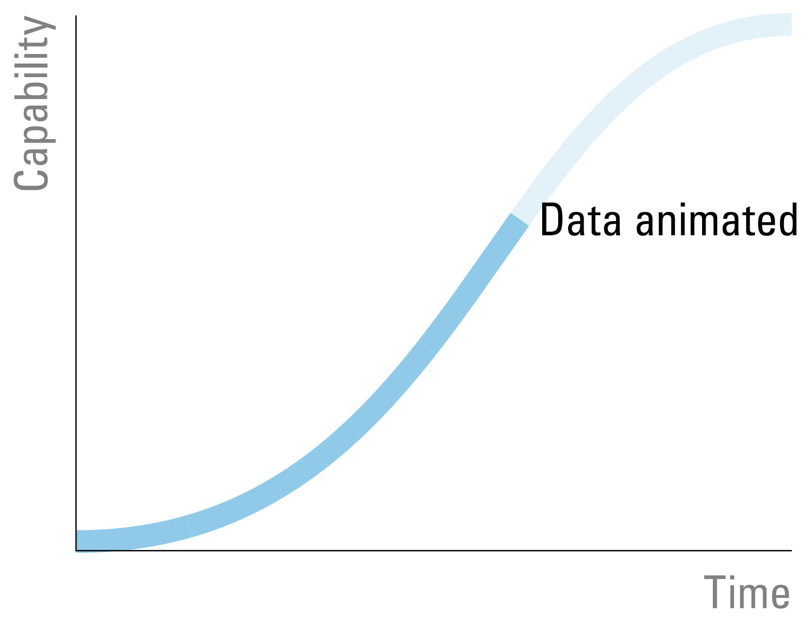


Step 4: Controlling key variables

Data-animated organizations “close the loop” on monitoring, automating response to alerts.

For example:

- Thermostats maintaining temperature in a “comfort range”
- Cruise control maintaining speed and distance between vehicles
- Auto-pilot systems maintaining course heading
- Insulin management systems maintaining blood glucose levels



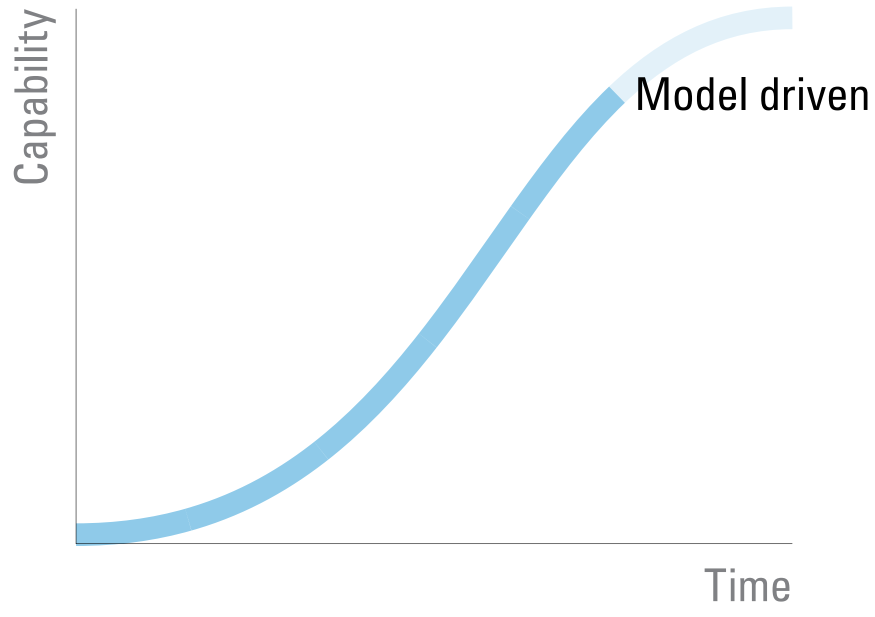
Step 5: Optimizing operations

Model-driven organizations mine historical data to find patterns, in order to predict events and drive human action.

For example:

- Relevance ranking
- People who bought this also bought that
- Image recognition
- Trading and arbitrage recommendations

Here organizations start to become semi-autonomous.



