# Optimizing Teams in a Distributed World

Conway's three other laws

Mike Amundsen CA Technologies @mamund

# Introduction





#### RETURN TO HOMEPAGE

#### **API ACADEMY SERVICES**





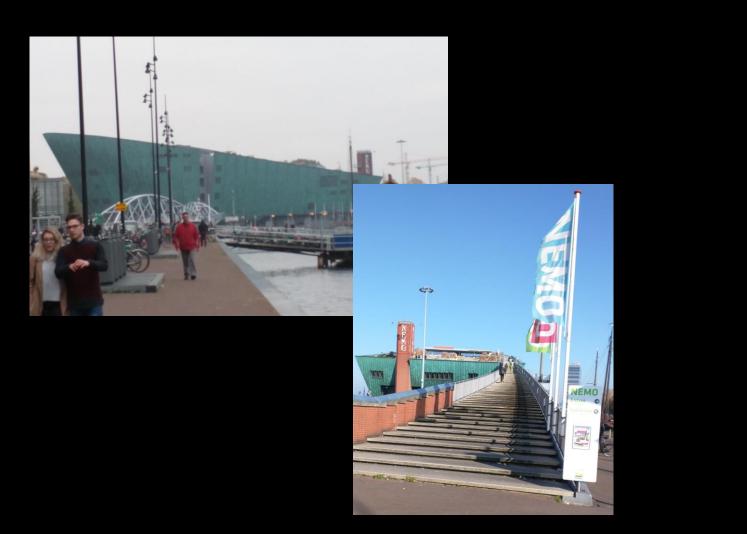


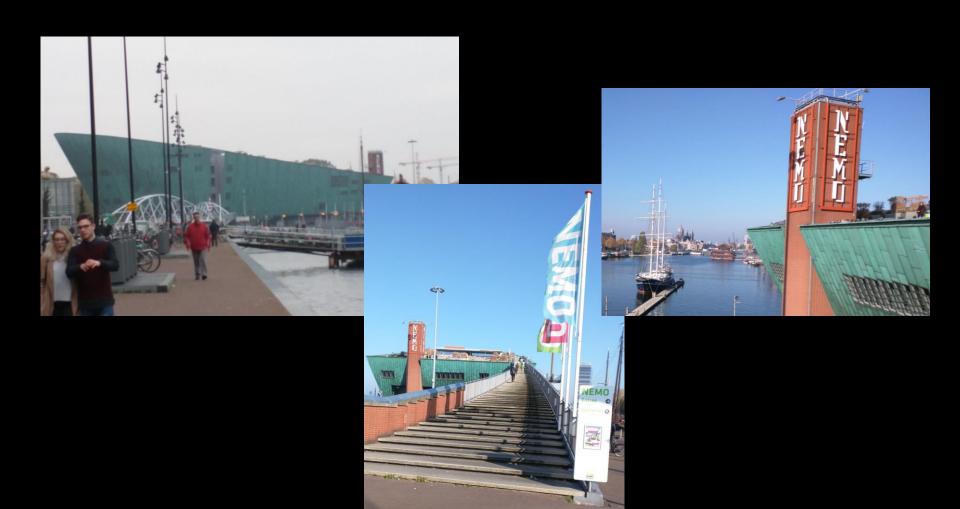
The API Academy team consists of industry experts who have been brought together by CA Technologies to provide expert consulting services for organizations that want to take their API programs to the next level.

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































## **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



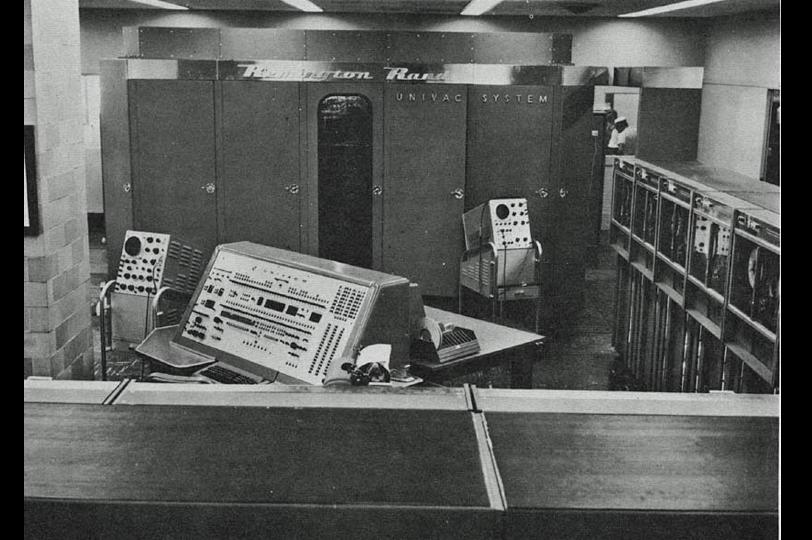
### Mel Conway

- 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)

