Optimizing Teams in a Distributed World

Conway's three other laws

Mike Amundsen
CA Technologies
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Introduction


Ctrl
PgUp
Mike Amundsen
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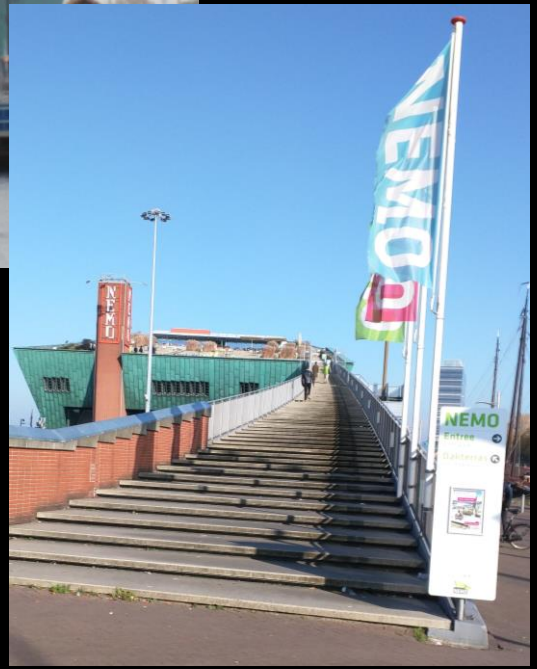
RETURN TO HOMEPAGE

API ACADEMY SERVICES

The API Academy team consists of industry experts who have been brought together by CA Technologies to provide expert consulting services for organizations that want to take their API programs to the next level.

Contact us to find out more about how we can help you understand the API economy, plan a program strategy, architect effective interfaces, build a secure, manageable API infrastructure and empower your developers to create truly valuable client apps.

Email: apiacademy@ca.com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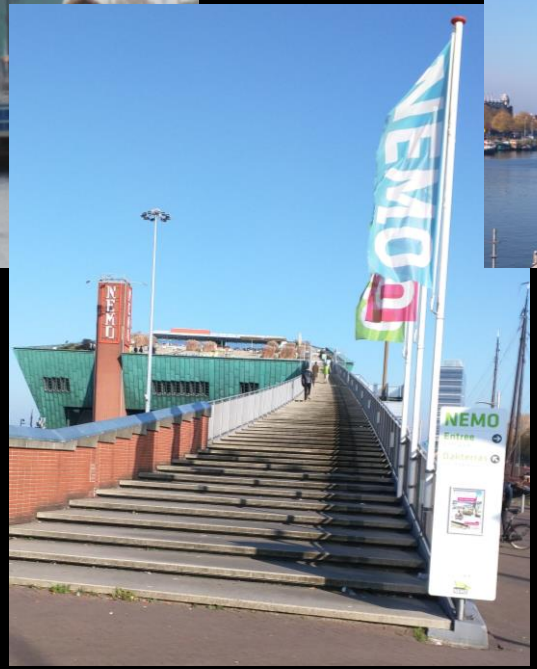
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VMA

Effective Teams

“Organizational metrics can predict software failure-proneness with a precision and recall of 85%”

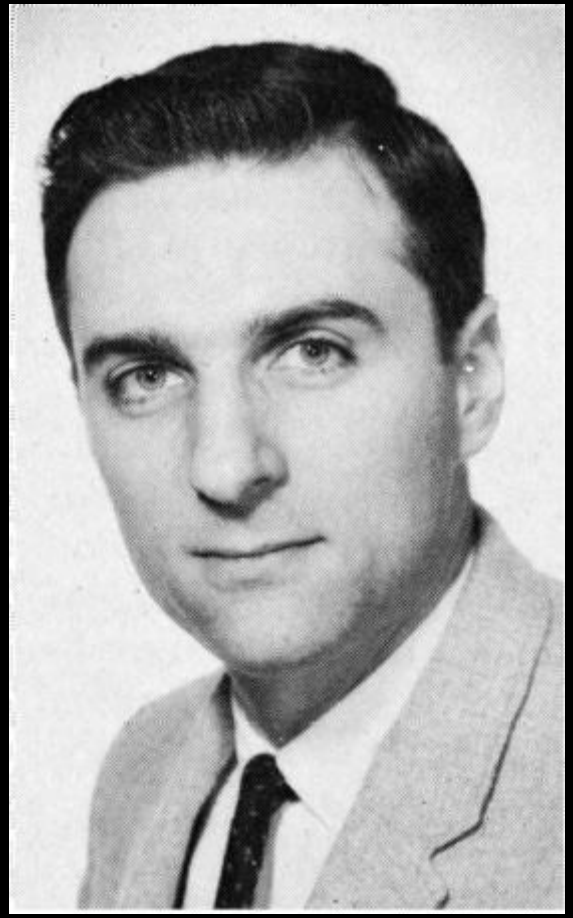
-- Nachi Nagappan, MS Research (2009)

Effective Teams for Microservices

“[Microservices] allow organizations [to align] the architecture of their systems to the structure of their teams.”

-- Sam Newman, “Demystifying Conway’s Law” (2015)

Mel Conway



Mel Conway

- Burroughs assembler (SAVE) 1950s
- UNCOL (universal compiler language) 1958
- First paper on Coroutines 1963
- “How Do Committees Invent”? (1967)
- MUMPS medical computing (1970s)
- Pascal for Mac & Apple II (1980s)
- #HumanizeTheCraft Project (2010s)

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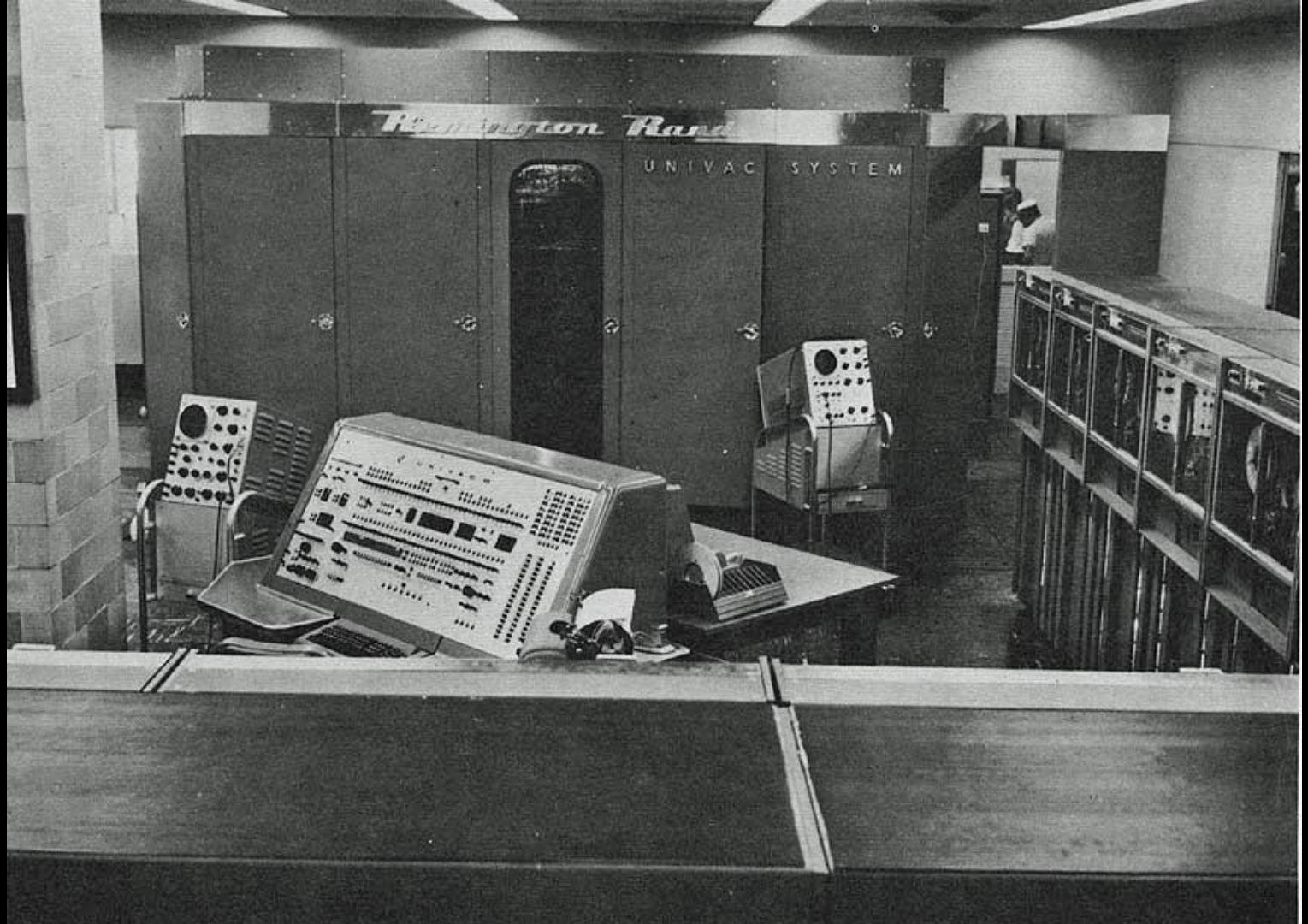
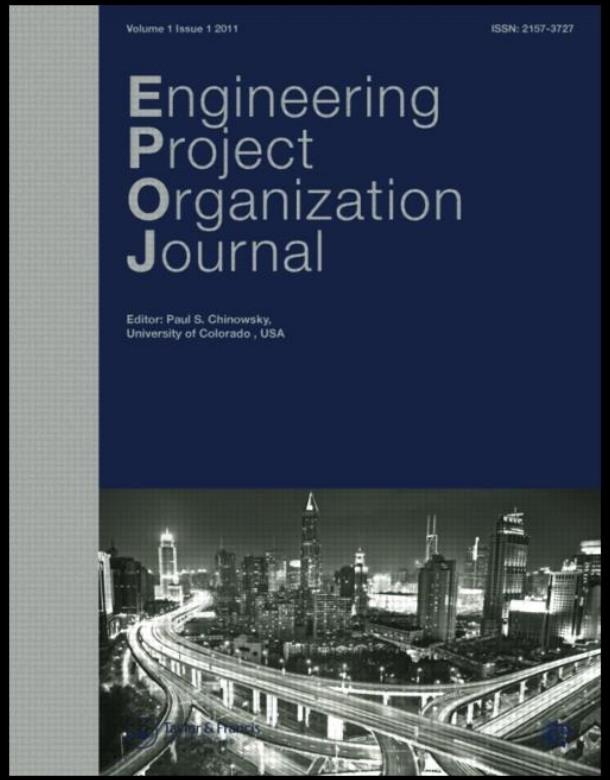

Remington Rand
UNIVAC SYSTEM

Project-Based Organizations



“Project-based organizations revolve around the concept that a group of individuals or firms join together with the explicit purpose of producing a tangible set of outputs”

-- Paul Chinowsky, EPOJ 2011

HOW DO COMMITTEES INVENT?

by MELVIN E. CONWAY

That kind of intellectual activity which creates a useful whole from its diverse parts may be called the *design* of a *system*. Whether the particular activity is the creation of specifications for a major weapon system, the formation of a recommendation to meet a social challenge, or the programming of a computer, the general activity is largely the same.

Typically, the objective of a design organization is the creation and assembly of a document containing a coherently structured body of information. We may name this information the *system design*. It is typically produced for a sponsor who usually desires to carry out some activity guided by the system design. For example, a public official may wish to propose legislation to avert a recurrence of a recent disaster, so he appoints a team to explain the catastrophe. Or a manufacturer needs a new product and designates a product planning activity to specify what should be introduced.

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It seems reasonable to suppose that the knowledge that one will have to carry out one's own recommendations or that this task will fall to others, probably affects some design choices which the individual designer is called upon to make. Most design activity requires continually making choices. Many of these choices may be more than design decisions; they may also be personal decisions the designer makes about his own future. As we shall see later, the incentives which exist in a conventional management environment can motivate choices which subvert the intent of the sponsor.[1]

stages of design

The initial stages of a design effort are concerned more with structuring of the design activity than with the system itself.[2] The full-blown design activity cannot proceed until certain preliminary milestones are passed. These include:

1. Understanding of the boundaries, both on the design activity and on the system to be designed, placed by the sponsor and by the world's realities.
2. Achievement of a preliminary notion of the system's organization so that design task groups can be meaningfully assigned.

We shall see in detail later that the very act of organizing a design team means that certain design decisions have already been made, explicitly or otherwise. Given any design team organization, there is a class of design alternatives which cannot be effectively pursued by such an organization because the necessary communication paths do not exist. Therefore, there is no such thing as a design group which is both organized and unbiased.

Once the organization of the design team is chosen, it is possible to delegate activities to the subgroups of the organization. Every time a delegation is made and somebody's scope of inquiry is narrowed, the class of design alternatives which can be effectively pursued is also narrowed.

Once scopes of activity are defined, a coordination problem is created. Coordination among task groups, although it appears to lower the productivity of the individual in the small group, provides the only possibility that the separate task groups will be able to consolidate their efforts into a unified system design.

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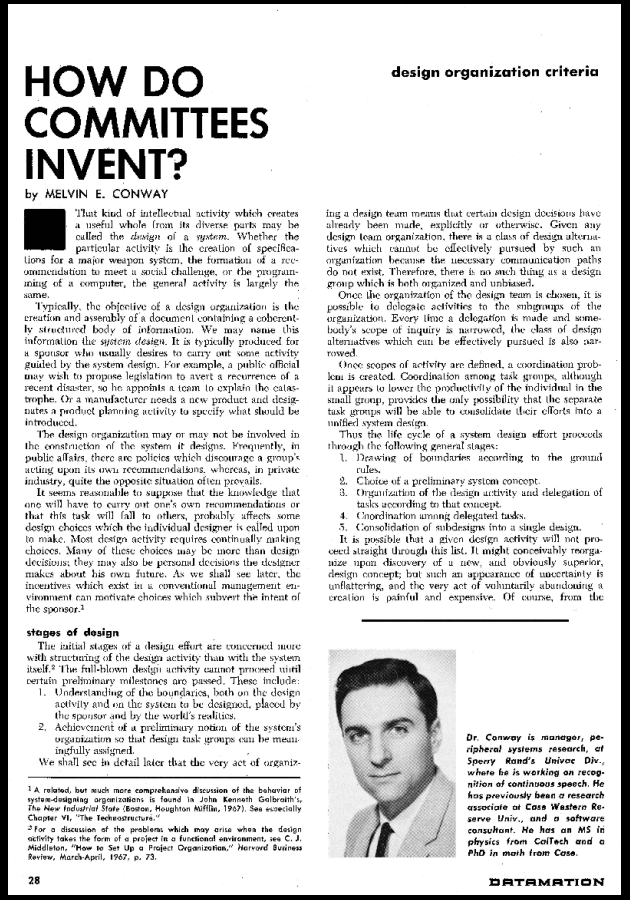

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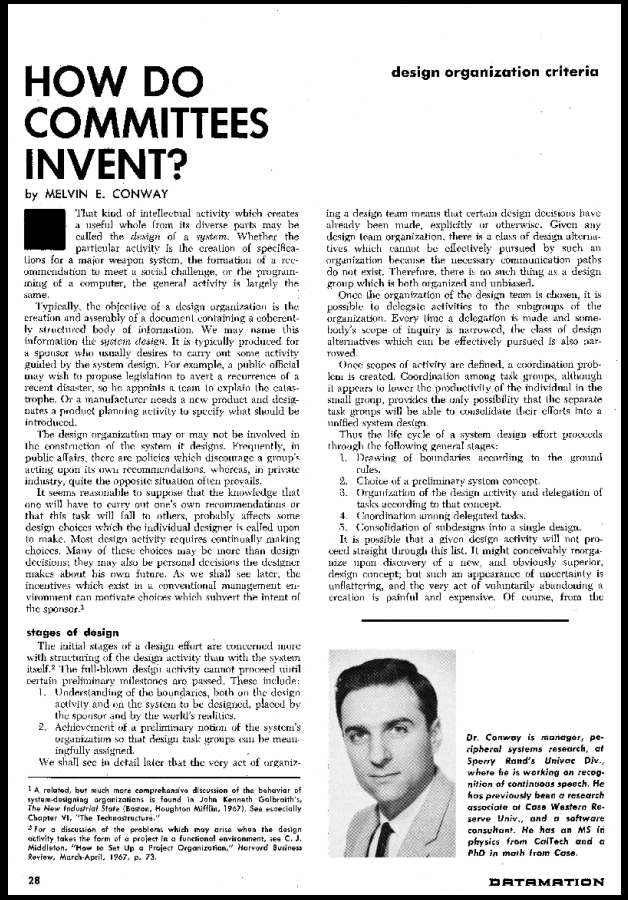
“Any organization that designs a system (defined more broadly here than just information systems) will inevitably produce a design whose structure is a copy of the organization's communication structure.”