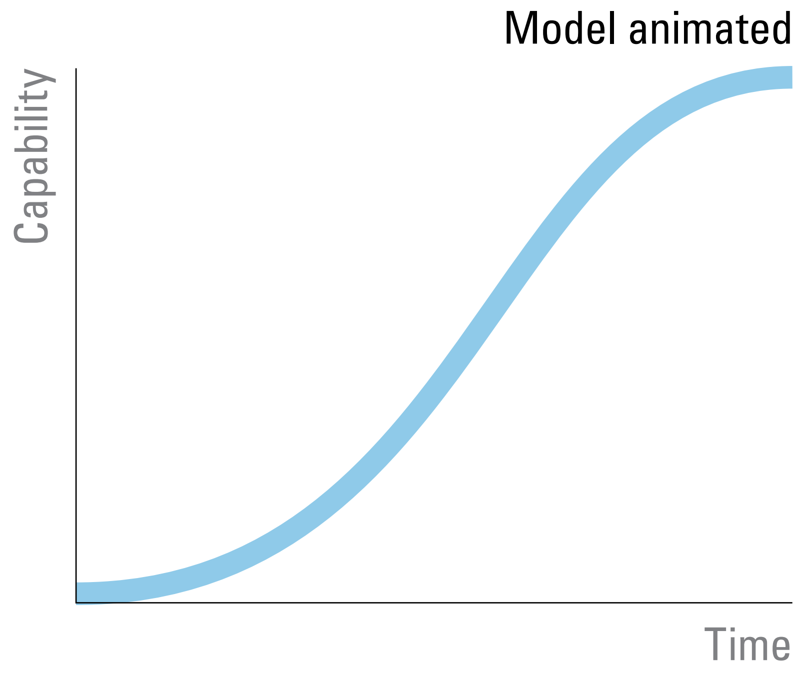
Step 6: Automating interactions

Model-animated organizations "close the loop" on optimizing, automating response to predictions.

For example:

- Self-driving vehicles
- Automated trading
- Customized pricing
- Google's Relationship Management system (GRM)

Here organizations start to automate the process of learning.

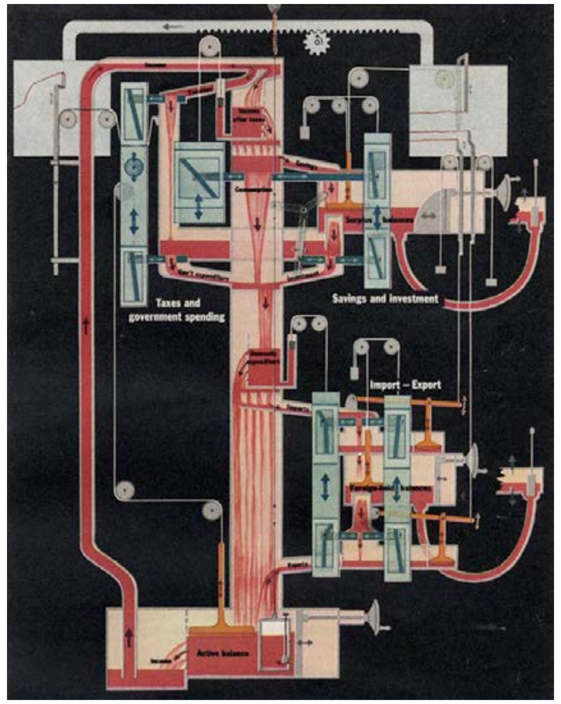


The Next Phase: Digital Twins

Major players have moved up the data learning curve. Increasingly, they are data-animated, building “digital twins,” and experimenting with autonomous interaction.

A “twin” is a replica, another version of a dynamic system.

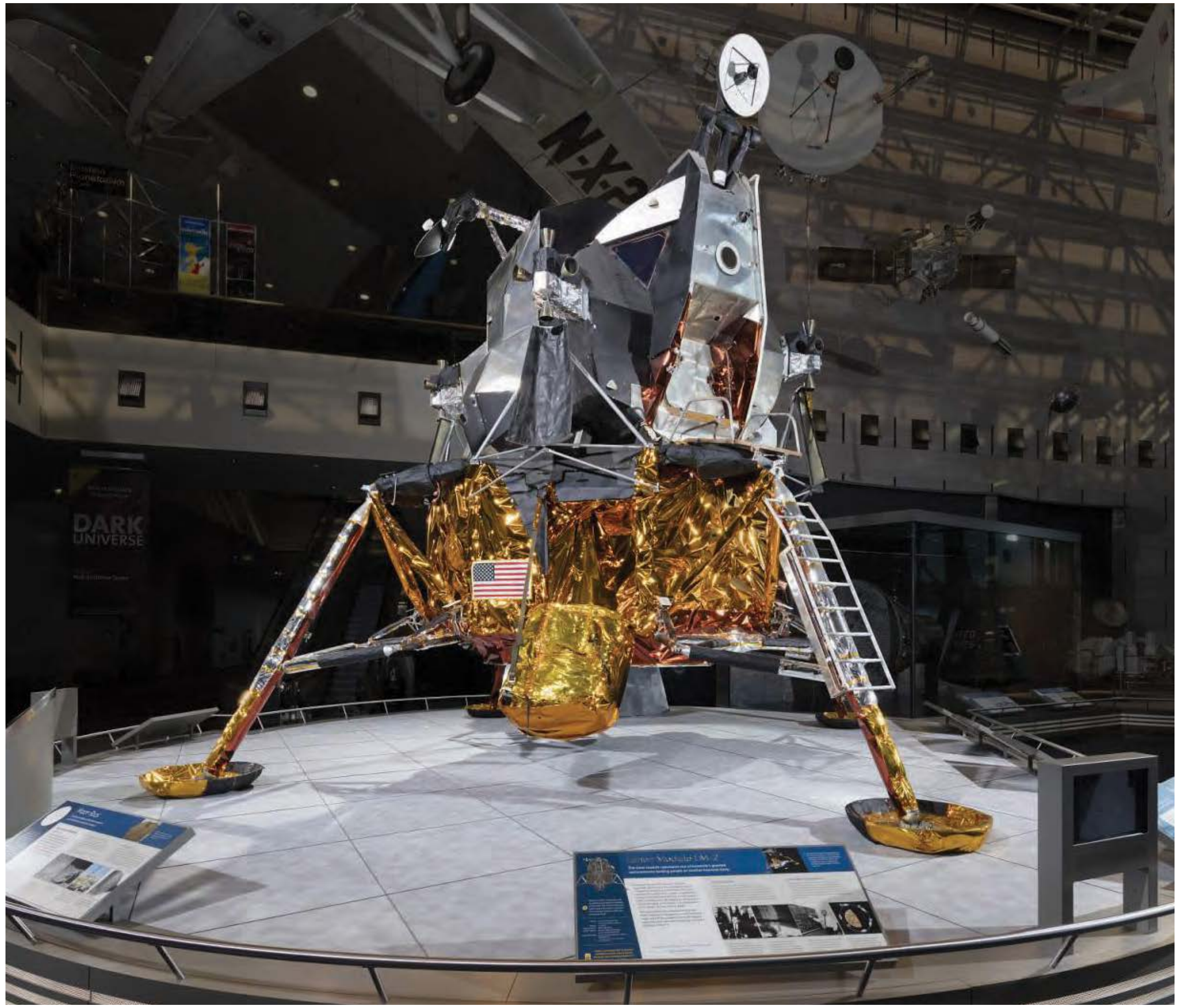
Mississippi River Basin Model
Built between 1943–1966