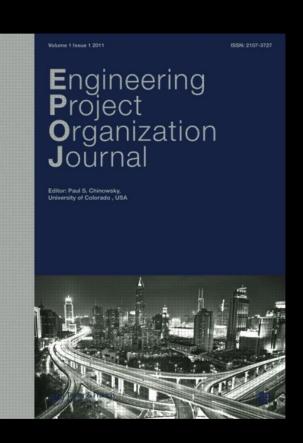
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http://www.melconway.com/



### 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



by MELVIN E. CONWAY

That kind of intellectual activity which creates a useful whole from its diverse parts may be called the dosign 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

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#### stages of design

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

- 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.
- Achievement of a preliminary notion of the system's organization so that design task groups can be meaningfully assigned.

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design organization criteria

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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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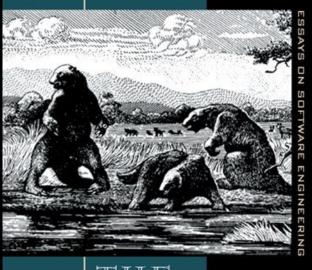
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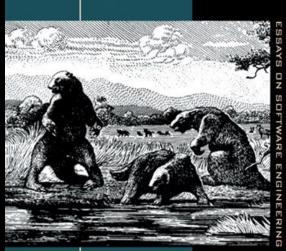
Communication dictates design.

-- Mel Conway, 1967

### Conway's Law



FREDERICK P. BROOKS, JR.

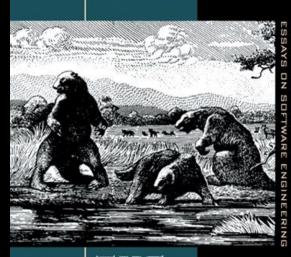


FREDERICK P. BROOKS, JR.

#### **Brooks' Law**

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

-- Fred Brooks, 1975

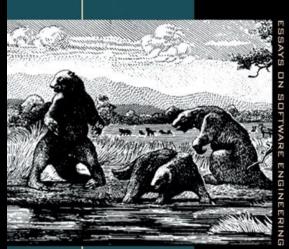


FREDERICK P. BROOKS, JR.

### Intercommunication formula

n(n-1) / 2

-- Fred Brooks, 1975



FREDERICK P. BROOKS, JR.