-- Mel Conway, 1967



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Communication dictates design.

-- Mel Conway, 1967

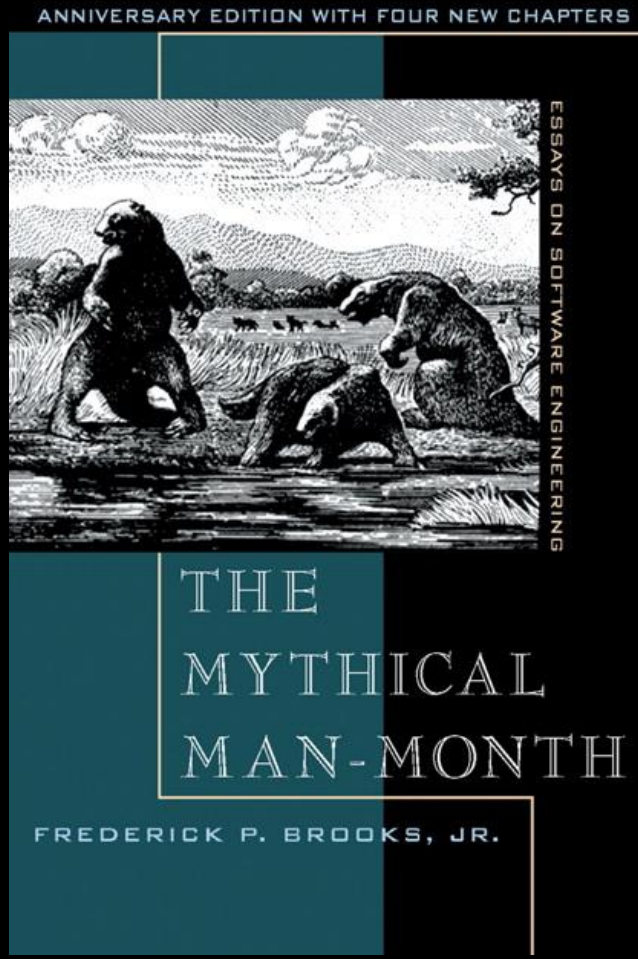
Conway's Law

ANNIVERSARY EDITION WITH FOUR NEW CHAPTERS

ESSAYS ON SOFTWARE ENGINEERING

THE MYTHICAL MAN-MONTH

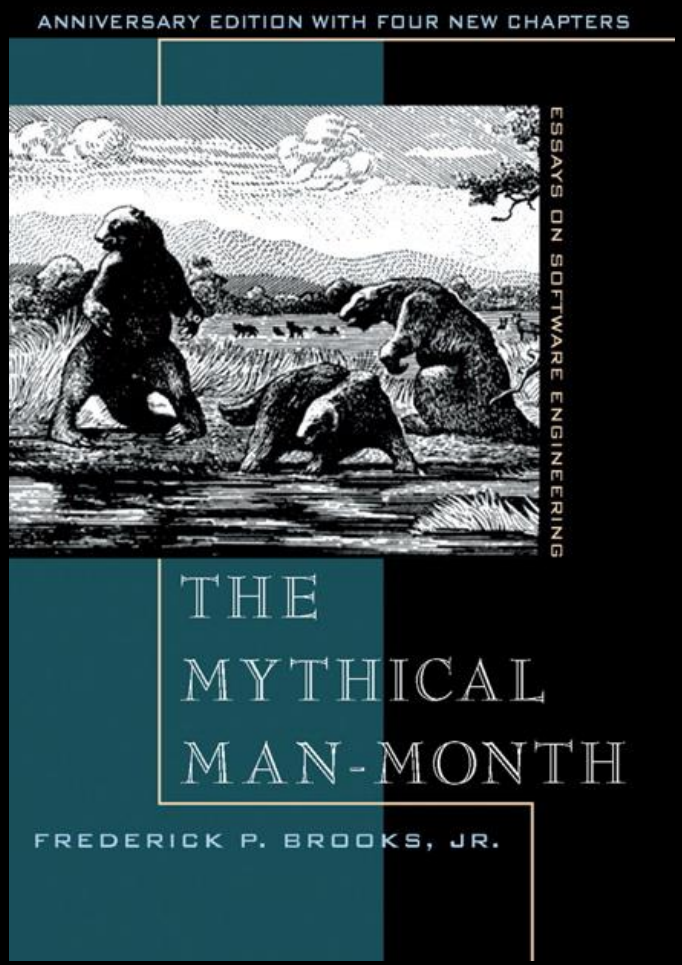
FREDERICK P. BROOKS, JR.



Brooks' Law

"*Adding manpower to a late software project makes it later*."

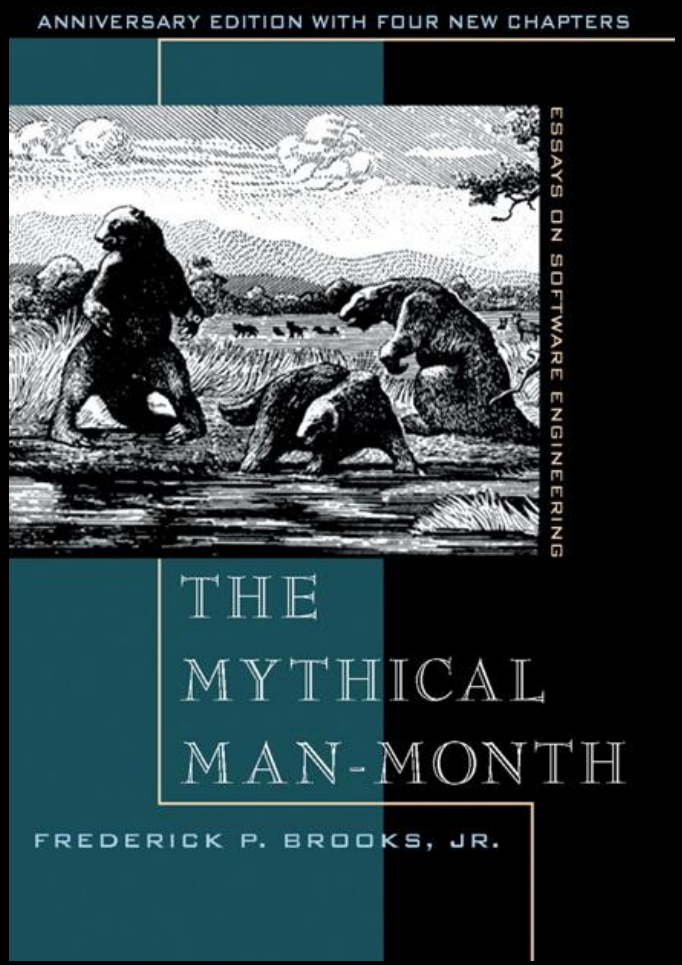
-- Fred Brooks, 1975



Intercommunication formula

$$n(n - 1) / 2$$

-- Fred Brooks, 1975



Intercommunication formula

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5*(5–1)/2 = 10
15*(15–1)/2 = 105
50*(50–1)/2 = 1,225
150*(150–1)/2 = 11,175
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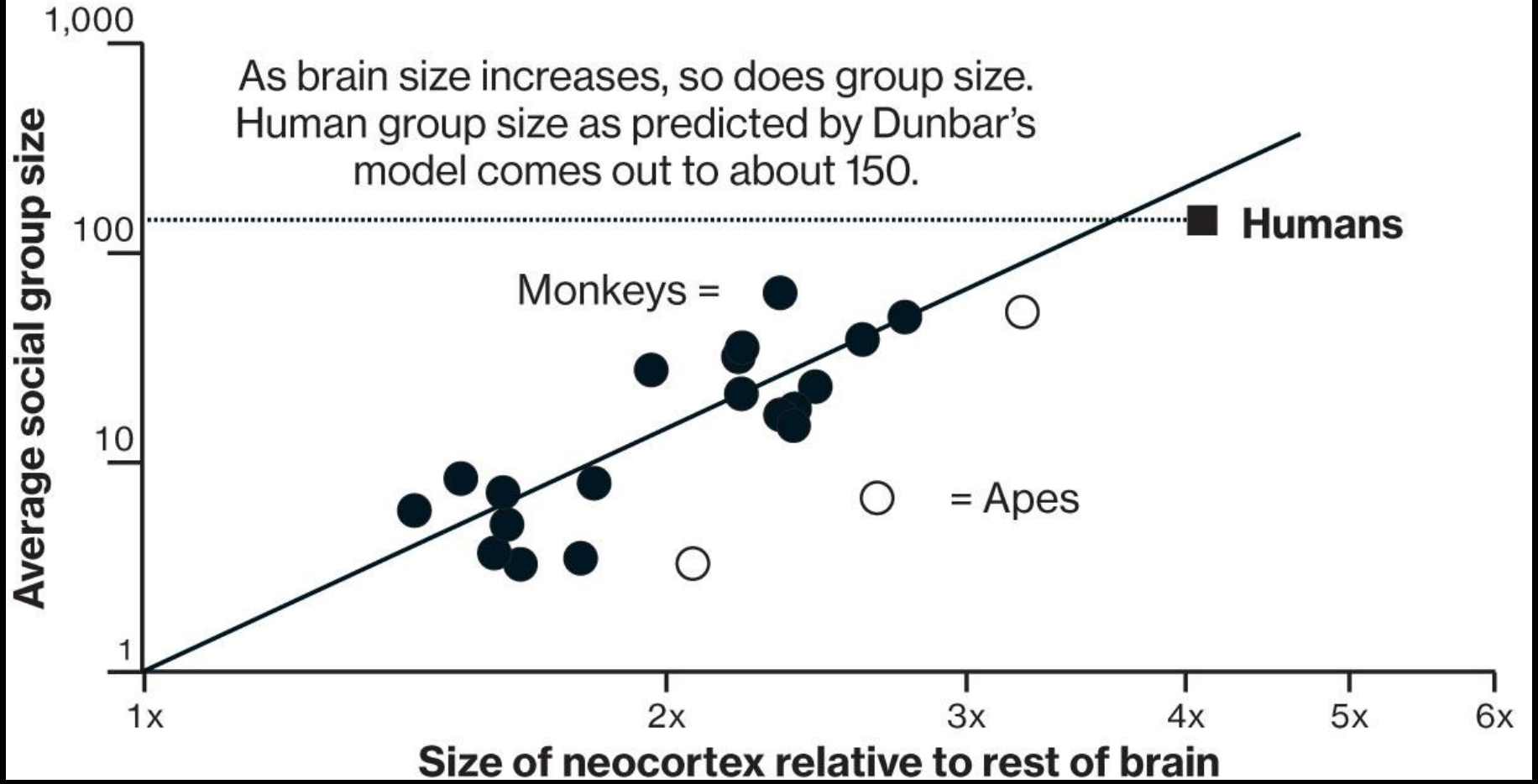
-- Fred Brooks, 1975

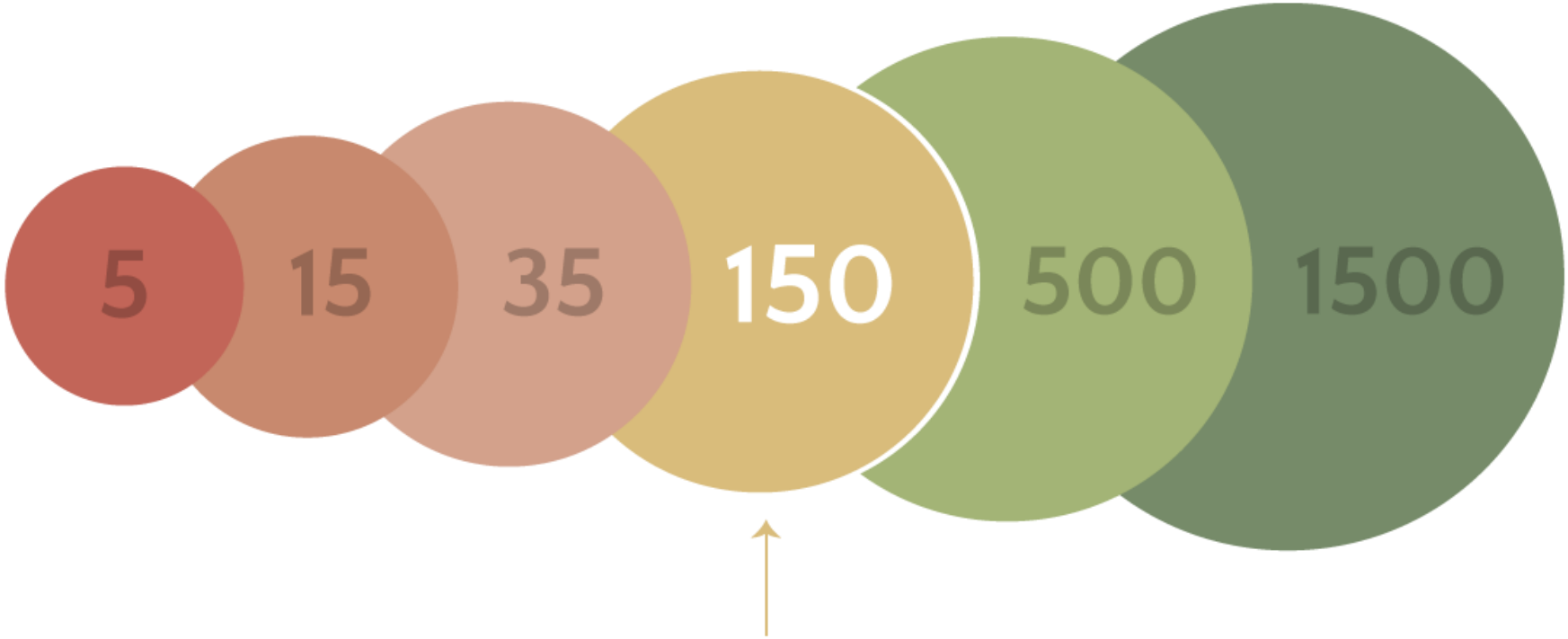
Dunbar's Number

A measurement of the "cognitive limit to the number of individuals with whom any one person can maintain stable relationships."