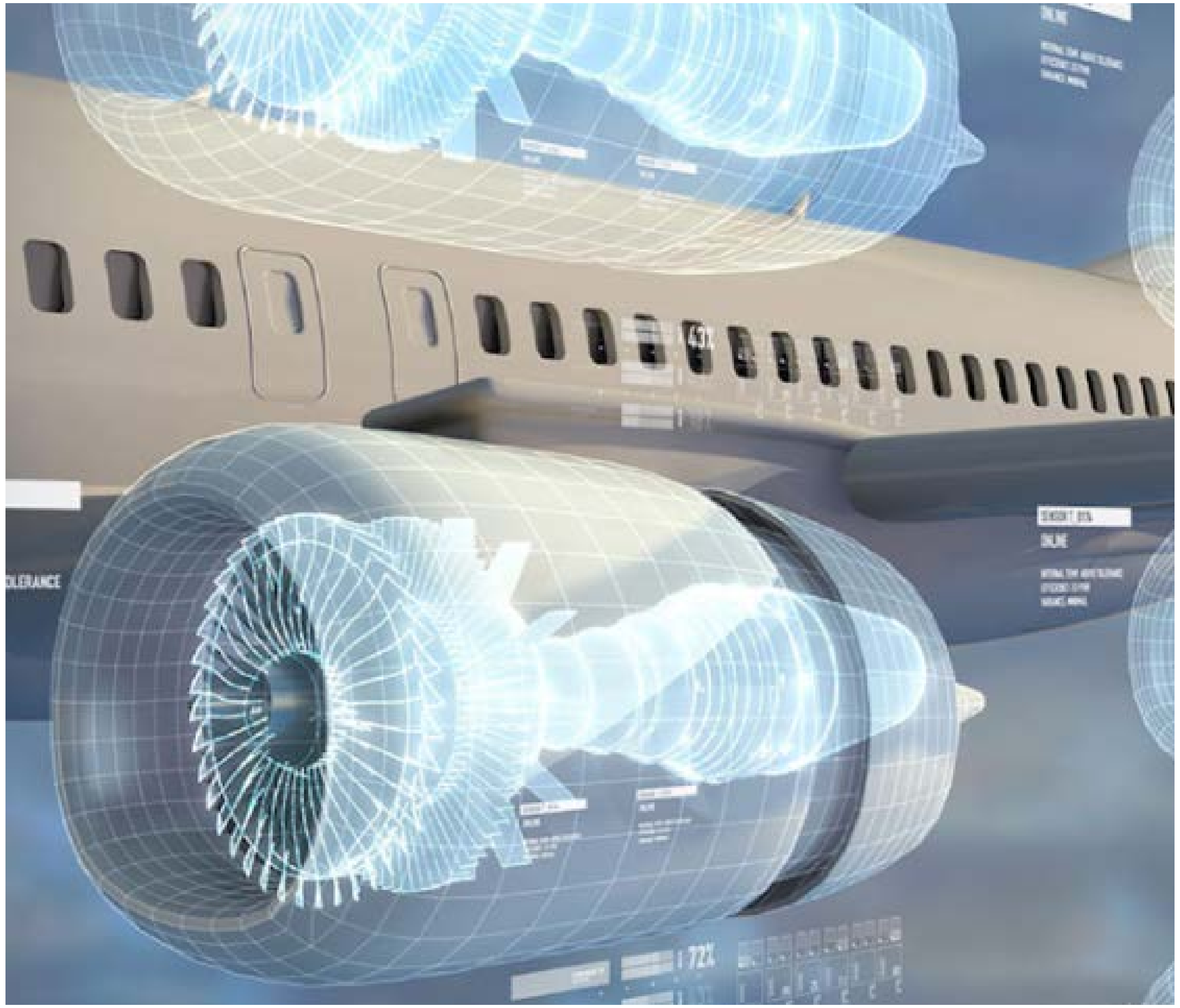
Economy Model
Built 1949

SF Bay Model
Built in 1957

NASA pioneered twins by locating a second spacecraft (physical twin) at mission control for troubleshooting; later, they