#### Intercommunication formula

$$5*(5-1)/2 = 10$$
  
 $15*(15-1)/2 = 105$   
 $50*(50-1)/2 = 1,225$   
 $150*(150-1)/2 = 11,175$ 

-- Fred Brooks, 1975

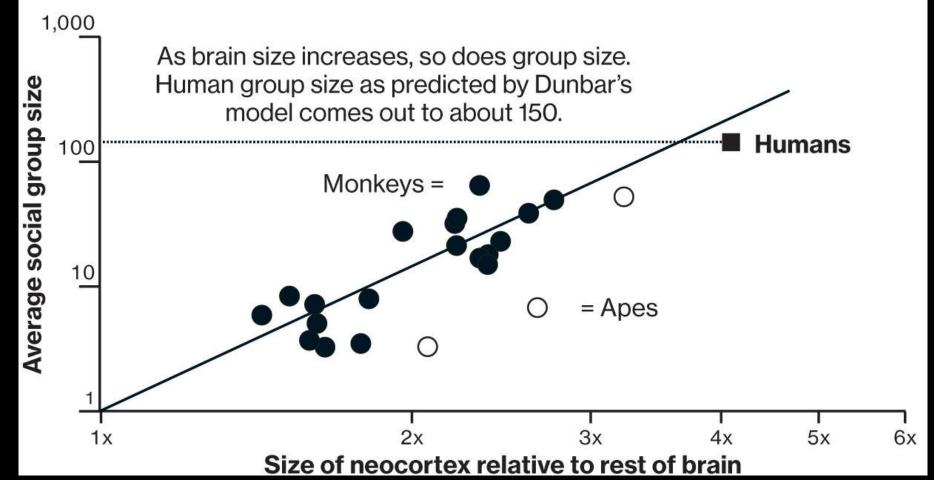


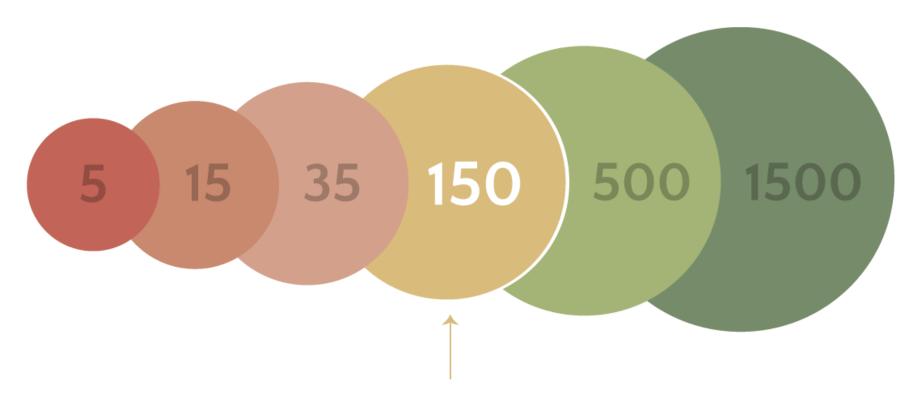
#### **Dunbar's Number**

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**

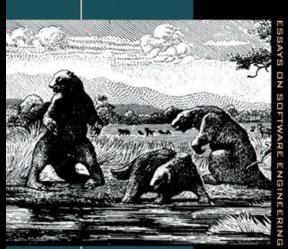
Intimate friends: 5

Trusted friends: 15

Close friends: 35

Casual friends: 150

-- Robin Dunbar, 1992



# THE MYTHICAL MAN-MONTH

FREDERICK P. BROOKS, JR.

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### HOW DO COMMITTEES INVENT?

by MELVIN E. CONWAY

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### Conway's (first) Law



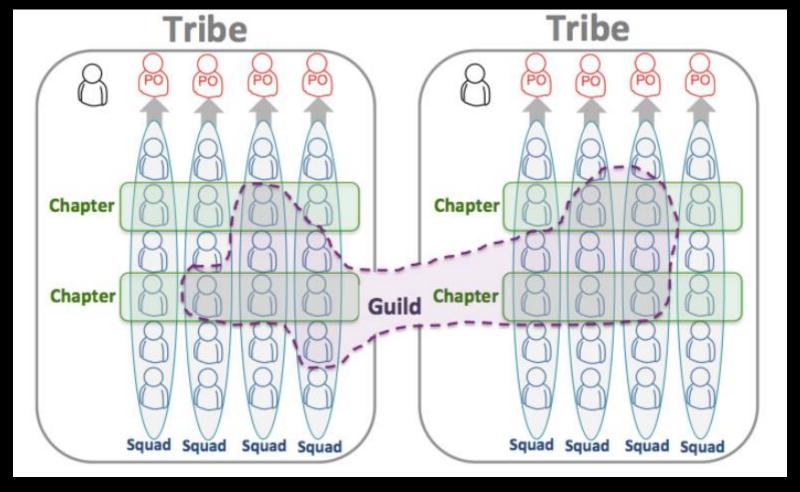
## Conway's (first) Law

## 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

activity takes the form of a project in a functional environment, see C. J. Middleton, "How to Set Up a Project Organization," Horvard Business Review, March-April, 1967, p. 73.

Chapter VI, "The Technostructure."

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DATAMATION

design organization criteria

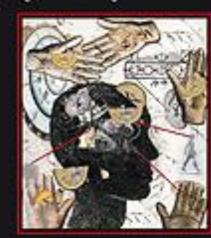
#### Trade Offs

## Efficiency-Thoroughness Trade Offs (ETTOs)

# ETTO

Efficiency-Thoroughness Trade-Off

Why Things That Go Right Sometimes Go Whong



ERIH 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

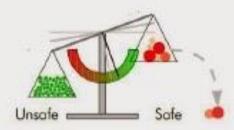
success more often than failure.

#### Two interpretations of safety



#### Safety-I

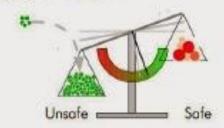
Safety means that the number of things that go wrong (accidents / incidents / near misses) is as low as possible.



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

#### Safety-II Resilience

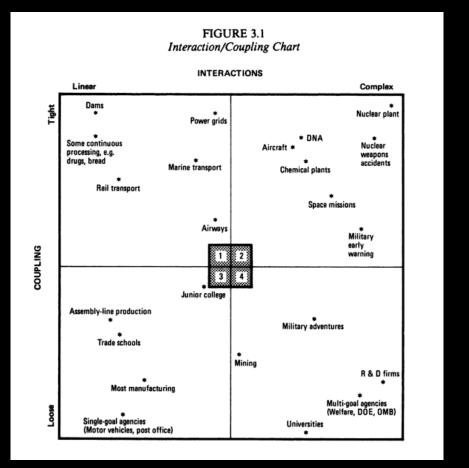
Safety means that the number of things that go right is as high as possible. Safety is the ability to succeed under varying conditions.