-- Robin Dunbar, 1992

The Social Cortex





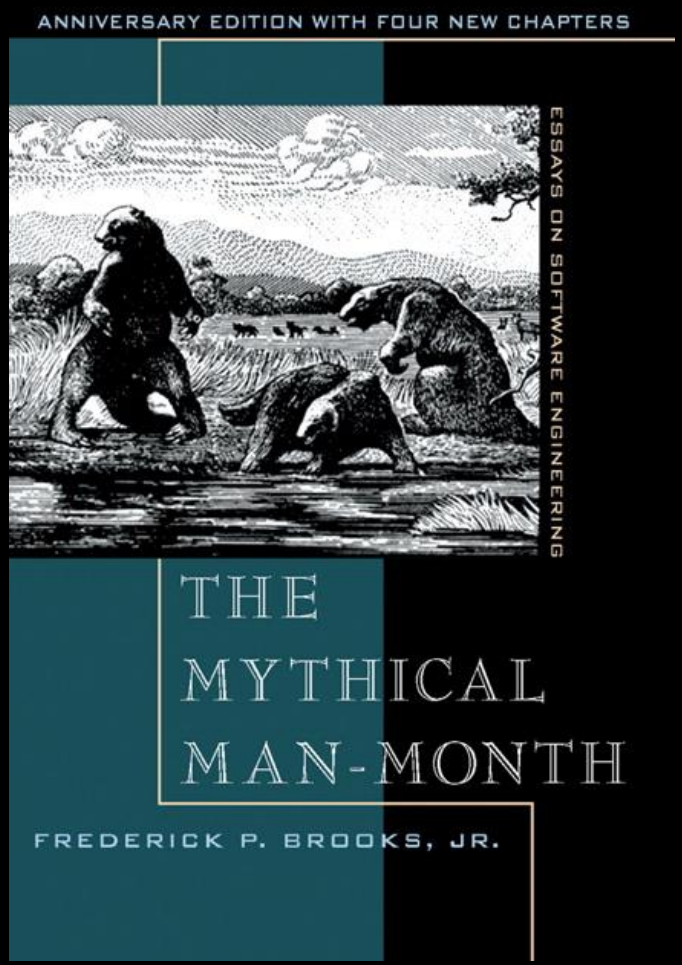
Dunbar's Number

the max number of relationships a person can maintain

Dunbar Groups

Intimate friends: 5
Trusted friends: 15
Close friends: 35
Casual friends: 150

-- Robin Dunbar, 1992



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Conway's (first) Law

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tells us TEAM SIZE is important

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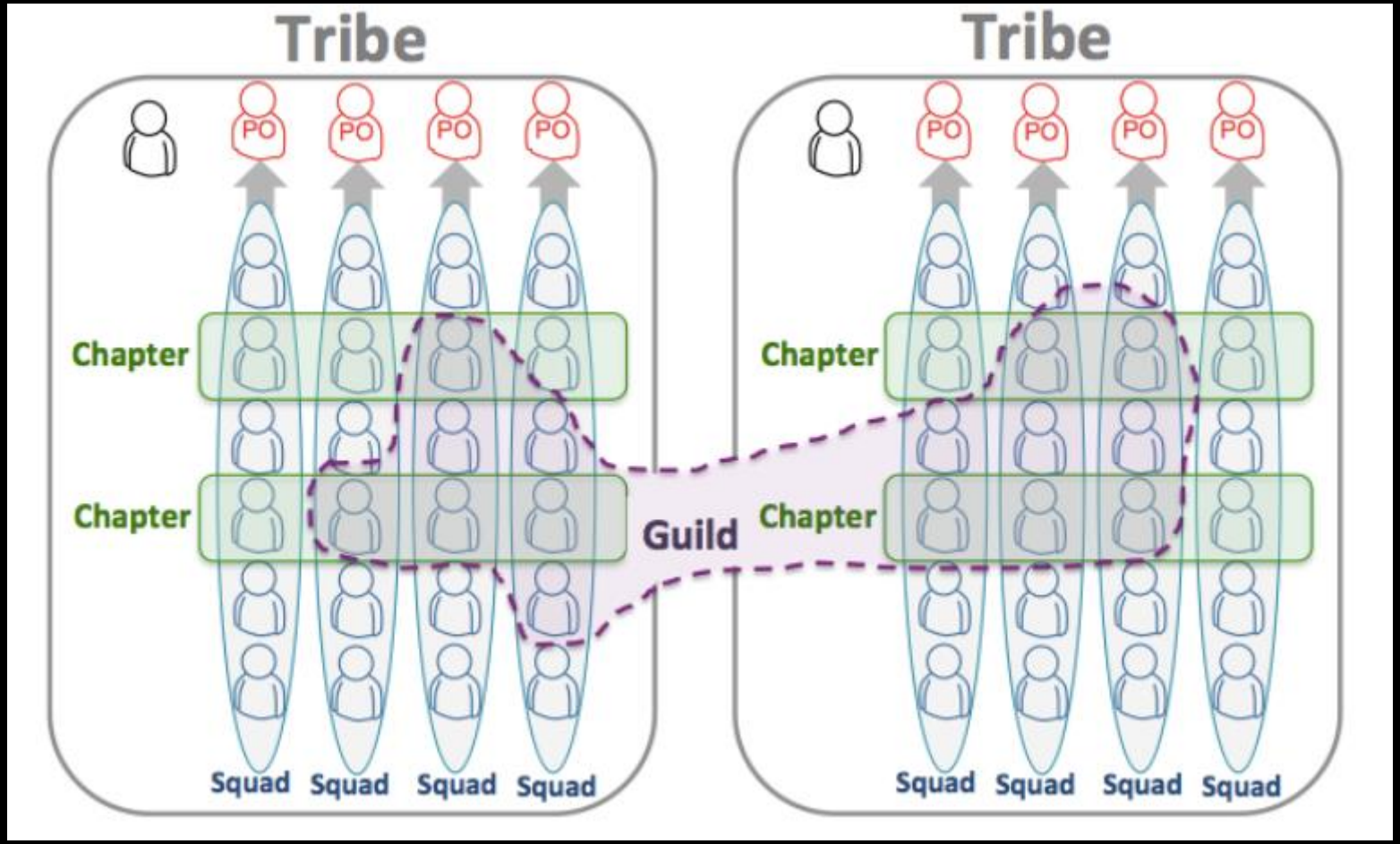
so…
Make the teams as small as necessary.



“Scaling Spotify”, Kniberg & Ivarrson (2012)

https://dl.dropboxusercontent.com/u/1018963/Articles/SpotifyScaling.pdf

ASSESSMENT:

If you don't have
a personal relationship
with every member of your TEAM,
your team is probably TOO BIG.

GUIDANCE:

Aim for TEAM SIZE
of “Dunbar level 1” (5),
possibly “Dunbar level 2” (15).

So… what about other Conway Laws?

Conway's Second Law

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Doing it Over

"There is never enough time to do something right, but there is always enough time to do it over."

-- Mel Conway, 1967

Trade Offs

Efficiency-Thoroughness Trade Offs (ETTOs)

The ETTO Principle:

Efficiency-Thoroughness Trade-Off

Why Things That Go Right Sometimes Go Wrong

ERIK HOLLNAGEL

Satisficing v. Sacrificing

*"**Satisficing** is explained as a consequence of limited cognitive capacity.*

***Sacrificing** is explained as a consequence of the intractability of the work environment"*

-- Eric Hollnagel, 2009

Satisficing v. Sacrificing

Problem too complicated?
Ignore details.

Not enough resources?
Give up features.

-- Eric Hollnagel, 2009

ETTOs are “normal” and result in success more often than failure.

Two interpretations of safety

Region Syddanmark

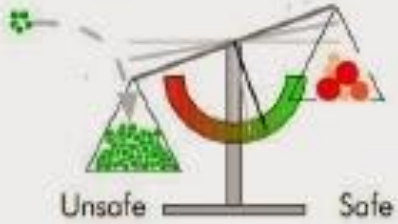
Safety-I

Safety means that the number of things that go wrong (accidents / incidents / near misses) is as low as possible.

Safety can be achieved by first finding and then eliminating or weakening the causes of adverse outcomes.

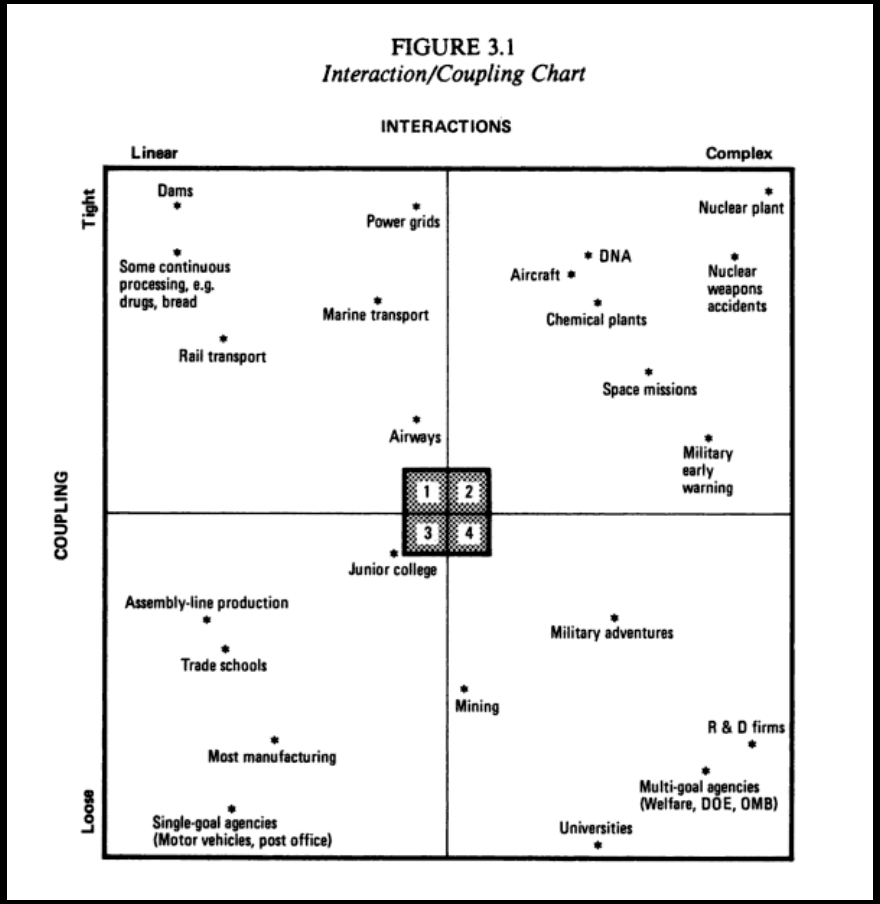
Safety-II Resilience

Safety means that the number of things that go right is as high as possible. Safety is the ability to succeed under varying conditions.



Safety requires an understanding of everyday performance. Safety can be achieved by strengthening this ability.

From "Safety-I and Safety-II", Hollnagel (2014)
http://www.ashgate.com/isbn/9781472423085



From "ETTO: The Efficiency-Thoroughness Trade-Off", Hollnagel (2009)

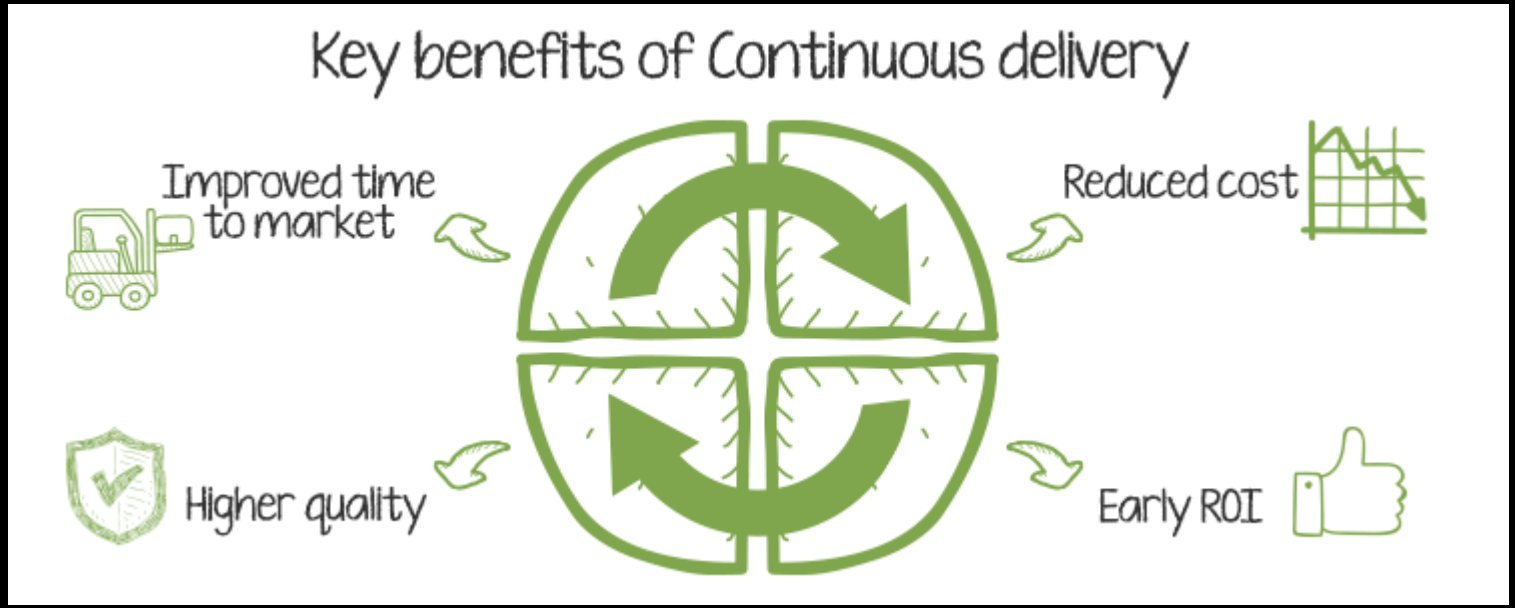
http://www.ashgate.com/isbn/9780754676782

The enemy is intractability.