made digital models of the spacecraft (digital twin).

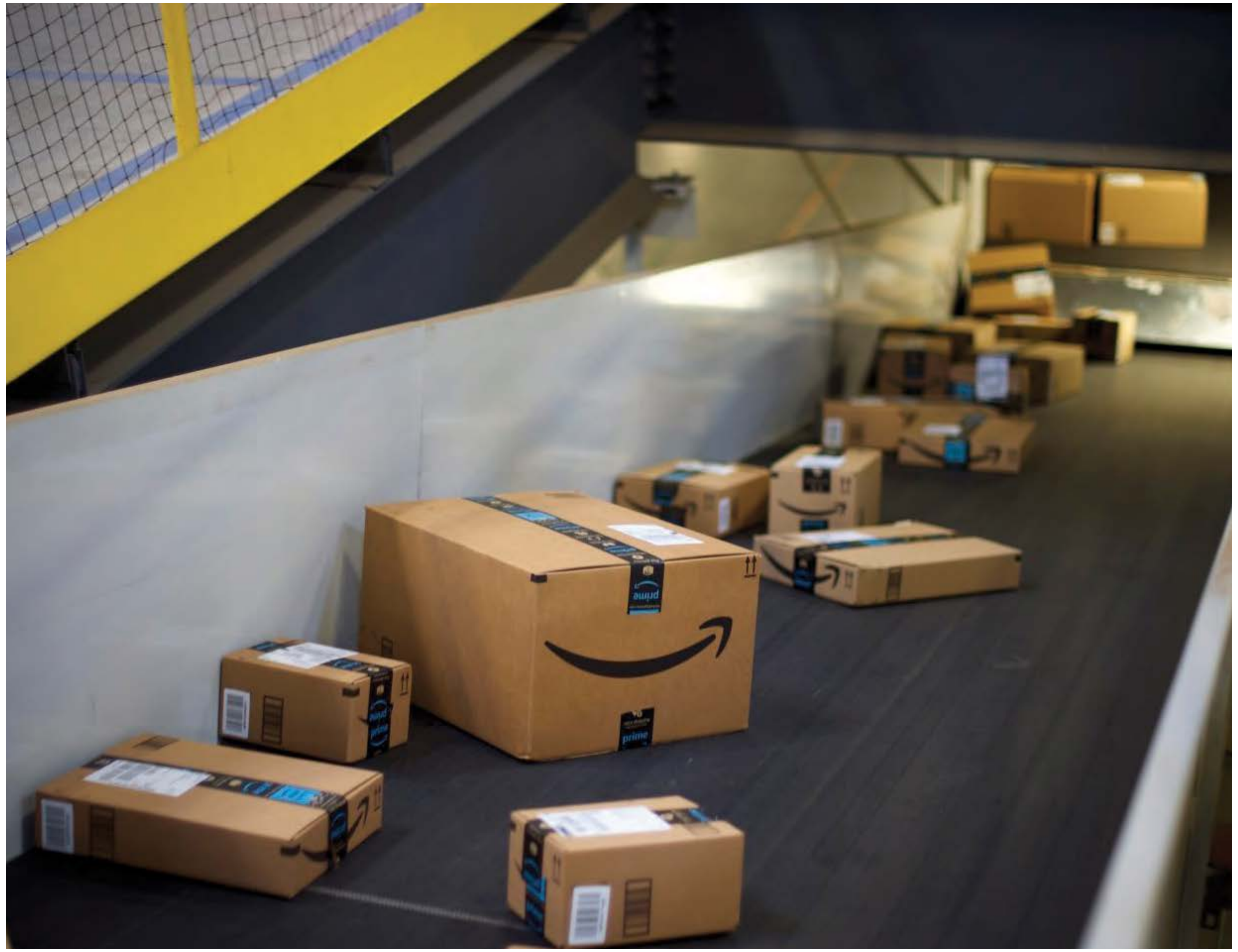


GE pioneered the use of digital twins in industry by building sophisticated models of turbine behavior.