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

© Enk Holinaget, 2015

### 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**

Systems grow too large
 Rate of change increases
 Overall expectations keep rising

-- Eric Hollnagel, 2009



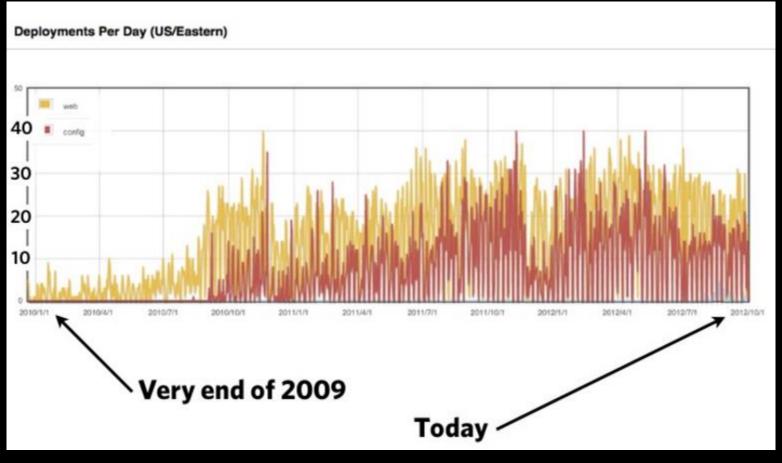
### "Continuous Delivery" Raphael Carvalho (2014) http://slides.com/raphaelcarvalho/continuous-delivery#/9

## Conway's Second Law tells us PROBLEM SIZE is important

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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



#### HOW DO **COMMITTEES INVENT?**

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design organization criteria

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#### Homomorphism

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

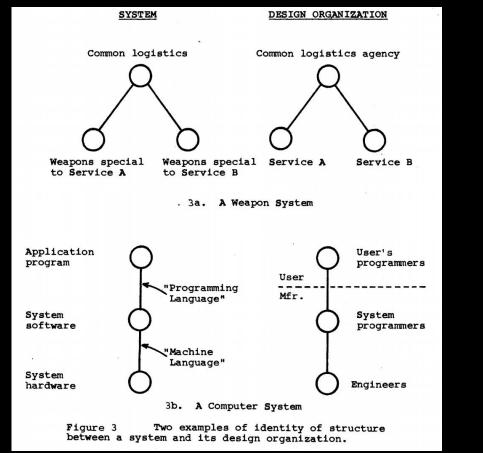
-- Mel Conway, 1967

#### ho·mo·mor·phism

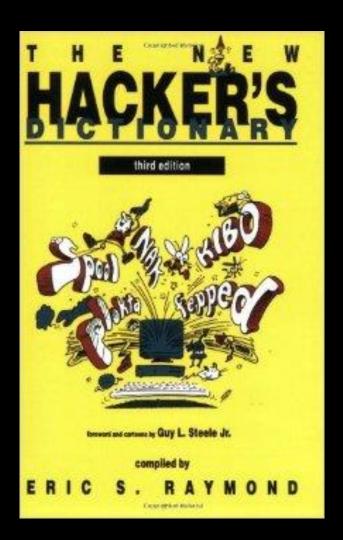
/ˌhōməˈmôrfizəm/

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.

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

So...

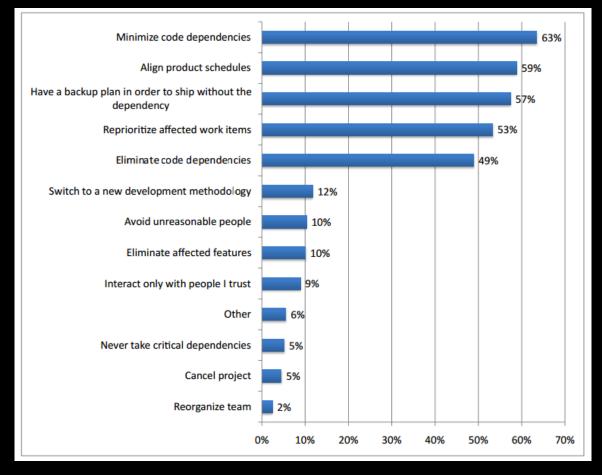
Make each team fully independent.