Increasing Intractability

1. Systems grow too large
2. Rate of change increases
3. Overall expectations keep rising

-- Eric Hollnagel, 2009



“Continuous Delivery” Raphael Carvalho (2014)
http://slides.com/raphaelcarvalho/continuous-delivery#/9

Conway's Second Law
tells us PROBLEM SIZE is important

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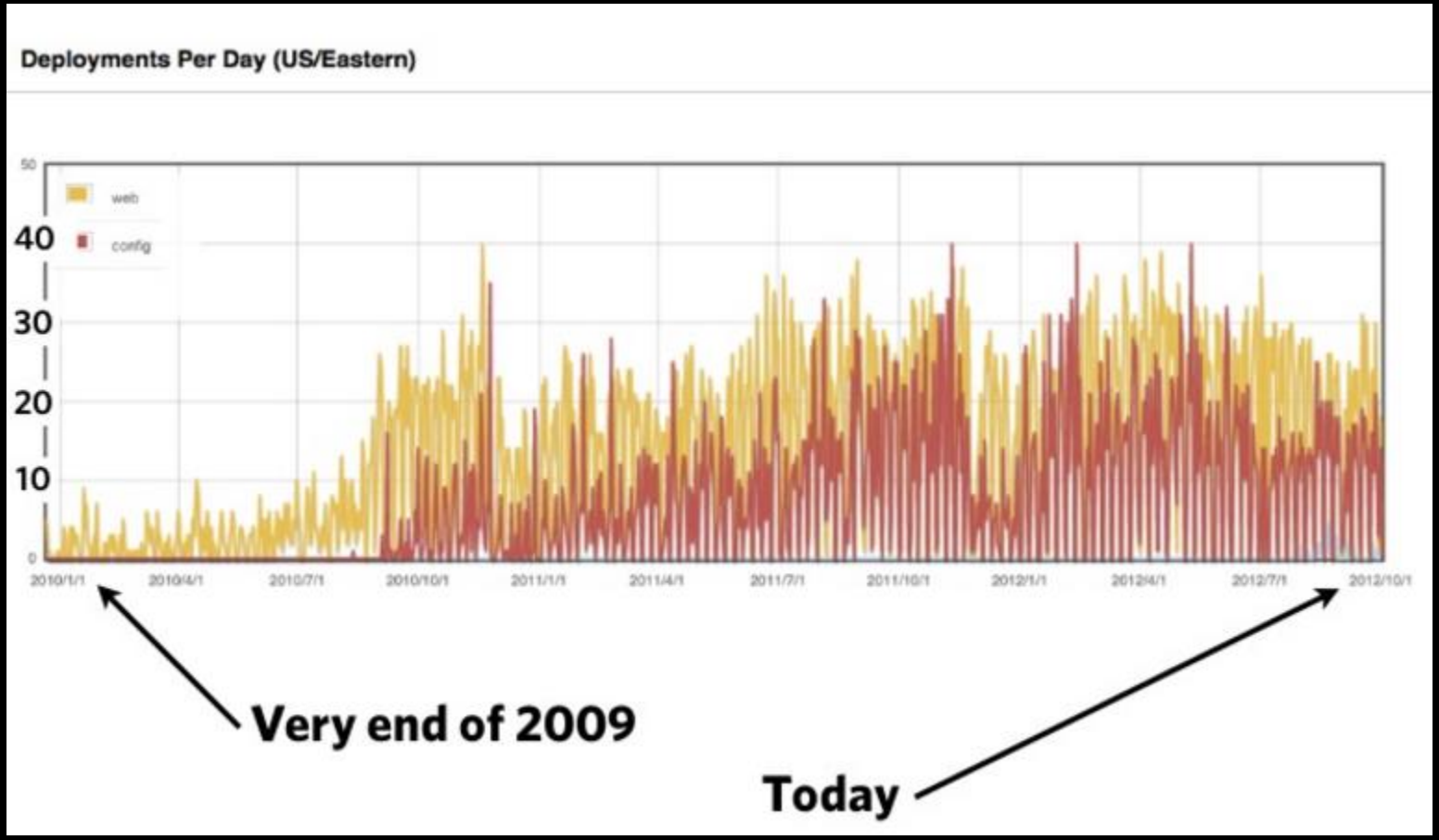
tells us PROBLEM SIZE is important

so…
Make the solution as small as necessary.



Continuous Delivery – The Dirty Details, Mike Britain, Etsy (2015)

http://www.slideshare.net/mikebrittain/continuous-delivery-the-dirty-details/8

ASSESSMENT:

If you (or your team)
cannot explain ALL the code
in your release package,
your release is TOO LARGE

GUIDANCE:

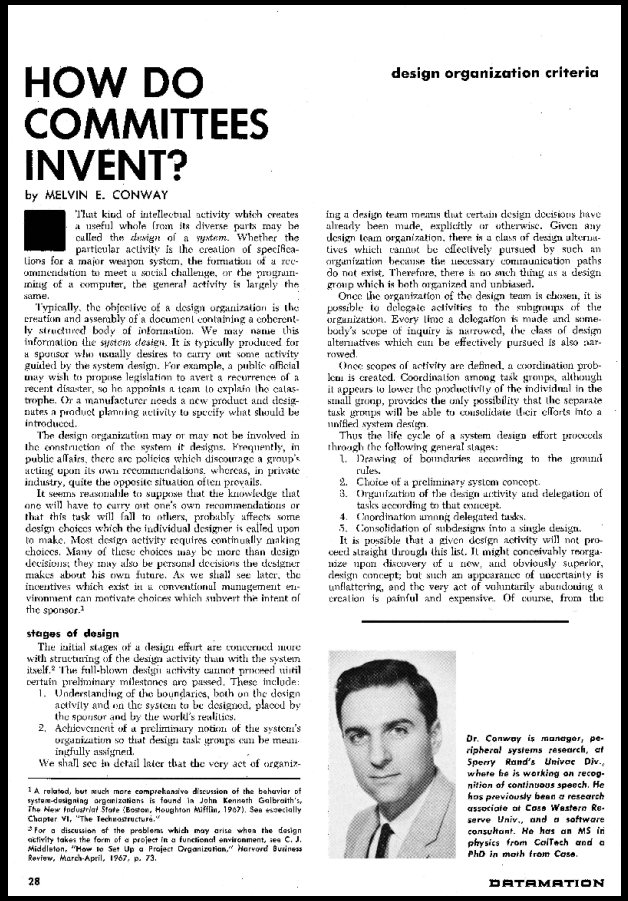
Execute many SMALL releases instead of a few LARGE releases.

Conway's Third Law

Homomorphism

"There is a homomorphism from the linear graph of a system to the linear graph of its design organization"

-- Mel Conway, 1967



HOW DO COMMITTEES INVENT?

by MELVIN E. CONWAY

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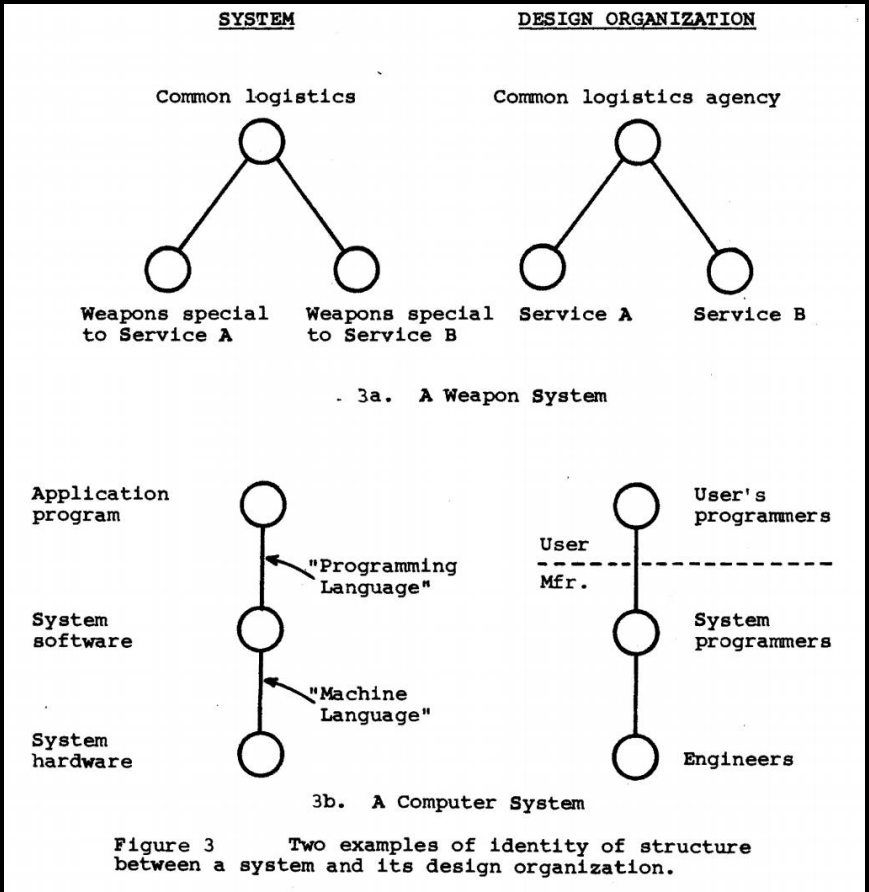
ho·mo·mor·phism

/ˌhōməˈmôrfizəm/

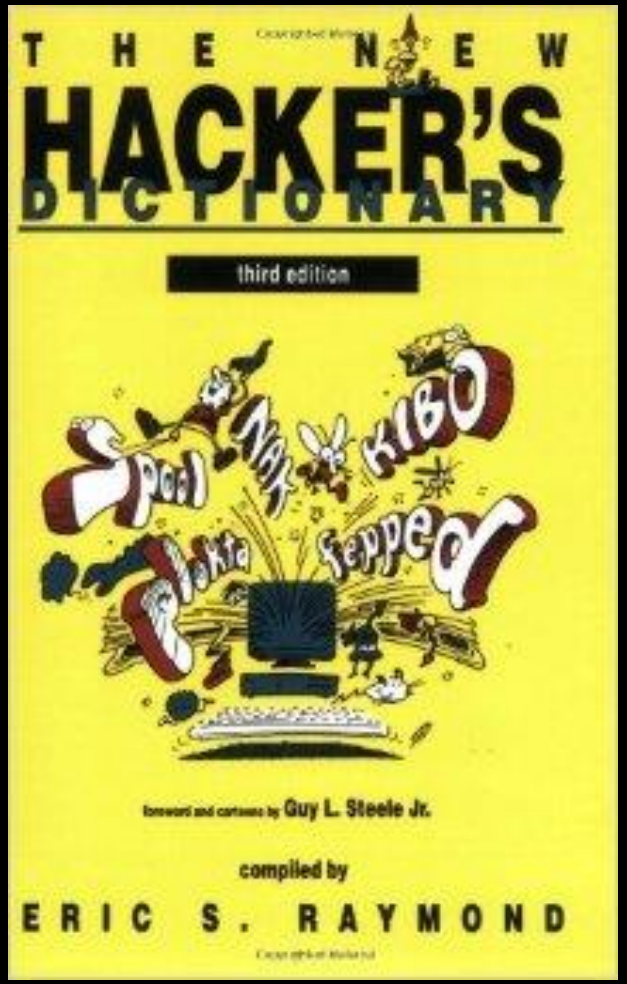
noun MATHEMATICS

a transformation of one set into another that preserves in the second set the relations between elements of the first.



“How Do Committees Invent?”, Conway (1967)

http://www.melconway.com/research/committees.html



Homomorphism

“If you have four groups working on a compiler, you'll get a 4-pass compiler.”

- Eric S. Raymond, 1991

Conway's Third Law
tells us CROSS-TEAM INDEPENDENCE
is important.

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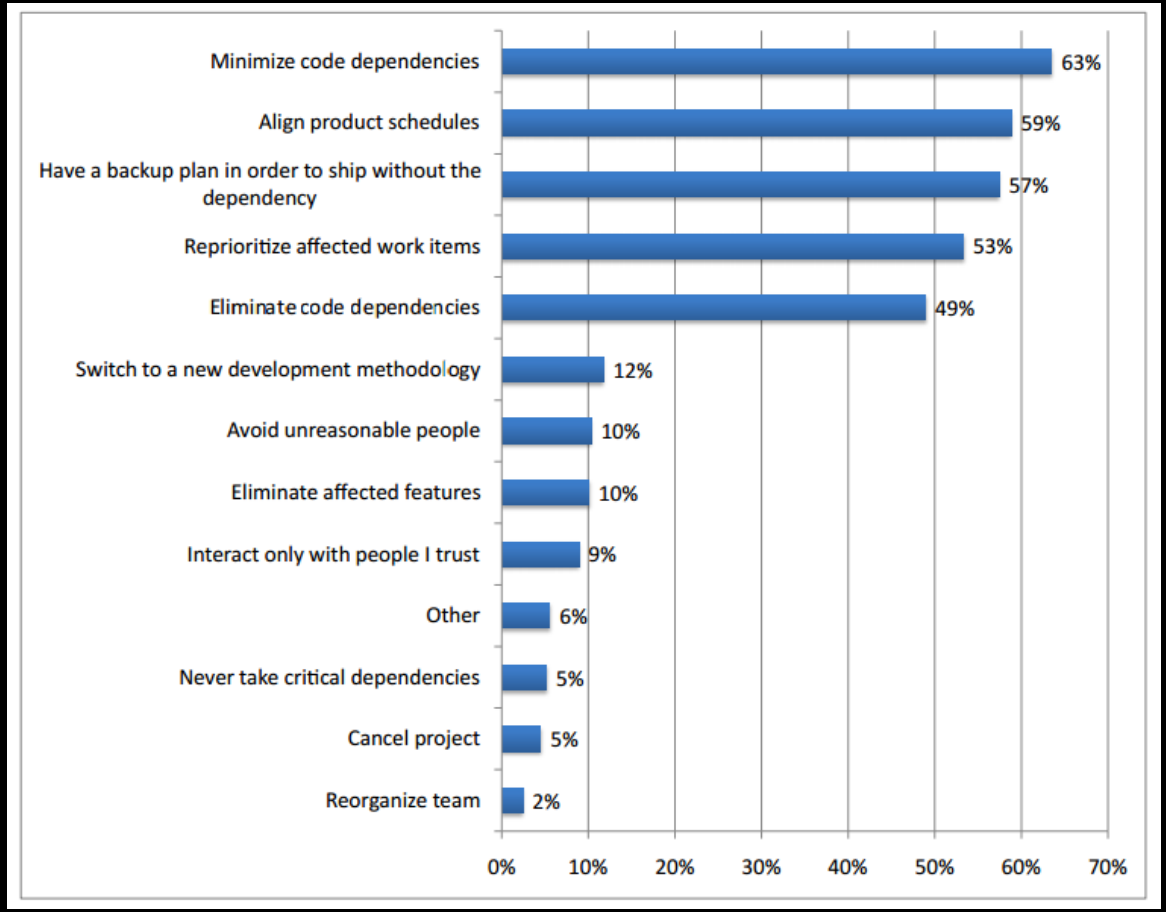
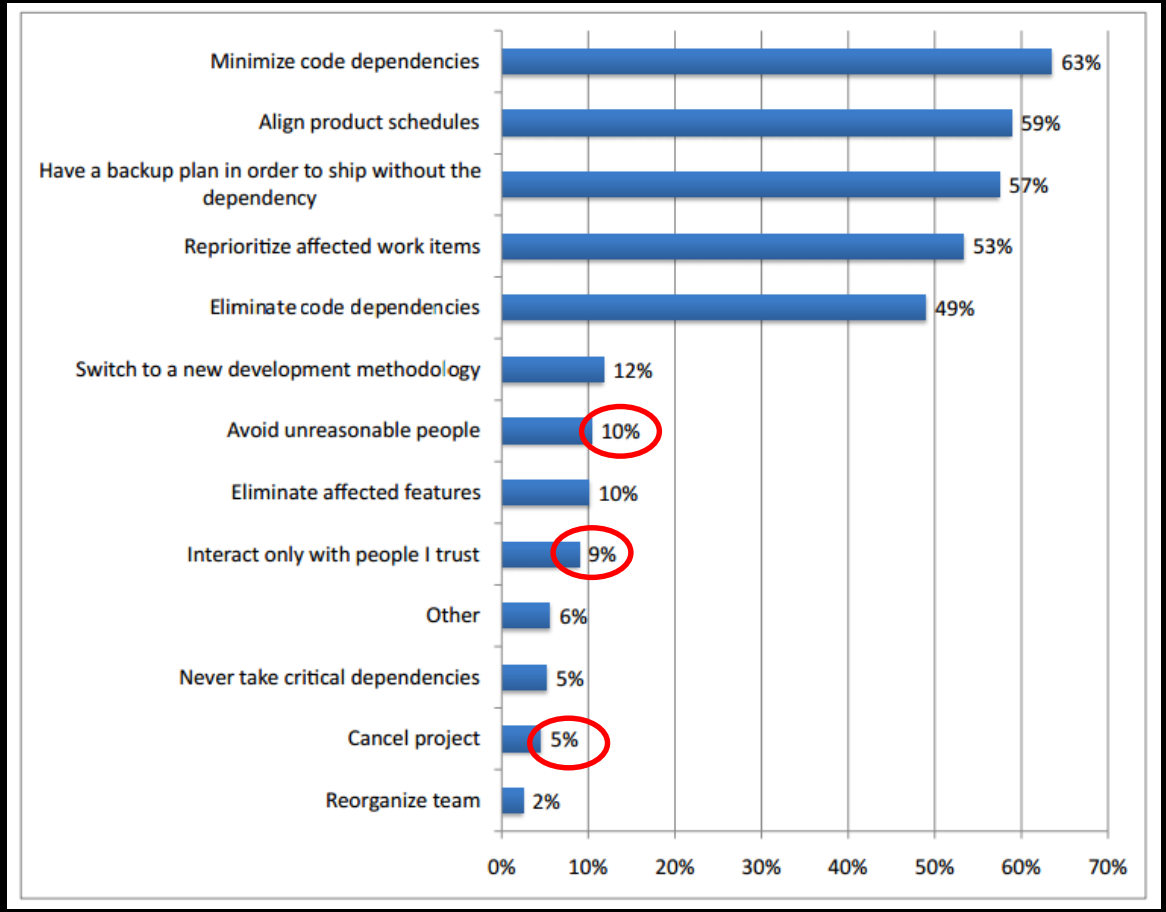
So…
Make each team fully independent.