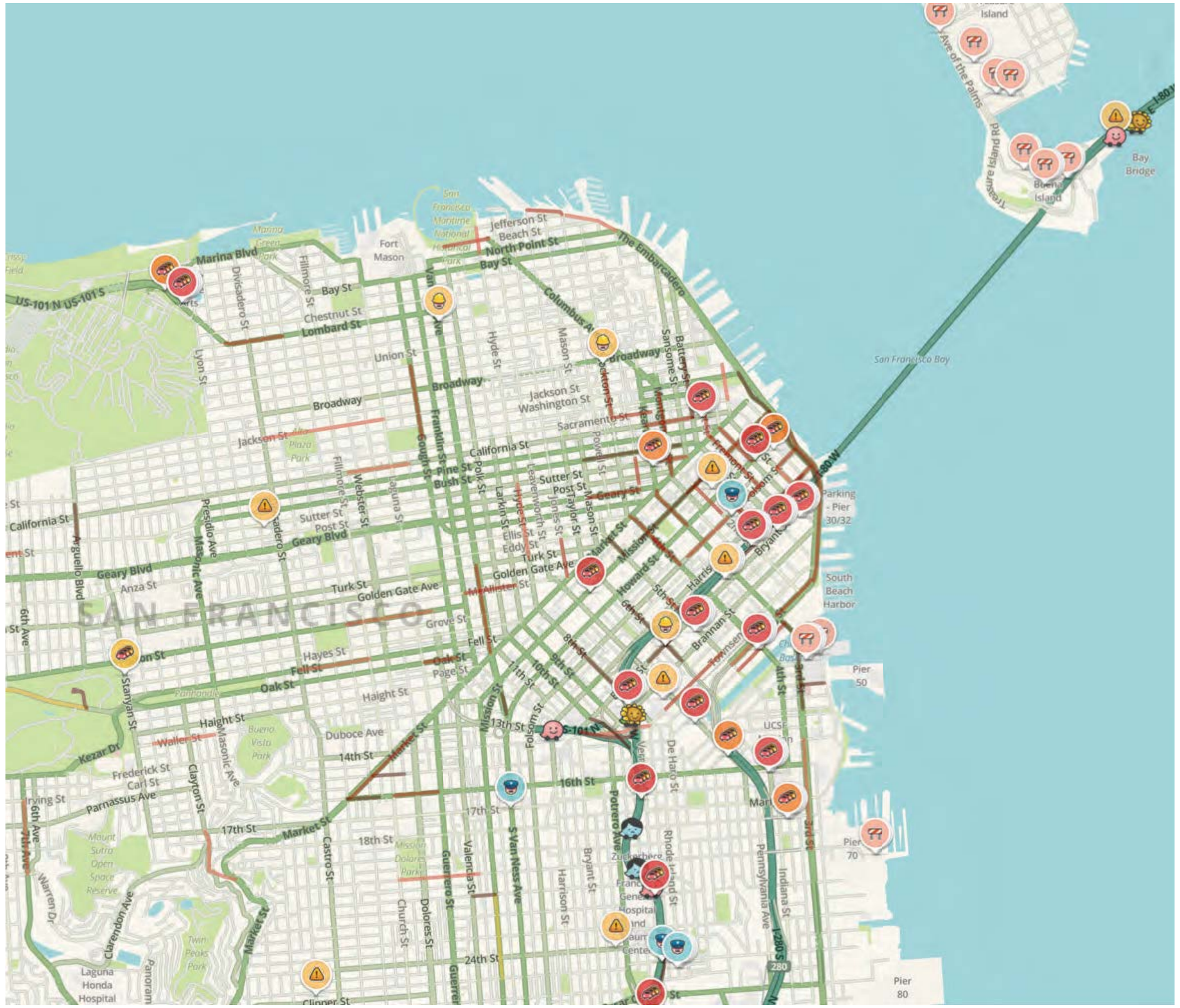
Amazon et al. maintain digital twins of millions of customers as well as digital twins of their business operations.

Amazon has digital twins of your individual package and digital twins of types of packages and their failures.



Self-driving cars maintain digital twins of both their operations and their environment.

Cruise control twin



Waze traffic twin

Digital twins can both empower individuals and can manage entire populations, too.

Blood glucose twin

Patient population health twin

Organizations build digital twins of their operations and the environment.

Individual solo twin

Entire supply chain twin

Imagine building digital twins of every individual and the whole earth—and every system in between.

What Does This Mean for Design?

"… a building cannot be viewed simply in isolation.
It is only meaningful as a human environment.
It perpetually interacts with its inhabitants,
on the one hand serving them
and on the other hand controlling their behavior.

In other words structures make sense
as parts of larger systems that include human components
and the architect is primarily concerned
with these larger systems;
they (not just the bricks and mortar part)
are what architects design."