## until some other team is ready,

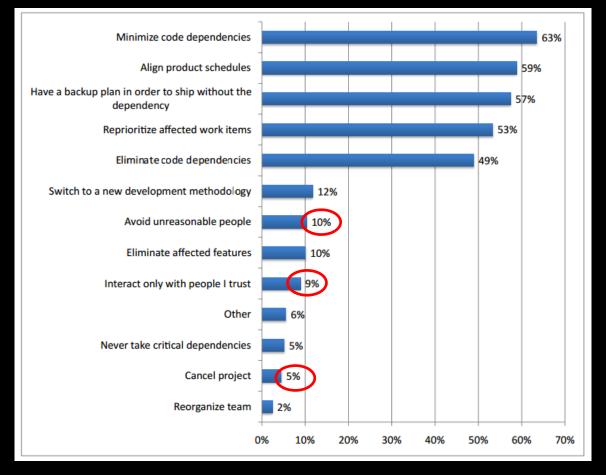
If you have to hold a release

you are not an

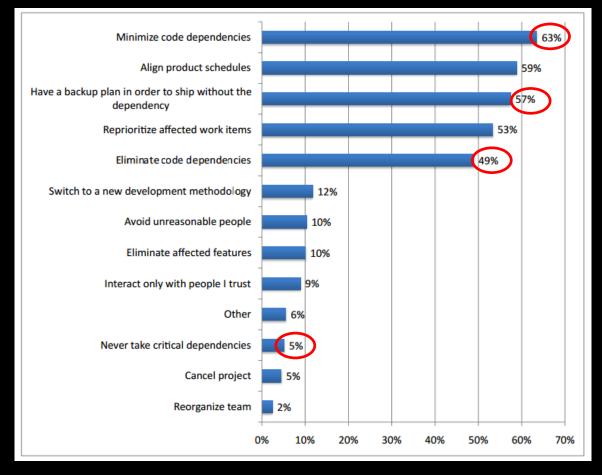
INDEPENDENT TEAM



Coordination in Large-Scale Software Teams, Begel, et al (2007) http://research.microsoft.com/en-us/um/people/abegel/papers/coordination-chase09.pdf



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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## Conway's Fourth Law



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NEIVIN E CONWAY

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### 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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DATAMATION

design organization criteria

# Three reasons Disintegration occurs...

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by MELVIN E. CONWAY

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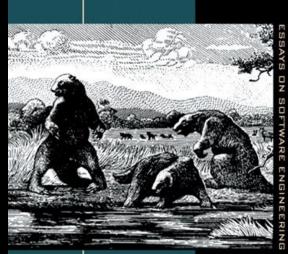


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### **Disintegration: Reason #1**

"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



THE MYTHICAL MAN-MONTH

FREDERICK P. BROOKS, JR.

### **Brooks' Law**

Adding manpower to a late software project makes it later.

-- Fred Brooks, 1975

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"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

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### **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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- Achievement of a preliminary notion of the system's organization so that design task groups can be meaninefully assigned.

We shall see in detail later that the very act of organiz-

<sup>1</sup> A related, but sends more comprehensive discussion of the behavior of system-designing organizations is found in John Kenneth Galbrotth's, The New Industrial State (Boston, Houghton Miffilia, 1962). See essectably Chapter VI, "The Technostructure".

Chapter VI, The reconcurriculus.

3 For a discussion of the problems which may arise whose the design activity takes the form of a project in a functional environment, see C. J. Middleston. "How to Set Up a Project Organization." Horward Suriness Review, March-April, 1967, p. 73.

### design organization criteria

ing a design team means that certain design decision base 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 commanization paths do not exist. Therefore, there is no such thing as a design group which is both organizated and unbiased.

Once the organization of the design team is chosen, it is possible to delegate activities to the subgroups of the organization. Every three a delegation is made and some body'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
- Choice of a preliminary system concept.
   Organization of the design activity and delegation of
- 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.

3. Consonation in successful man a stage uses in the proceed straight through this list. It might conceivably roorganize upon discovery of a new, and obviously superior, design concept; but such an appearance of uncertainty is unflattering, and the very act of voluntarily abundoning a creation is painful and espensive. Of course, from the



Dr. Conwey is manager, peripheral systems research, et Sperry Rand's Univac Div., whate he is working an recognition of continuous speech. He has previously been a research associate at Case Wastern Reserve Univ., and a software consultant. Ne has an MS in physics from Collech and a 4hD in meth from Case.

ge activity will not propart activity respatant developely superior.

Let a superior the superior of the s

Communication dictates design.