If you have to hold a release until some other team is ready, you are not an INDEPENDENT TEAM



Coordination in Large-Scale Software Teams, Begel, et al (2007)

http://research.microsoft.com/en-us/um/people/abegel/papers/coordination-chase09.pdf



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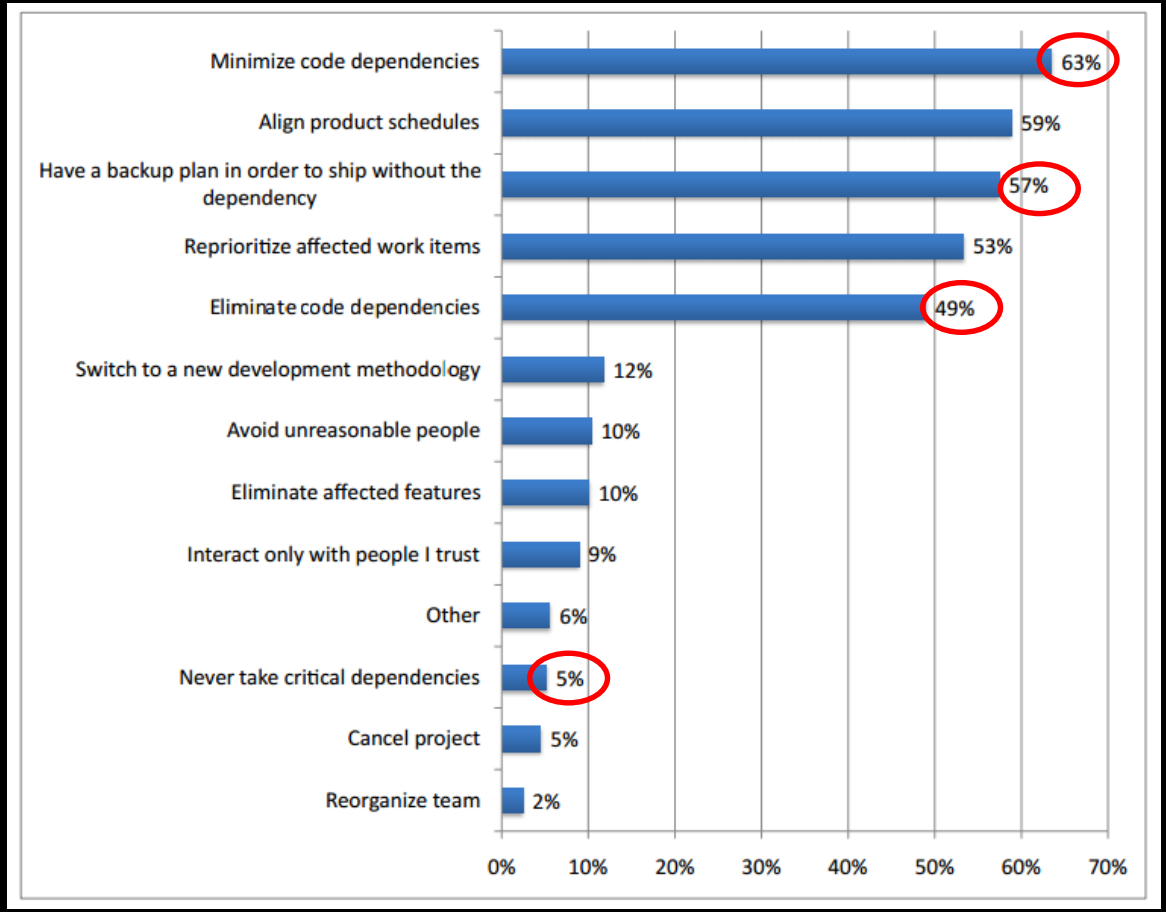

Coordination in Large-Scale Software Teams, Begel, et al (2007)

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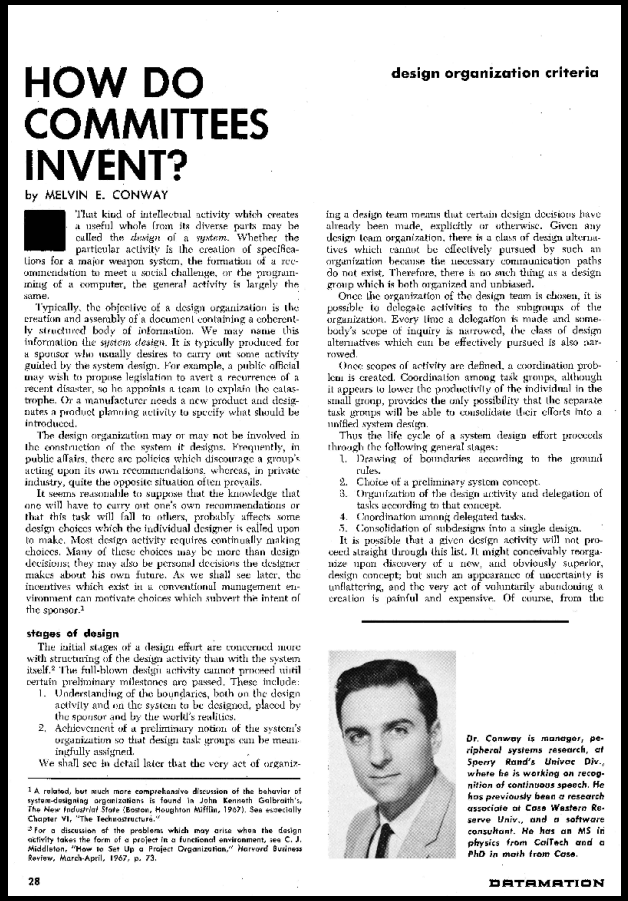
Conway's Fourth Law

Disintegration

"The structures of large systems tend to disintegrate during development, qualitatively more so than with small systems."

-- Mel Conway, 1967



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design organization criteria

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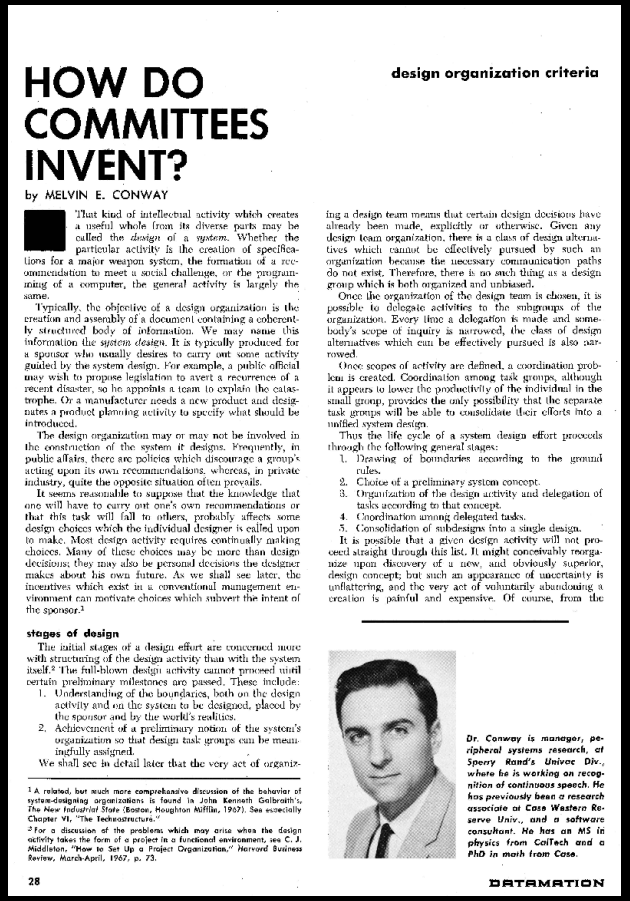
Three reasons Disintegration occurs…

Disintegration: Reason #1

“The realization that the system will be large, together with organization pressures, make irresistible the temptation to assign too many people to a design effort”

-- Mel Conway, 1967



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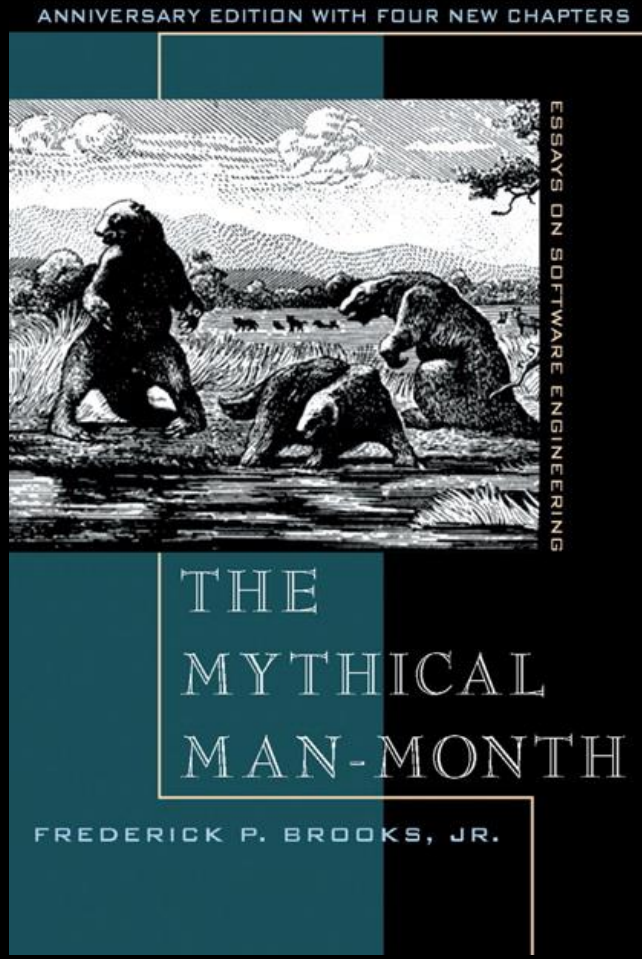


Brooks' Law

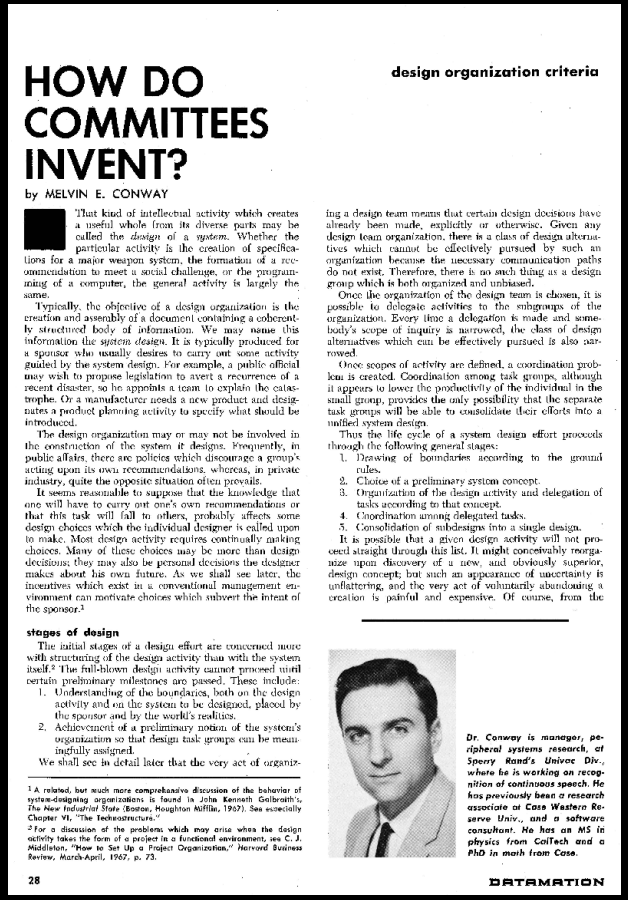
Adding manpower to a late software project makes it later.

-- Fred Brooks, 1975

Disintegration: Reason #2

"Application of the conventional wisdom of management to a large design organization causes its communication structure to disintegrate."

-- Mel Conway, 1967



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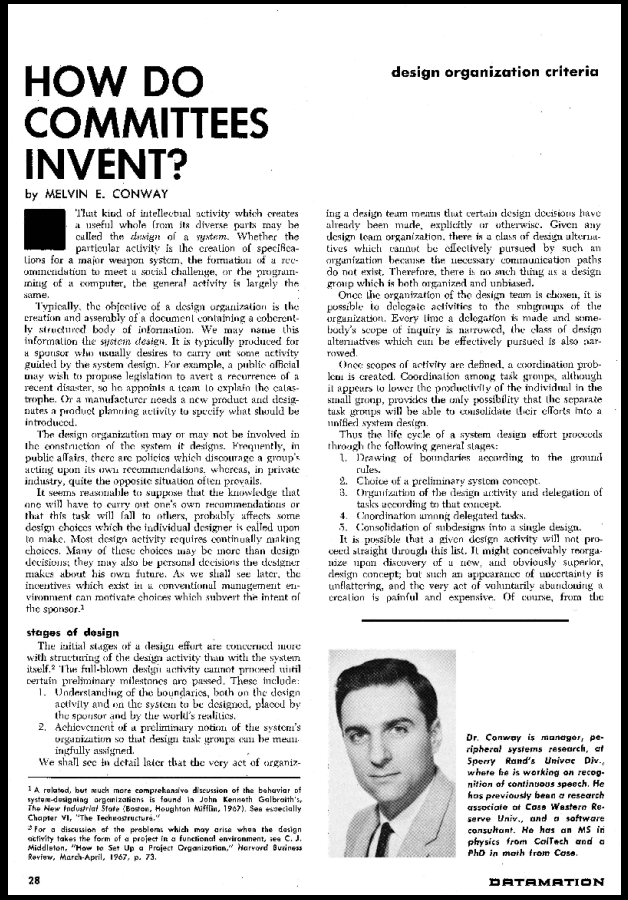
Dunbar's Number

A measurement of the "cognitive limit to the number of individuals with whom any one person can maintain stable relationships."

-- Robin Dunbar, 1992



HOW DO COMMITTEES INVENT?

by MELVIN E. CONWAY

That kind of intellectual activity which creates a useful whole from its diverse parts may be called the *design* of a *system*. Whether the particular activity is the creation of specifications for a major weapon system, the formation of a recommendation to meet a social challenge, or the programming of a computer, the general activity is largely the same.

Typically, the objective of a design organization is the creation and assembly of a document containing a coherently structured body of information. We may name this information the *system design*. It is typically produced for a sponsor who usually desires to carry out some activity guided by the system design. For example, a public official may wish to propose legislation to avert a recurrence of a recent disaster, so he appoints a team to explain the catastrophe. Or a manufacturer needs a new product and designates a product planning activity to specify what should be introduced.