— **Gordon Pask**, *The Architectural Relevance of Cybernetics*, 1967

“In most people’s vocabularies, design means veneer. It’s interior decorating. It’s the fabric of the curtains and the sofa. But to me, nothing could be further from the meaning of design. Design is the fundamental soul of a man-made creation that ends up expressing itself in successive outer layers of the product or service.”

— **Steve Jobs,** *Fortune,* January 24, 2000

A matrix of design: the six types
Jay Doblin, 1987

Tangible objects and messages	Sets of coordinated products and the people who operate them	Competing unisystems
Appearance Products Christmas ornaments Medals Trophies	**Appearance Unisystems** Restaurant environment South Street Seaport Disneyland	**Appearance Multisystems** The fashion industry
Performance Products Crowbars Paper clips	**Performance Unisystems** Compact kitchen NASA space mission United Airlines	**Performance Multisystems** The airline industry The computer industry

From “A Short, Grandiose Theory of Design,” STA Design Journal

Era analysis: evolution of design
Joi Ito, 2017

Objects (physical and immaterial)	**Systems**	**Complex Adaptive Systems**

*"Design has also evolved
from the design of objects
both physical and immaterial,
to the design of systems,
to the design of complex adaptive systems.*

*This evolution is shifting the role of designers;
they are no longer the central planner,
but rather participants
within the systems they exist in.
This is a fundamental shift —
one that requires a new set of values."*

— **Joi Ito**, "Design and Science," January 11, 2016

John Maeda has offered a sort of era analysis.

1 **Classical Design**
There is a right way to make what is perfect, crafted, and complete.

2 **Design Thinking**
Because execution has outpaced innovation, and experience matters.

3 **Computational Design**
Design for billions of individual people and in real time, is at scale and TBD.

—Design in Tech Report, 2018

Stephen Anderson says, "The future of design is complexity + computation."

Design 1.0
Product

Design 2.0
Experience

Design 3.0
Outcomes

—https://medium.com/@stephenanderson/the-future-of-design-computation-complexity-a434d2da3cd5

Richard Buchanan proposed “four orders of design.“

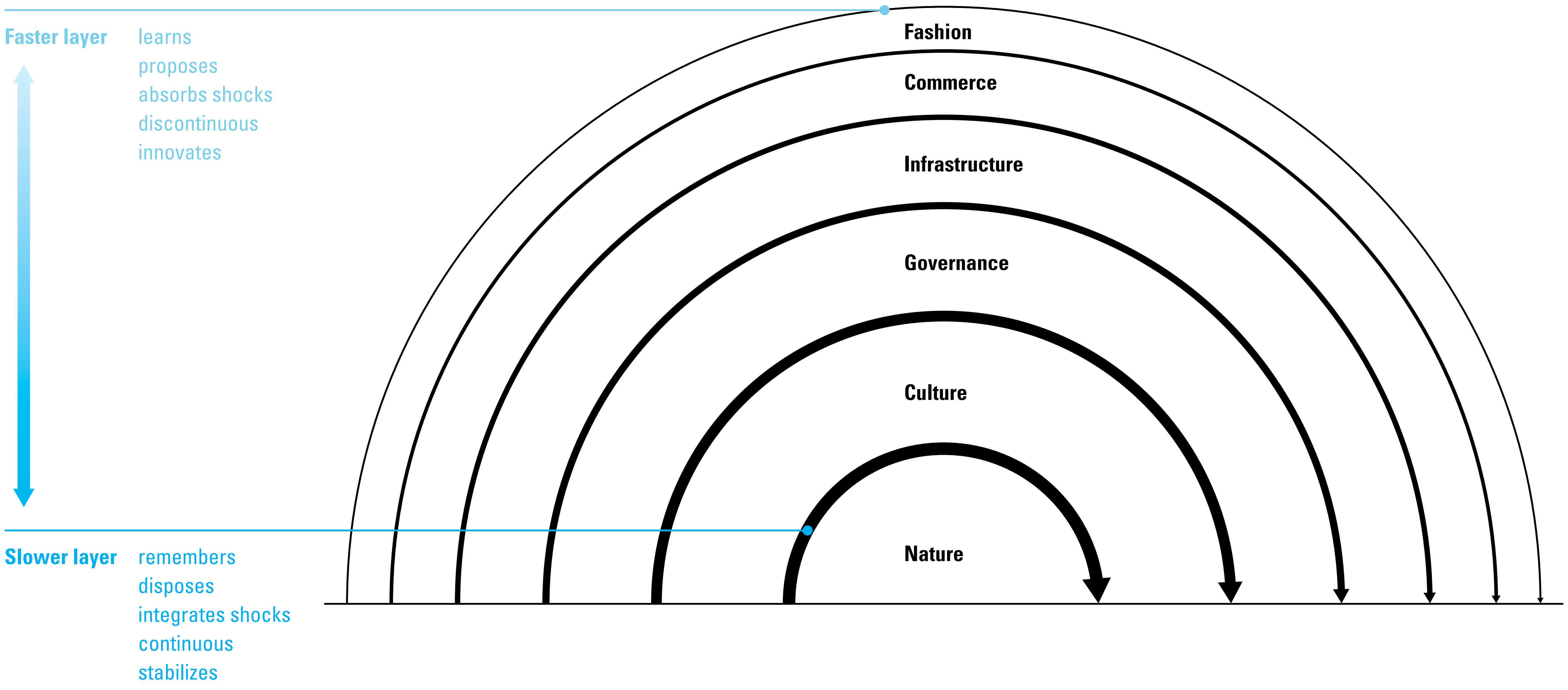
1 **Communications —**
a focus on meaning and symbols