-- Mel Conway, 1967

Conway's Fourth Law

tells us TIME is against LARGE teams.

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

So...

Make release cycles short and small.



Standish Group Chaos Report 2015 (via http://www.infoq.com/articles/standish-chaos-2015)

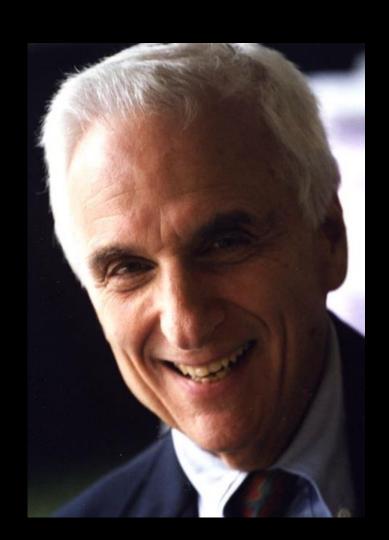
### ASSESSMENT:

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

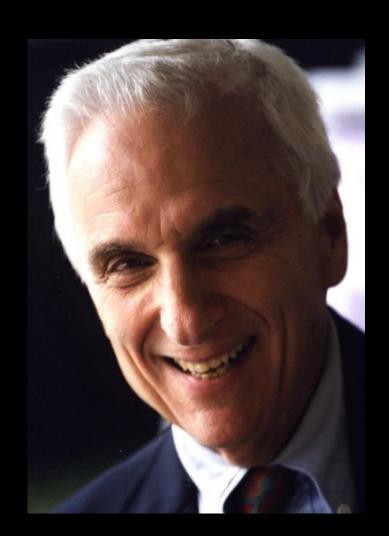
### GUIDANCE:

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

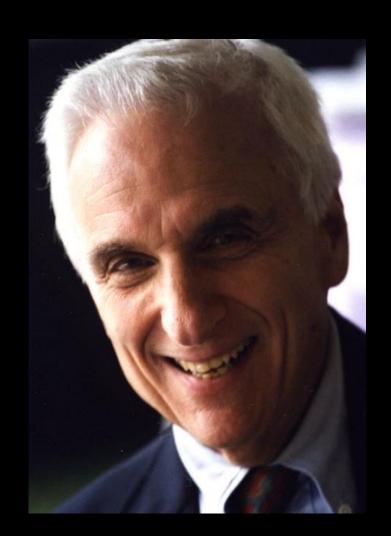
## So, let's review our options...



# Conway's Laws can help us succeed



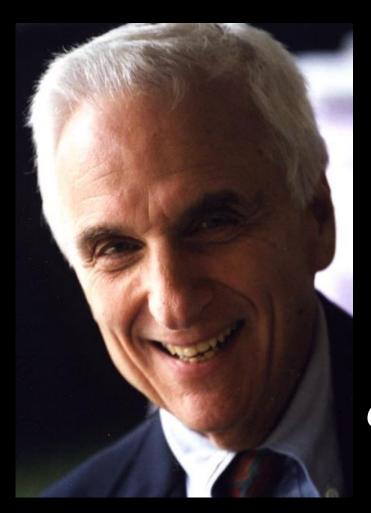
Conway's Laws can help us succeed when working with microservice teams.