The design organization may or may not be involved in the construction of the system it designs. Frequently, in public affairs, there are policies which discourage a group's acting upon its own recommendations, whereas, in private industry, quite the opposite situation often prevails.

It seems reasonable to suppose that the knowledge that one will have to carry out one's own recommendations or that this task will fall to others, probably affects some design choices which the individual designer is called upon to make. Most design activity requires continually making choices. Many of these choices may be more than design decisions; they may also be personal decisions the designer makes about his own future. As we shall see later, the incentives which exist in a conventional management environment can motivate choices which subvert the intent of the sponsor.[1]

stages of design

The initial stages of a design effort are concerned more with structuring of the design activity than with the system itself.[2] The full-blown design activity cannot proceed until certain preliminary milestones are passed. These include:

1. Understanding of the boundaries, both on the design activity and on the system to be designed, placed by the sponsor and by the world's realities.
2. Achievement of a preliminary notion of the system's organization so that design task groups can be meaningfully assigned.

We shall see in detail later that the very act of organizing a design team means that certain design decisions have already been made, explicitly or otherwise. Given any design team organization, there is a class of design alternatives which cannot be effectively pursued by such an organization because the necessary communication paths do not exist. Therefore, there is no such thing as a design group which is both organized and unbiased.

Once the organization of the design team is chosen, it is possible to delegate activities to the subgroups of the organization. Every time a delegation is made and somebody's scope of inquiry is narrowed, the class of design alternatives which can be effectively pursued is also narrowed.

Once scopes of activity are defined, a coordination problem is created. Coordination among task groups, although it appears to lower the productivity of the individual in the small group, provides the only possibility that the separate task groups will be able to consolidate their efforts into a unified system design.

Thus the life cycle of a system design effort proceeds through the following general stages:

1. Drawing of boundaries according to the ground rules.
2. Choice of a preliminary system concept.
3. Organization of the design activity and delegation of tasks according to that concept.
4. Coordination among delegated tasks.
5. Consolidation of subdesigns into a single design.

It is possible that a given design activity will not proceed straight through this list. It might conceivably reorganize upon discovery of a new, and obviously superior, design concept; but such an appearance of uncertainty is unflattering, and the very act of voluntarily abandoning a creation is painful and expensive. Of course, from the

Dr. Conway is manager, peripheral systems research, at Sperry Rand's Univac Div., where he is working on recognition of continuous speech. He has previously been a research associate at Case Western Reserve Univ., and a software consultant. He has an MS in physics from CalTech and a PhD in math from Case.

[1] A related, but much more comprehensive discussion of the behavior of system-designing organizations is found in John Kenneth Galbraith's, *The New Industrial State* (Boston, Houghton Mifflin, 1967). See especially Chapter VI, "The Technostructure."

[2] For a discussion of the problems which may arise when the design activity takes the form of a project in a functional environment, see C. J. Middleton, "How to Set Up a Project Organization," *Harvard Business Review*, March-April, 1967, p. 73.

Disintegration: Reason #3

"Homomorphism insures that the structure of the system will reflect the disintegration which has occurred in the design organization."

-- Mel Conway, 1967

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Communication dictates design.

-- Mel Conway, 1967

Conway's Fourth Law
tells us TIME is against LARGE teams.

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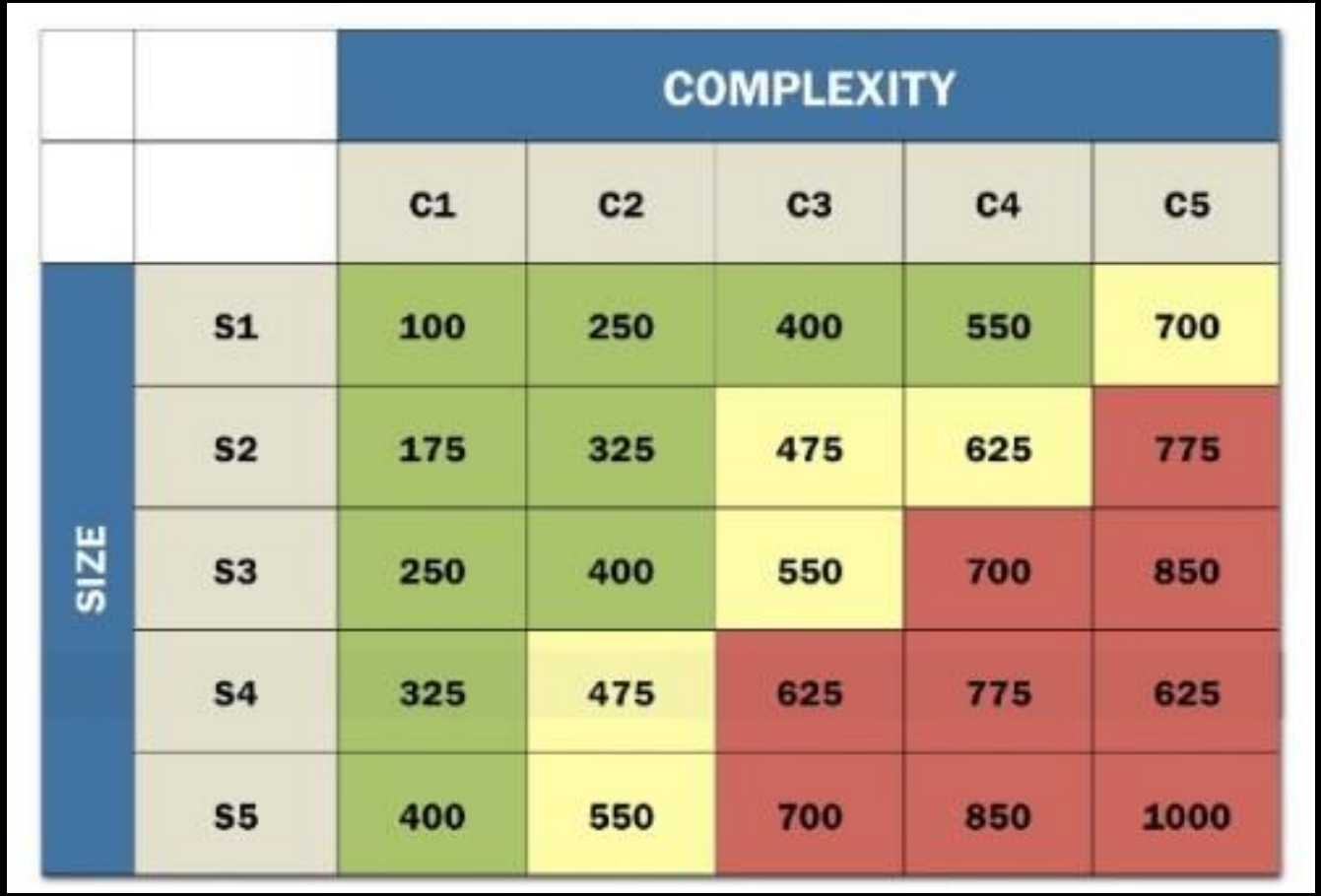
tells us TIME is against LARGE teams.

So…
Make release cycles short and small.



		COMPLEXITY				
		C1	C2	C3	C4	C5
SIZE	S1	100	250	400	550	700
	S2	175	325	475	625	775
	S3	250	400	550	700	850
	S4	325	475	625	775	625
	S5	400	550	700	850	1000

Standish Group Chaos Report 2015

(via http://www.infoq.com/articles/standish-chaos-2015)

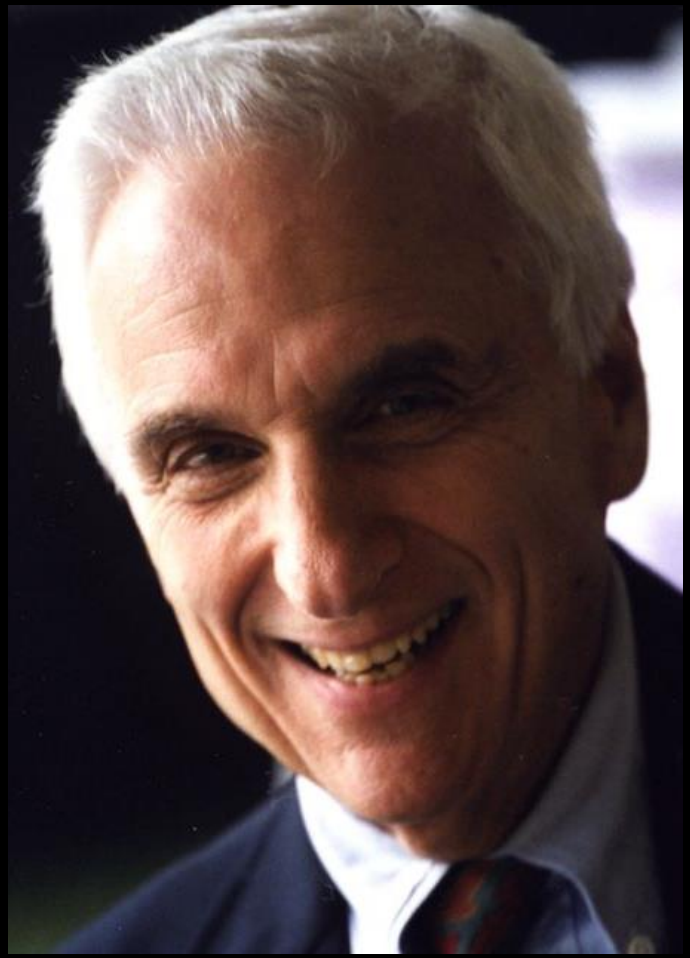
ASSESSMENT:

If your release dates are often missed, your SCOPE is TOO BIG.

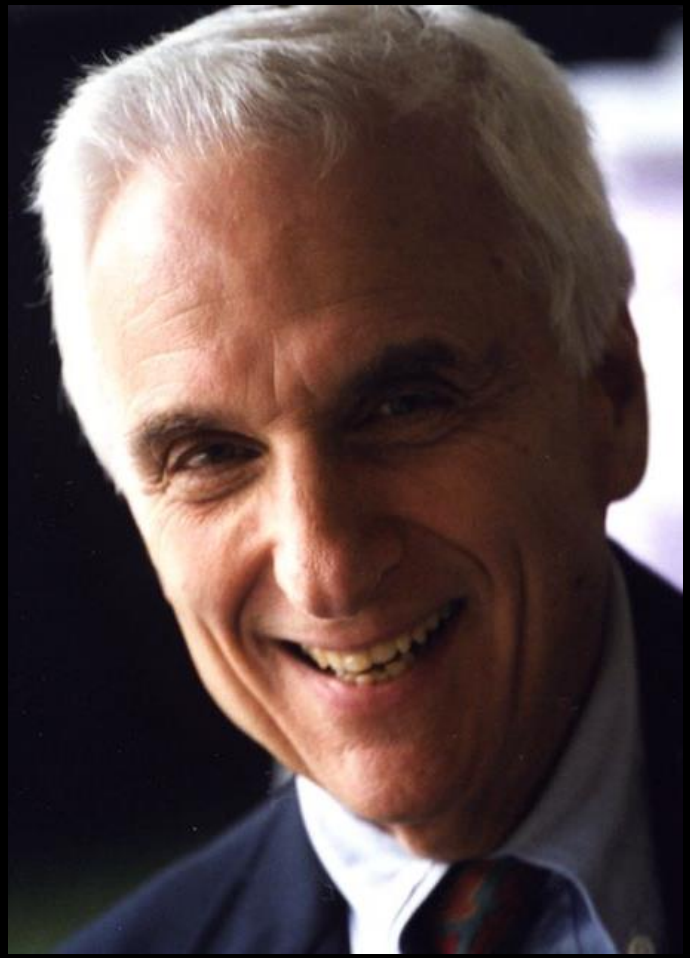
GUIDANCE:

Aim for a SCOPE that supports a release cycle of two weeks or less.

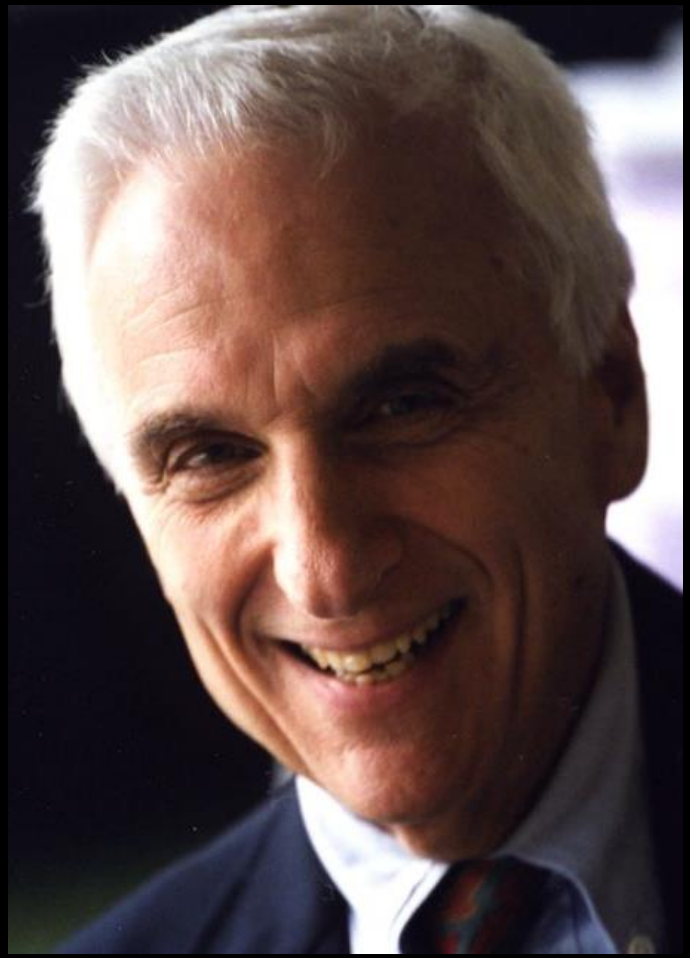
So, let's review our options…



Conway's Laws
can help us succeed

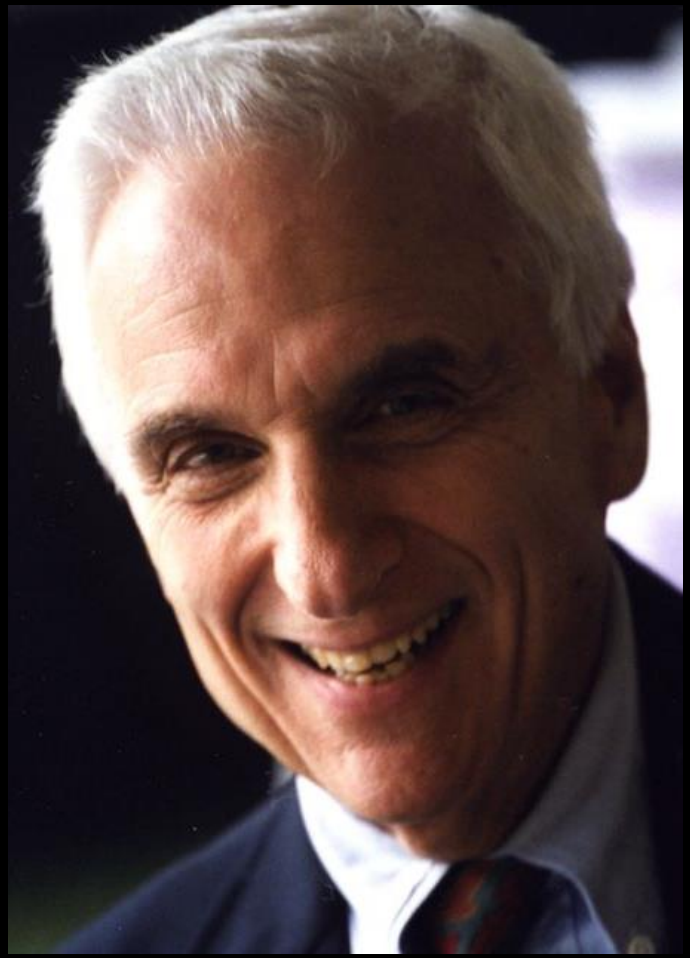


Conway's Laws can help us succeed when working with microservice teams.