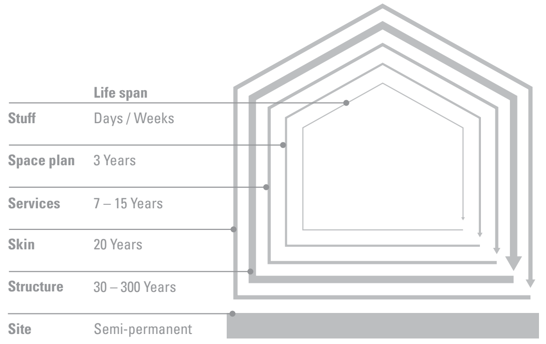
2 **Artifacts —**
a focus on form and things

3 **Interactions —**
a focus on behavior and action

4 **Fourth order —**
a focus on “environments and systems in which all other orders exist“

Stewart Brand has proposed “a pace layer model.“



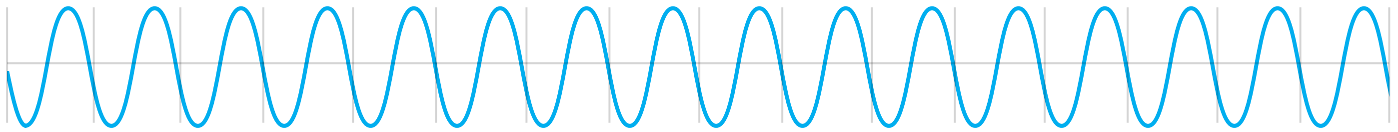


Pace layers in product management Jorge Arango, 2018

Faster
More Volatile

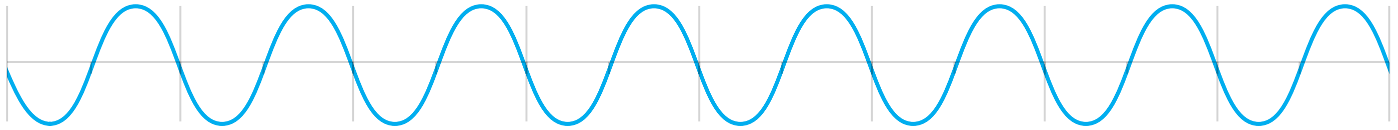
Form

User interfaces through which people interact with products and services—where structure is articulated...



Structure

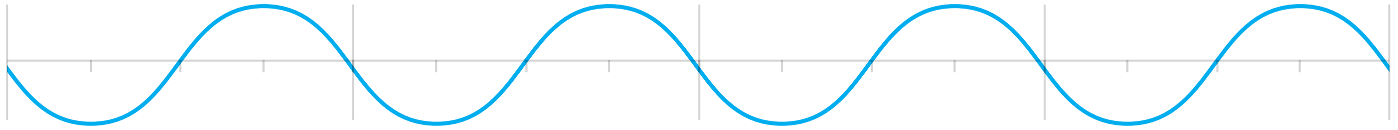
The relationships between particular semantic elements that will inform end products and services.



Designers tend to operate in these layers

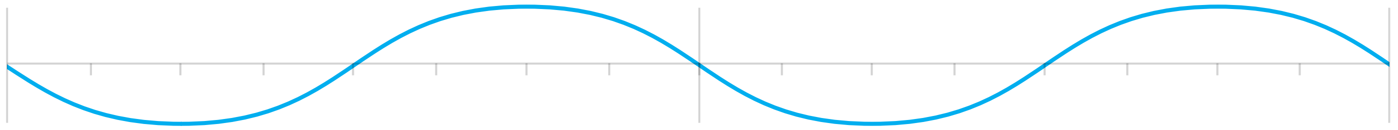
Governance

How the organization shapes itself to implement its strategy. The rules and means of engagement...



Strategy

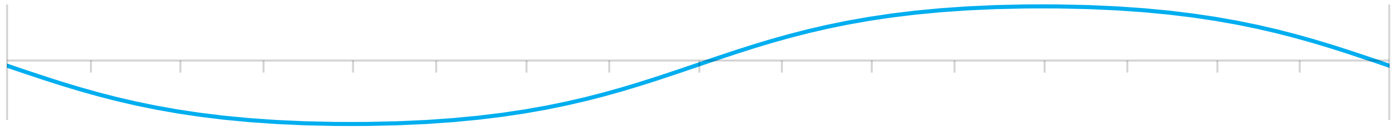
How the organization aspires to do things differently to strive towards its purpose; how it's going to compete.