### Conway's First Law

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

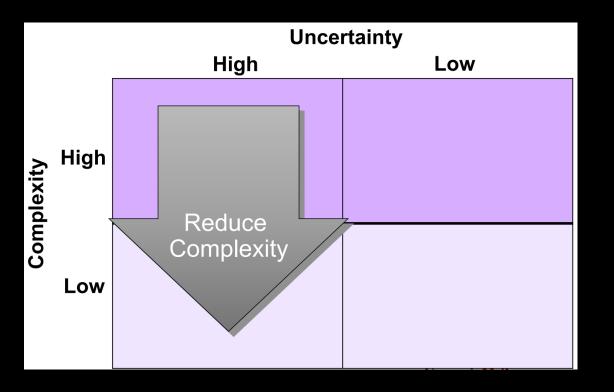




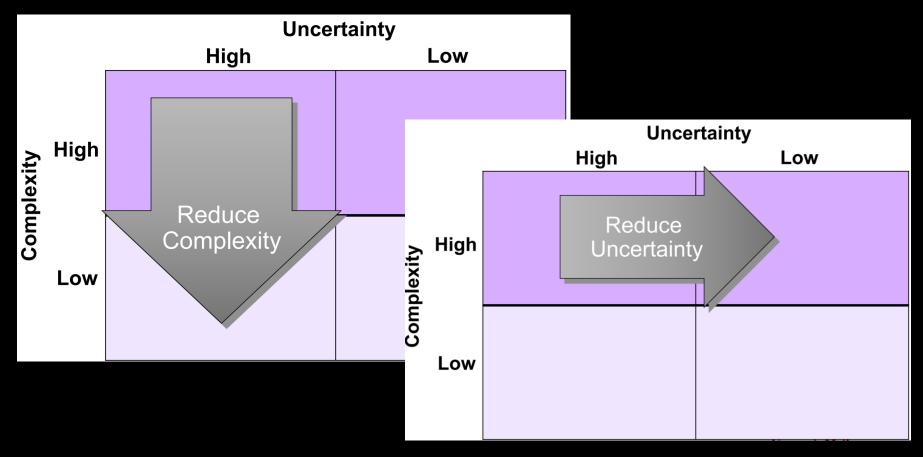
### Conway's First Law

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

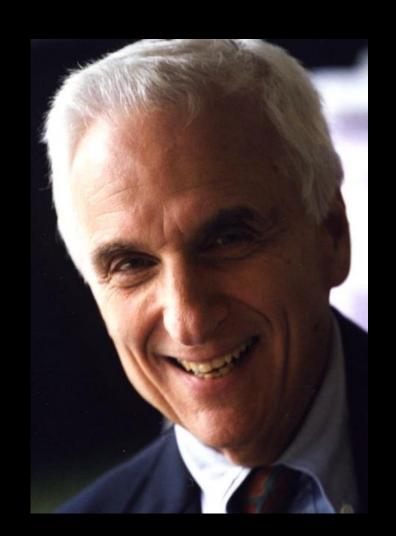


"Tactics for Global Software Development", Herbsleb (2008) http://herbsleb.org/web-pres/slides/Siemens-conference-7-17-08-dist.pdf

### Increase communications

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

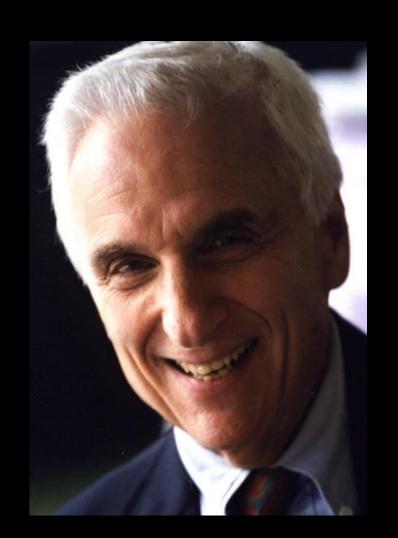
Reduce the effort required to locate and interact with the 'right people'



### **Conway's Second Law**

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

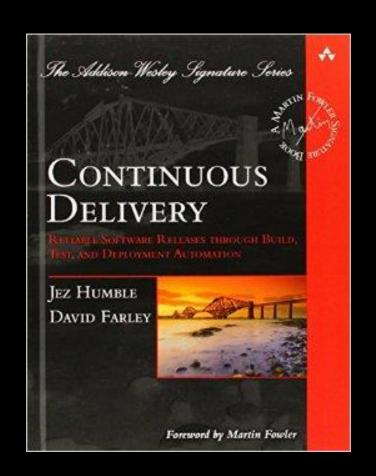




### **Conway's Second Law**

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

Remember the process is continually repeating.



### **Continuous Delivery**

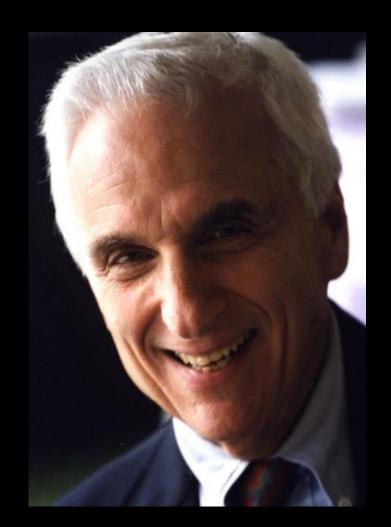
"The core concept of making small frequent changes, and testing at every step, reduces the risk inherent in deploying new code."

Jez Humble, Thoughtworks.

