Conway's Four Laws

Mike Amundsen @mamund 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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design organization criteria

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Choice of a preliminary system concept. 3. Organization of the design activity and delegation of

tasks according to that concept.

Coordination among delegated tasks.

group which is both organized and unbiased.

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unified system design.

rules.

through the following general stages:

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

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It seems reasonable to suppose that the knowledge that one will have to curry 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

28

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.

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DATAMATION

Communication dictates design.

-- Mel Conway, 1<u>96</u>7

Conway's Law



THE MYTHICAL MAN-MONTH

FREDERICK P. BROOKS, JR.



Brooks' Law

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

THE MYTHICAL MAN-MONTH

FREDERICK P. BROOKS, JR.



THE MYTHICAL MAN-MONTH

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Intercommunication formula

n(n - 1) / 2



THE MYTHICAL MAN-MONTH

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



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



Conway's (first) Law tells us TEAM SIZE is important

SO...

Make the teams as small as necessary.

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?

design organization criteria

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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."







Increasing Intractability

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

-- Eric Hollnagel, 2009

Conway's Second Law tells us PROBLEM SIZE is important

SO...

Make the solution as small as necessary.

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.

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> > DATAMATION

Homomorphism

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





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.

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

Chapter VI, "The Technostructure." ³ For a discussion of the problems which may arise when the design

Review, March-April, 1967, p. 73.

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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

Three reasons Disintegration occurs...

design organization criteria

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DATAMATION

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





Brooks' Law

Adding manpower to a late software project makes it later.

THE MYTHICAL MAN-MONTH

FREDERICK P. BROOKS, JR.

Disintegration: Reason #2

design organization causes its

communication structure to

"Application of the

disintegrate."

conventional wisdom of

management to a large

-- Mel Conway, 1967

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> > DATAMATION



Dunbar's Number

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





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design organization criteria

Once the organization of the design team is chosen, it is possible to delegate activities to the subgroups of the organization. Every line a delegation is made and same botly'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 agpents 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:

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

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



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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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 overt 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 arting 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 curry 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

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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 organiz-

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

³ 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.

Dr. Conway is manager, peripheral systems research, at Sperry Rand's Univoc Div. where he is working on reconnition of continuous speech. He has previously been a research associate at Case Western Reserve Univ., and a software consultant He has an MS in obvsics from Callech and a

PhD in math from Case.

DATAMATION

Communication dictates design.

-- Mel Conway, 1<u>96</u>7

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

So...

Make release cycles short and small.

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.



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.



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.



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.



Conway's Fourth Law

The structures of large systems tend to disintegrate during development.

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



Conway's Lessons from 1967

Increase communications
 Support continuous process
 Organize teams by products
 Make teams small as necessary









Conway's Four Laws

Mike Amundsen @mamund