Slower
More Stable

Purpose

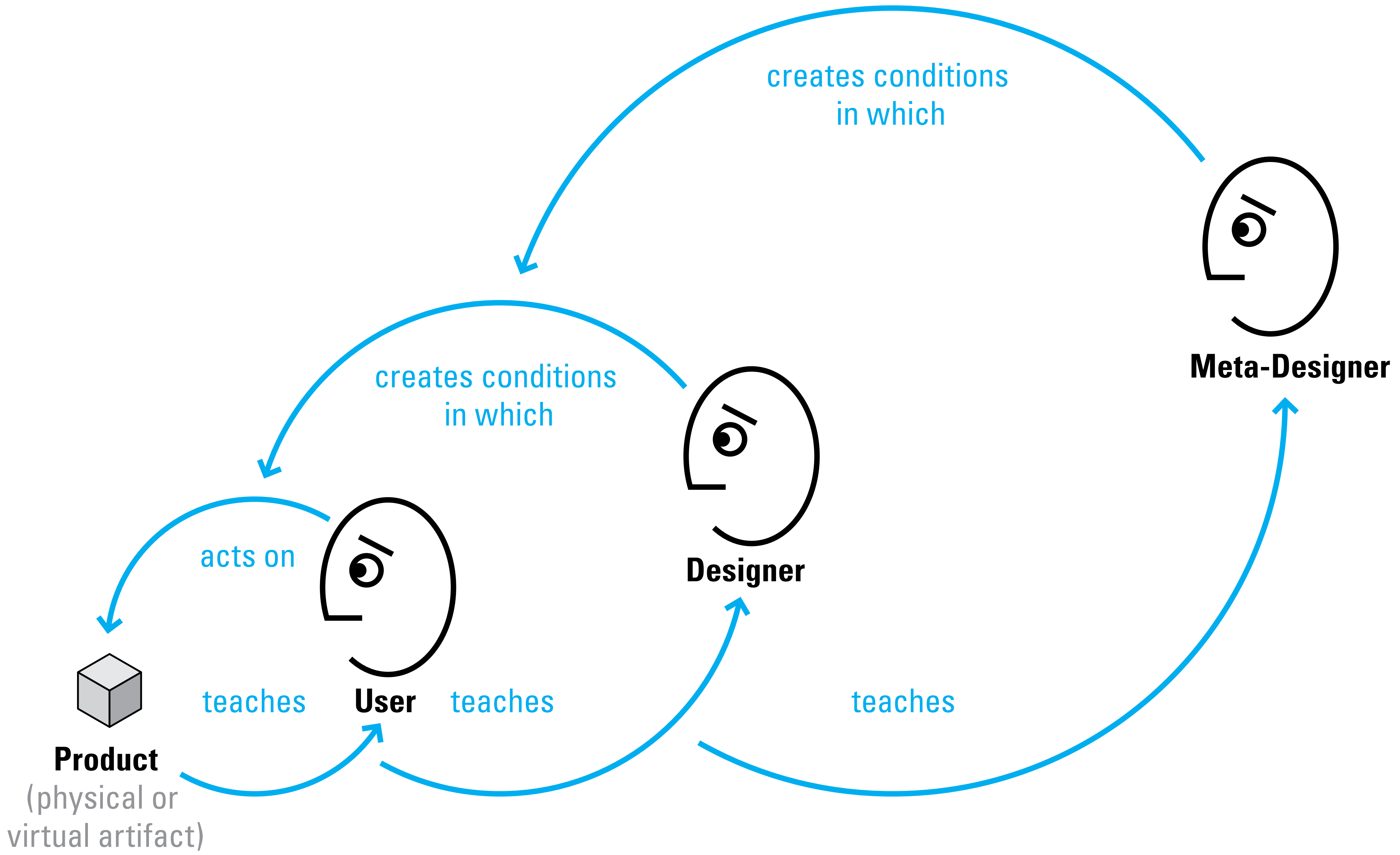
Why the organization, team, or product exists.
An aspiration, not a goal since it can never be achieved...



Designing with data and systems—moving...

	from:	to:
Values	**Seek simplicity**	**Embrace complexity**
Designer’s role	**Expert/Deciding**	**Collaborator/Facilitating**
Construction	**Direct**	**Mediated**
Stopping condition	**Almost perfect**	**Good enough for now**
Result	**More deterministic**	**Less predictable**
End state	**Completed**	**Adapting, growing**

Meta design: Creating conditions for systems to grow, learn, and thrive—and for the conversations that make that possible.



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Hugh Dubberly
Dubberly Design Office

Presentation posted at
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