### Support continuous processes

- Implement small changes
- Test immediately
- Deploy constantly

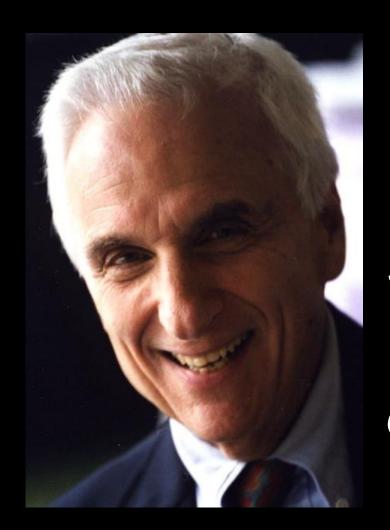
Shorten the feedback loop as much as possible.



### **Conway's Third Law**

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





### **Conway's Third Law**

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

Organize teams in order to achieve desired system.

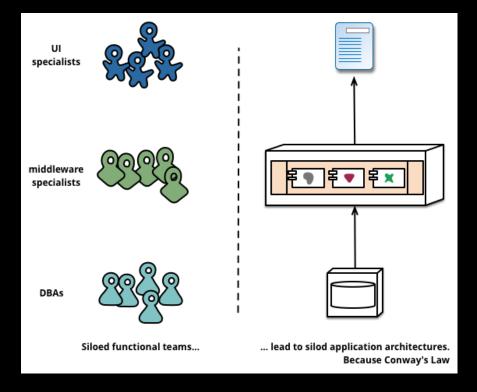


### **Microservices**

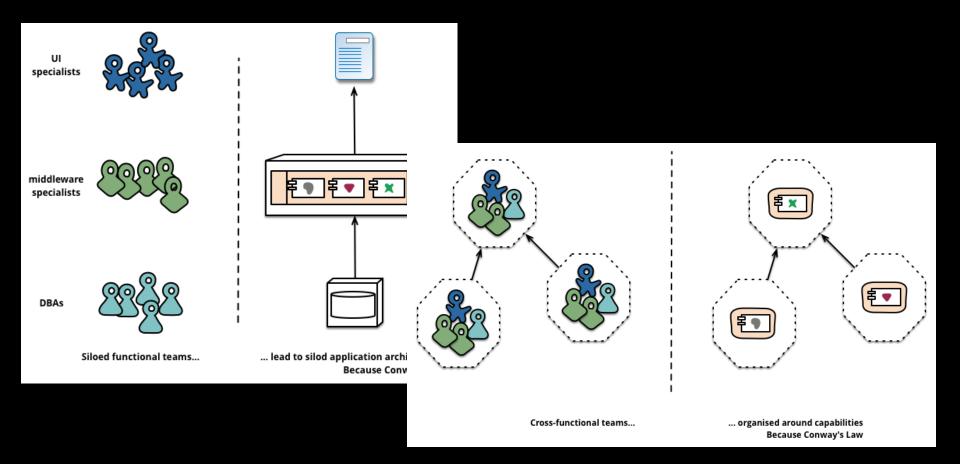
Organized around business capabilities.

Products, not projects.

Martin Fowler, Thoughtworks



## "Microservices", Fowler & Lewis (2014) http://martinfowler.com/articles/microservices.html

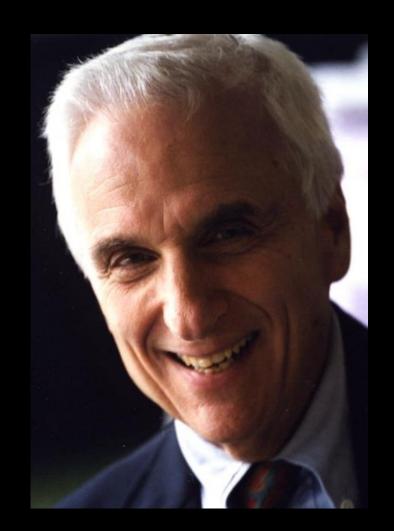


"Microservices", Fowler & Lewis (2014)
http://martinfowler.com/articles/microservices.html

### 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

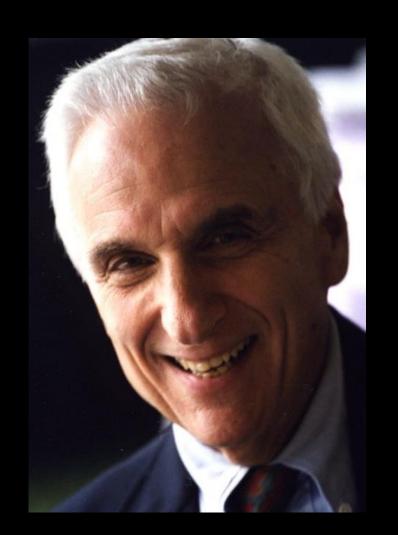
Make sure teams own their complete lifecycle.



### Conway's Fourth Law

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."



- 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

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