Conway's First Law

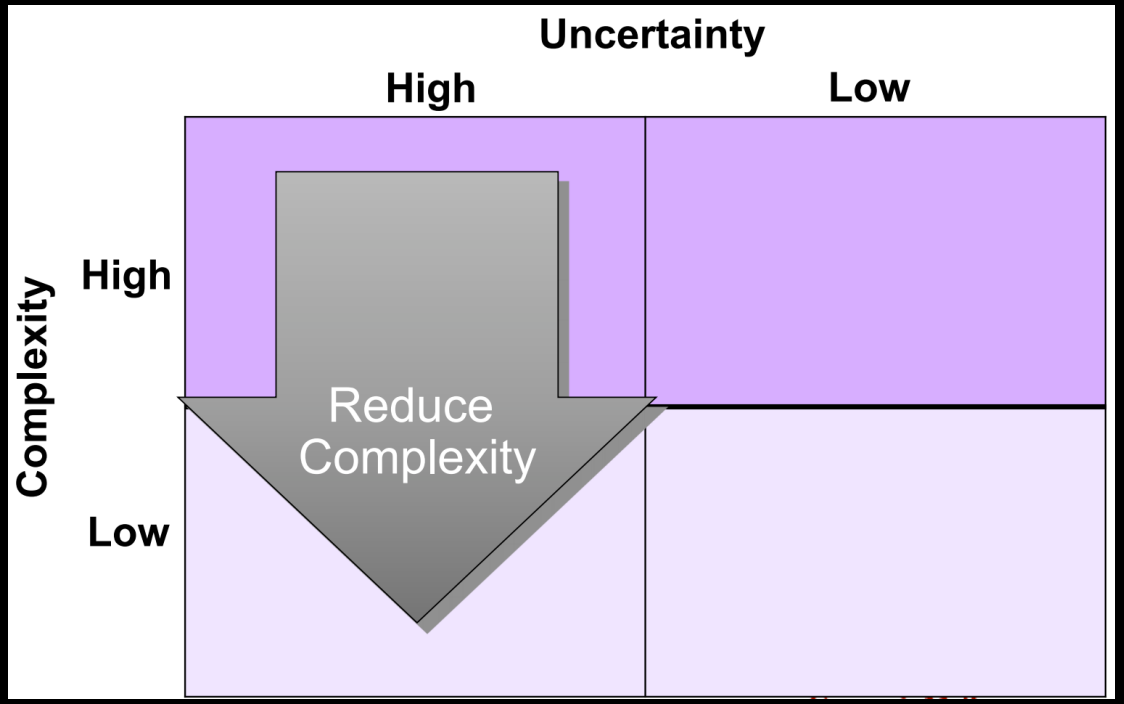
A system's design is a copy of the organization's communication structure.



Conway's First Law

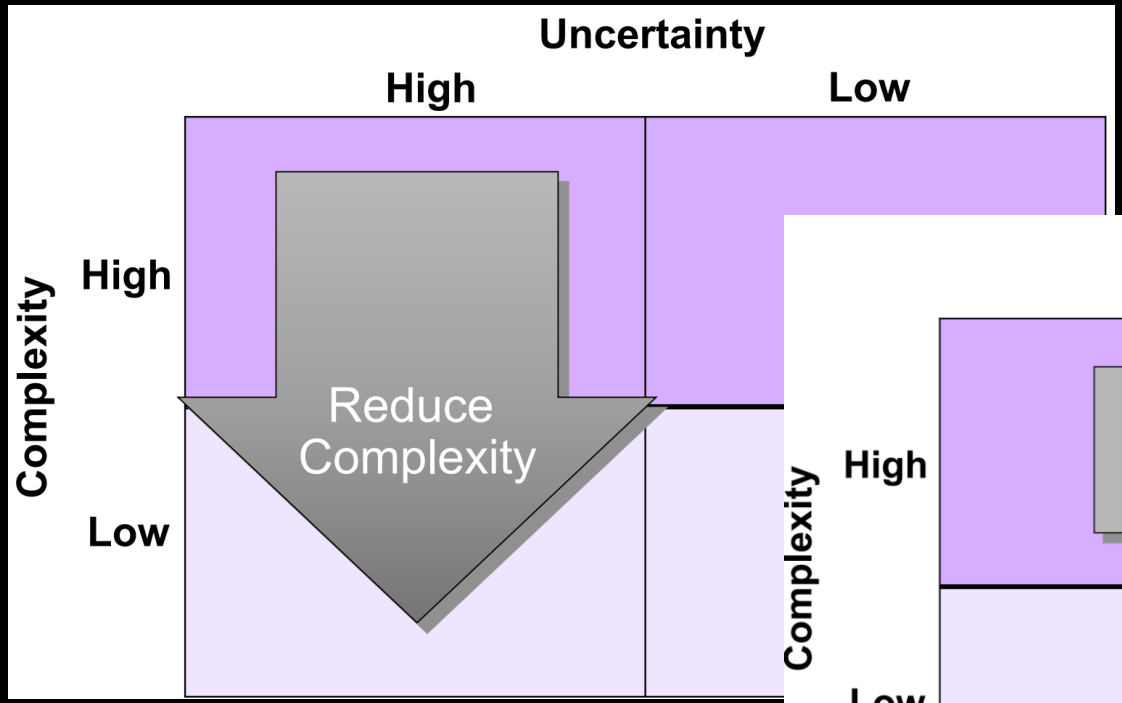
A system's design is a copy of the organization's communication structure.

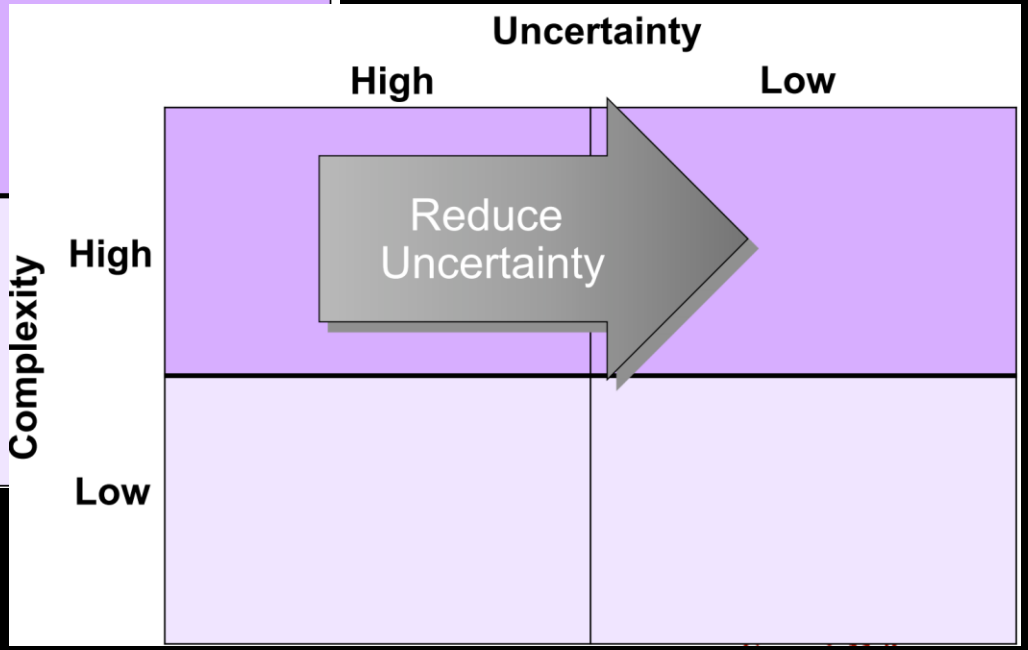
Actively manage communications within the teams and across teams.



"Tactics for Global Software Development", Herbsleb (2008)

http://herbsleb.org/web-pres/slides/Siemens-conference-7-17-08-dist.pdf





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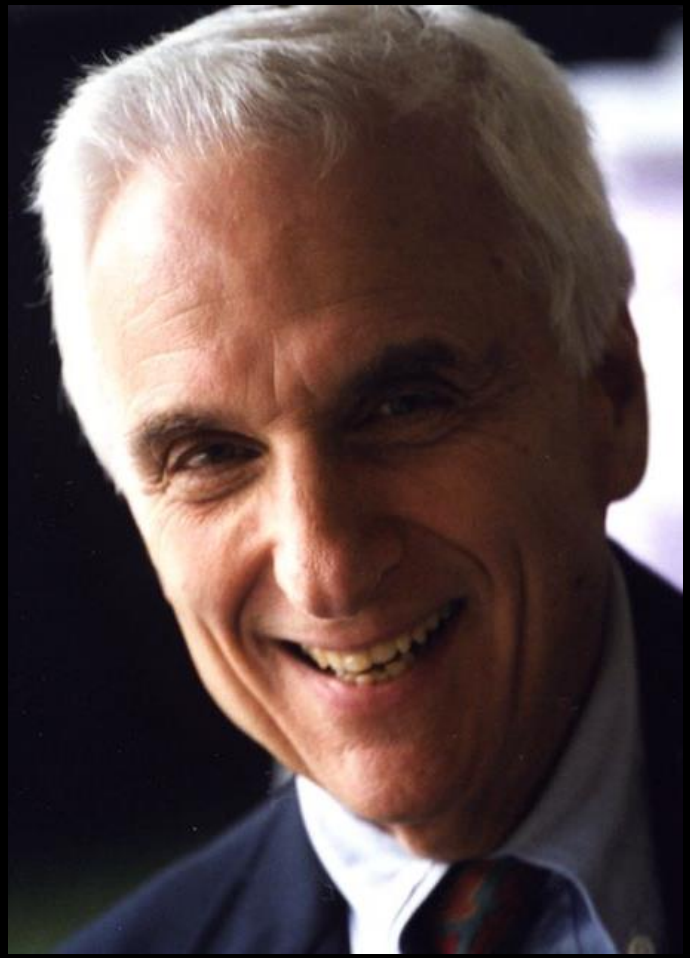
Increase communications

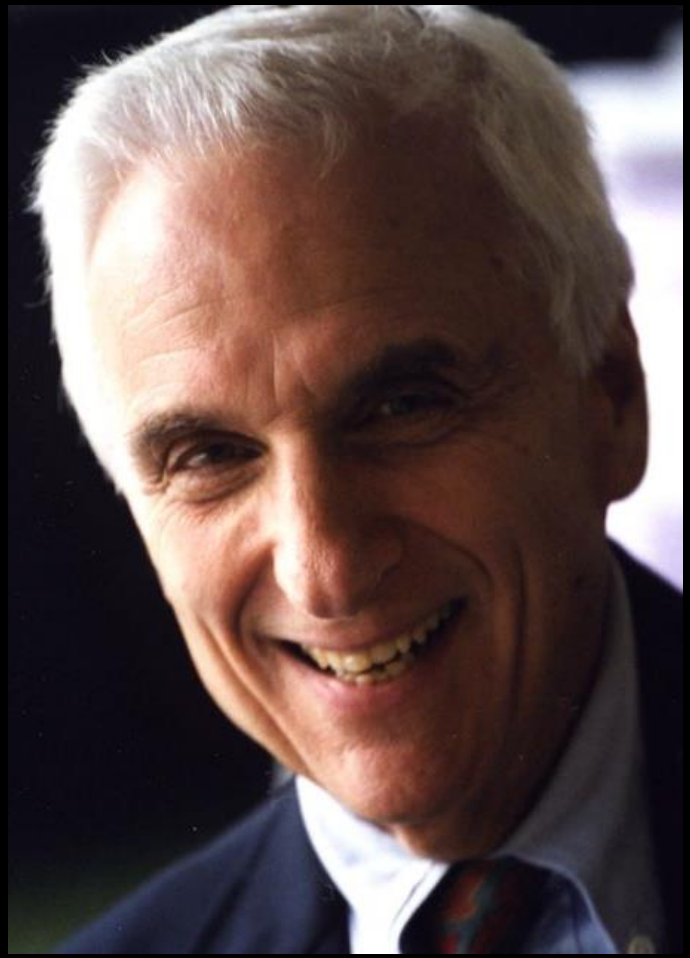
- Real-time Chat Tools
- Video Conferencing
- Online Forums/News Groups
- Wiki and Web Sites

Reduce the effort required to locate and interact with the ‘right people’



Conway's Second Law

There is never enough time to do something right, but there is always enough time to do it over.



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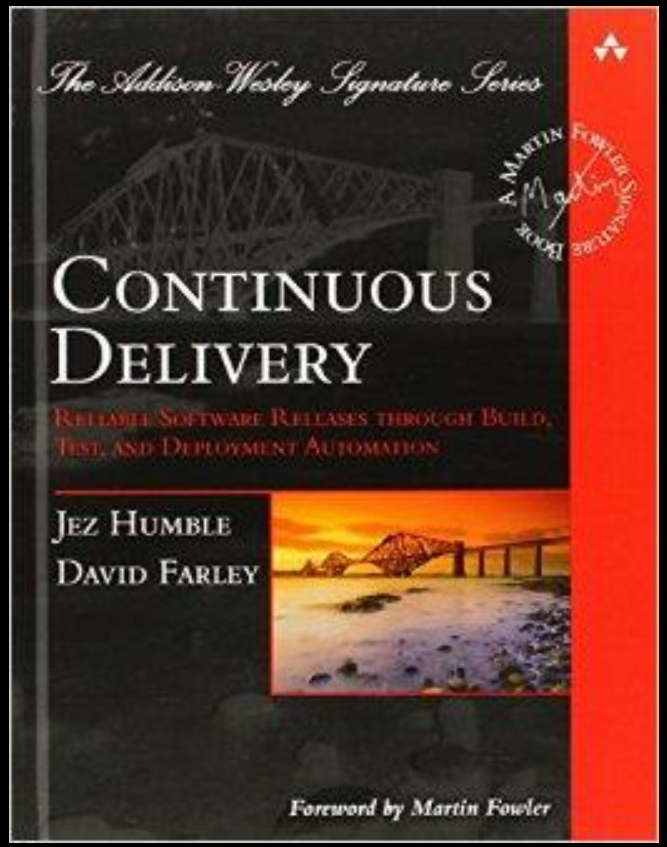
Remember the process is continually repeating.



Continuous Delivery

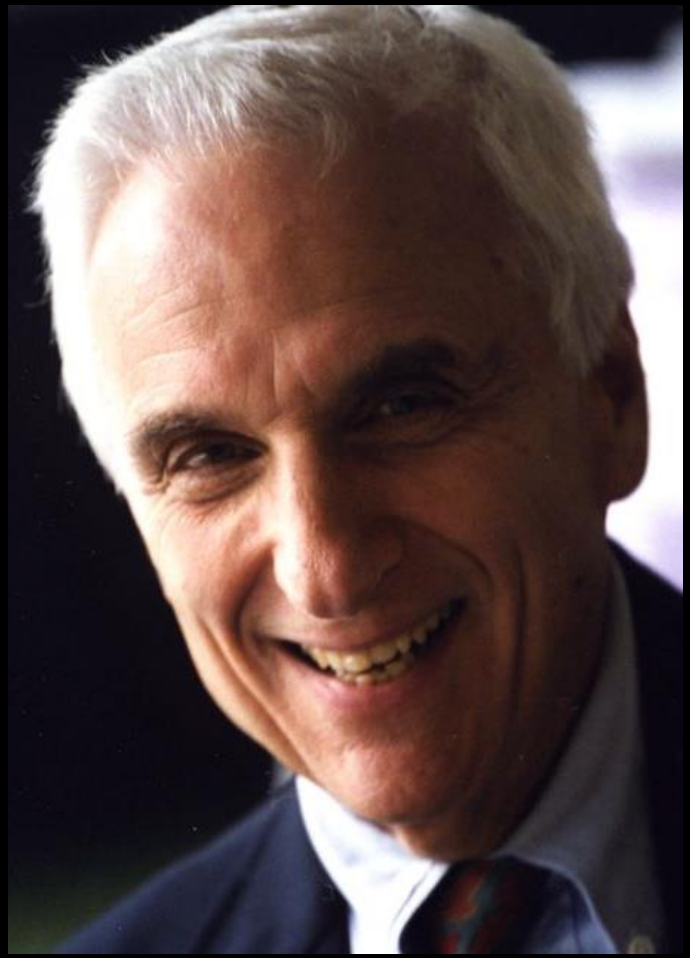
"The core concept of making small frequent changes, and testing at every step, reduces the risk inherent in deploying new code."

Jez Humble, Thoughtworks.

Support continuous processes

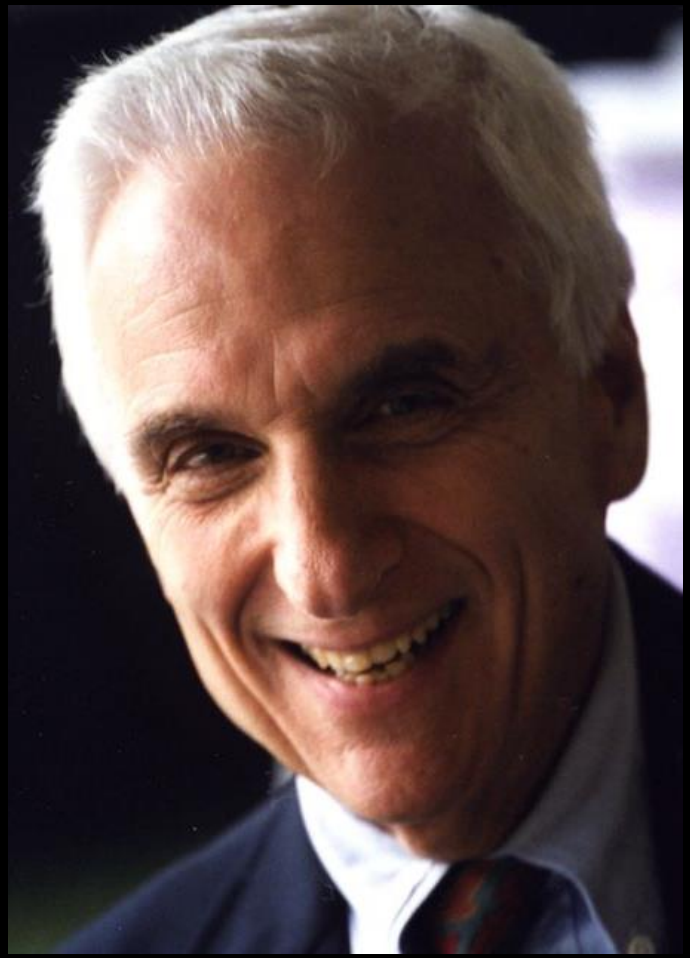
- Implement small changes
- Test immediately
- Deploy constantly

Shorten the feedback loop as much as possible.



Conway's Third Law

There is a homomorphism from the linear graph of a system to the linear graph of its design organization.



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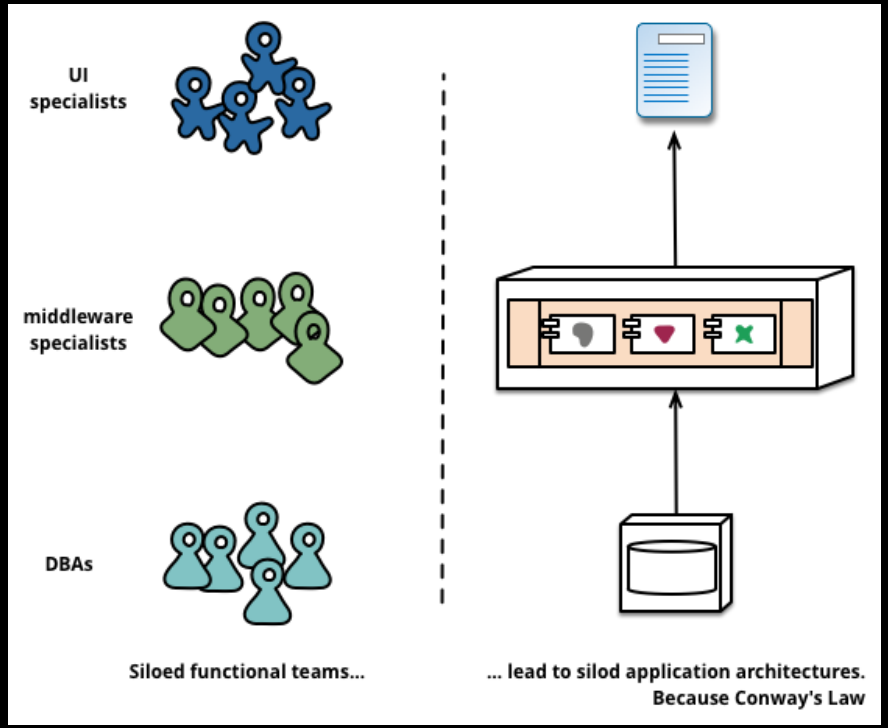
Organize teams in order to achieve desired system.

Microservices

Organized around
business capabilities.

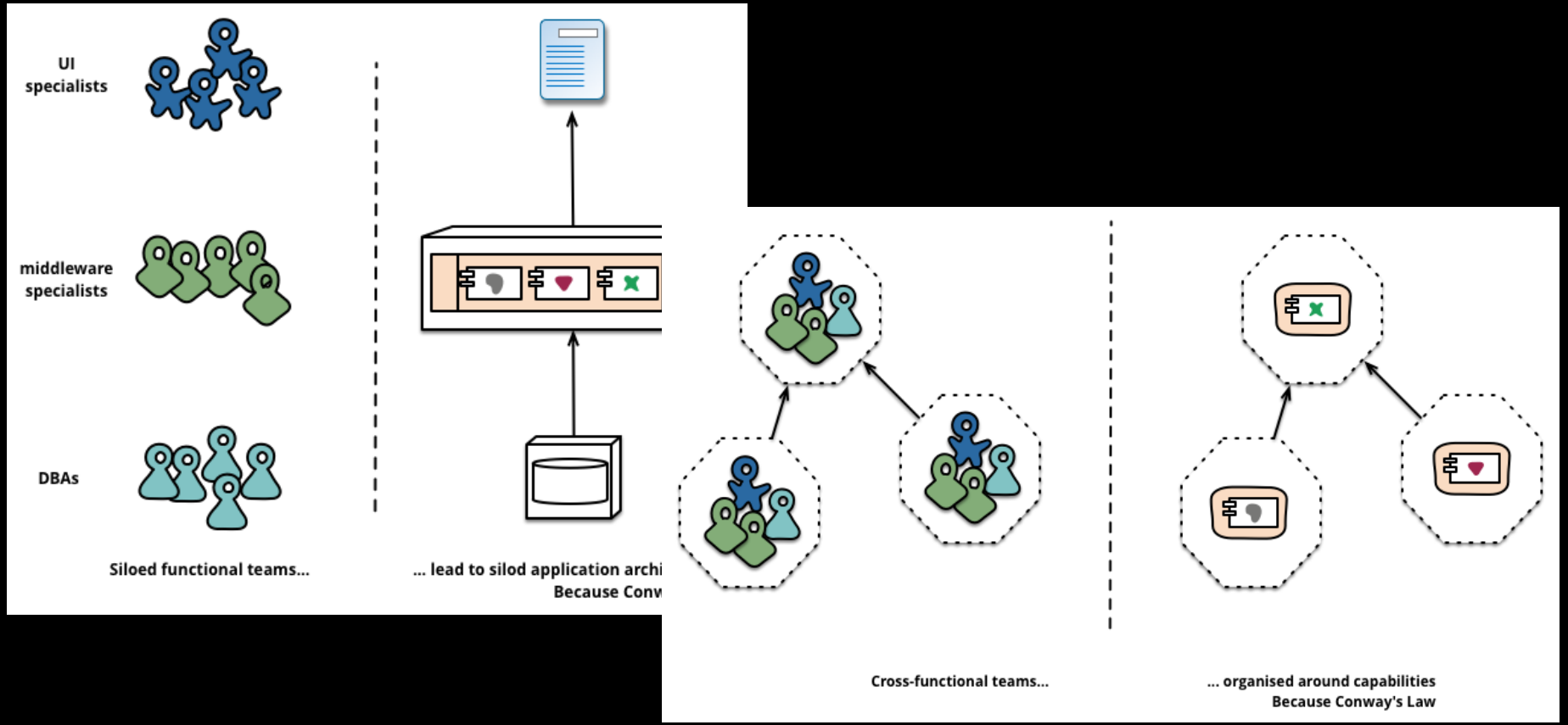
Products, not projects.

Martin Fowler, Thoughtworks



“Microservices”, Fowler & Lewis (2014)

http://martinfowler.com/articles/microservices.html



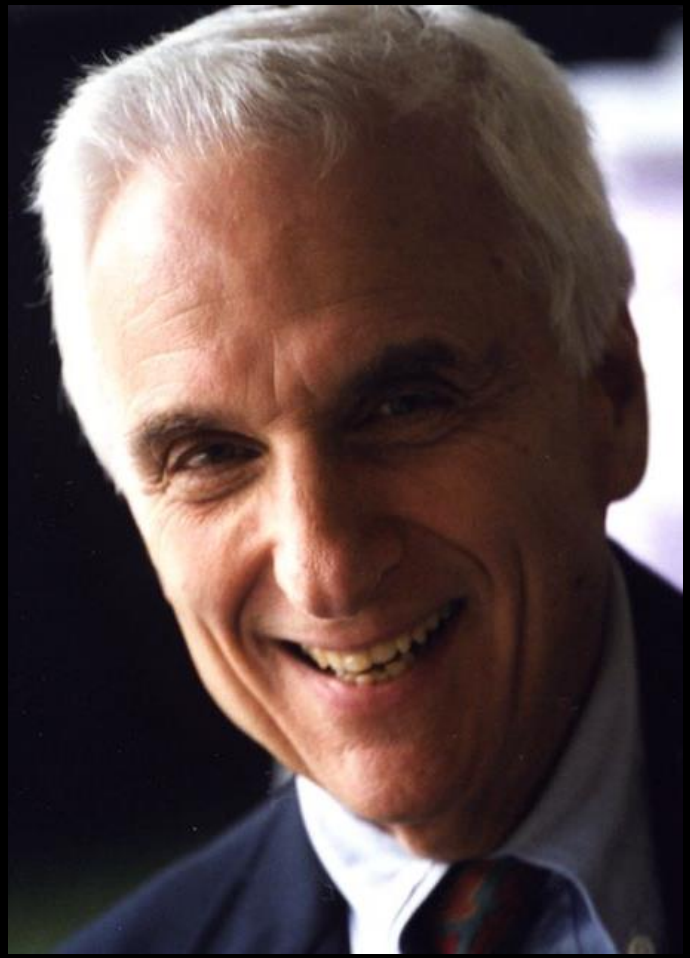
“Microservices”, Fowler & Lewis (2014)

http://martinfowler.com/articles/microservices.html

Organize teams by product or BU

- Combine design, develop, test, & deploy
- Include storage, business process, & UI
- Allow teams autonomy *within* their boundary
- Require teams to *inter-operate,* not integrate

Make sure teams own their complete lifecycle.



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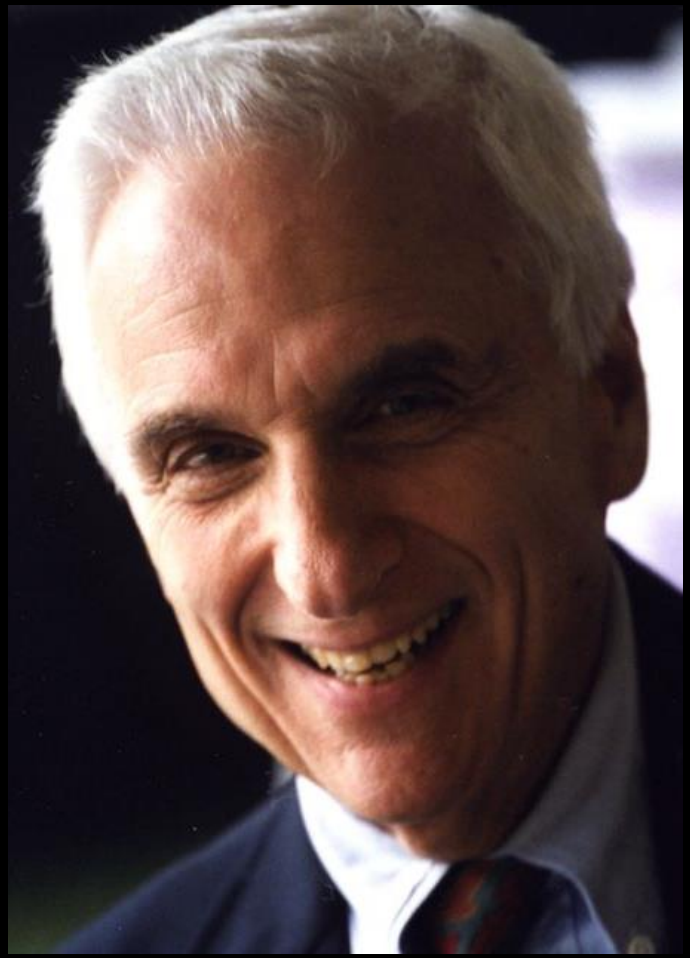
The structures of large systems tend to disintegrate during development.



Conway's Fourth Law

The structures of large systems tend to disintegrate during development.

Keep your teams as small as necessary, but no smaller.

Sizing Teams

Jeff Bezos, Amazon

Sizing Teams

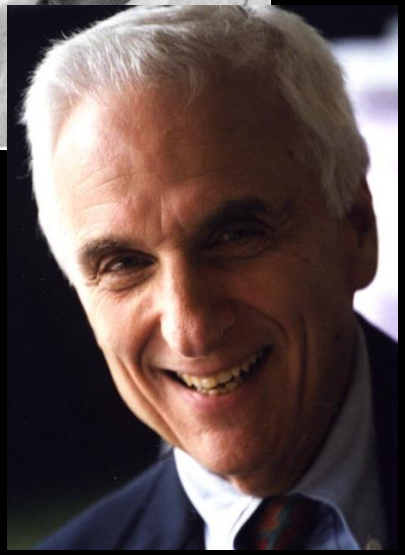
If a team can’t be fed with two pizzas, it’s too big.

Jeff Bezos, Amazon

Make team as small as necessary

- Resist urge to grow teams in response to deadlines
- Consider Dunbar's groups when sizing teams
- Be prepared to break into smaller teams

It's better to be "too small" than to be "too big."



Conway's Lessons from 1967

1. Increase communications
2. Support continuous process
3. Organize teams by products
4. Make teams small as necessary

Optimizing Teams in a Distributed World

Conway's three other laws

Mike Amundsen
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