The Siren Song of Linear Thinking

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Agenda

- The Appeal of Linear Thinking
- What is Linear Thinking?
- A Special Case of Considerable Interest
- An Illustrative Example
- Lessons
This is a work in progress.

While the basic ideas of this talk are stable, the best way to organize and represent them is less so.

This is probably one of my more “out there” talks, so I have left out a lot of wonkish detail to focus on a few basic ideas.

Still, there is a lot of material to cover so please capture questions via the chat facility, and I will answer as many as I can at the end of the talk, and try to post answers to all of them soon after the talk.
What the Sirens Are Known For

In Greek mythology, the **Sirens** were dangerous creatures who lured nearby sailors with their enchanting music and voices to shipwreck on the rocky coast of their island.

Wikipedia
The Appeal of Linear Thinking

- We understand the “real world” by modeling aspects of it “in our heads”.
- The simplest models we can make are linear models, and they often work well, especially for linear phenomena.
- Simple linear models are also easy to understand and implement, and seem amenable to straightforward management control, especially assessment of progress.
- This offers a compelling incentive for us to try to linearize complex (i.e., inherently non-linear) phenomena.
- After all, everyone knows the shortest distance between two points is a straight line.
What makes something linear?

- Representable as a Scalar
- Ordering and precedence
- I.e., discrete entities that can be mapped onto a line, and in many cases to the set of integers.
Examples of Linear Phenomena

- Counting
- Time
- Distance, Mass, Force
- Area, Volume, Speed, Density, Pressure
- Speech, Writing
What Makes Something Nonlinear?

- Things that don’t have an inherent ordering.
- Things that are not completely representable by a scalar.
- Things that are hard to compare with one another in a consistent manner.
- For example, ideas are such things.

Conjecture: the larger the role thinking plays in an activity, the more likely it is to be nonlinear.
Linear Concepts

- These follow from scalar ordering and precedence:
  - First, Last, Beginning, End
  - Next, After, Previous, Before
  - Less, Least, More, Most
  - Smaller, Smallest, Larger, Largest
  - Closer, Closest, Farther, Farthest
  - Sooner, Soonest, Later, Latest
  - Best, Optimal, Most Important

- The ability to identify things playing these roles is where much of the practical value of linear thinking comes from.
We can often map a non-scalar entity onto a scalar, for example, a vector onto its length or direction.

Note that if we insist on knowing both the length and direction, the mapping is no longer scalar.
Other attempts at linearization are less tractable – which is the “first” vertex of a Platonic solid (e.g., this icosahedron)? Given a vertex, which is the “next” vertex?
Linear thinking is the predisposition to model some phenomenon as a linear phenomenon, such that the linear concepts of the earlier slide apply to it, in particular to think of it in terms of a fixed order of discrete entities.
The Case of Interest

- A class of linear models of significant concern to enterprise architects is the class of system development lifecycle (SDLC) models, or more generally design (and thus architectural) methods.
- The argument that SDLCs and architectural methods are special cases of design methods is a subject for its own talk. The crux is the understanding of design as a broadly applicable activity, that entails deliberately making decisions (i.e., narrowing options) that lead to a desired outcome.
  - Most importantly, this is much more inclusive than the idea of design embodied by “the design phase” of an SDLC.
- The opposite of “by design” is “left to chance”.
Linear Models of Design Methods

- Such models posit an ordered sequence of discrete (bounded nominally non-overlapping) activities, each of which produces some outcome, real or virtual, that is input to subsequent activities.

- There are notions of the first activity, the last activity, the next activity, and the previous activity.
The Gated Waterfall Model

- Probably the most extremely linearized SDLC model.
- An ordered succession of discrete activities ("phases"), each creating an artifact that is an input to its successor phase.
- A phase cannot begin until its immediate predecessor phase is completed. This "gate" is usually "opened" only by the approval of some review authority.
- Once completed, a phase cannot be revisited, nor can its output artifact be revised.
Example
Concessions to Reality

- This model requires that you “get it right the first time” in each phase (because you only get one chance), and is unforgiving of the failure to do so.

- In particular, early flaws generate cascades of adverse consequences that are increasingly difficult (and thus costly of both time and effort) to repair.

- This has led to the introduction of iterated incremental progress towards the final activity.
One is reminded…

… of certain historical attempts to preserve a simple model by adding complexity “around the edges”:
Consequences

- The introduction of these opportunities to “do it again” make the process more complex and decreases the nominal value of the “linearity” of the process (predictability and control).

- However, this doesn’t really solve the problem, which is that linear models are not well suited to nonlinear phenomena.

- Still, we are often willing to go to considerable lengths to preserve the illusion of linearity.
An Analogy

Remember:

“An analogy is like a bucket of water with a hole in it – you can only carry it so far.”

Huston Smith
An Extremely Linear Method for Doing a Jigsaw Puzzle

- Layout all the pieces.
- Find the “first” piece (i.e., upper left hand corner), and place it in its proper position.
- Find the “next” piece and place it in its proper position. Repeat until the row is completed.
- Repeat for each successive row until the puzzle is completed.
Observation

- This method would obviously work, but it’s not how anyone with the least bit of sense does a jigsaw puzzle.
How We Actually Do Jigsaw Puzzles

- First we find and place as many of the corners and edges as we can, as they are easier to identify and they “bound the problem”.
- While doing the edges, we take advantage of finding pieces that are near the edges by placing them in the general area we expect them to be. At the same time we may start assembling “obviously localized substructures”.
- We look for pieces that extend areas we have already assembled, by using matching heuristics such as shape, color or pattern.
- The “solved” part of the puzzle grows by accretion, until it becomes a problem of filling in voids that get progressively smaller, and thus easier to fill, until the puzzle is completed.
Snapshot 1
Snapshot 2
The End

Image © B. Kliban, used without permission.
Please Don’t Miss the Point …

- The point of this example is not that an enterprise is like a jigsaw puzzle.
- Obviously, an enterprise is very different from a jigsaw puzzle –
  - you don’t have a detailed picture of the final result, which is changing all the time anyway;
  - you don’t have all the pieces of the solution available from the very beginning.
Which is …

- The point is that the way experienced, successful designers approach complex design problems (as revealed by a considerable body of research) is much more like how we intuitively solve jigsaw puzzles than it is like adherence to some linear SDLC.
What We Really Need to be Able to Do
A Key Observation

- It really doesn’t matter what order we do these things or if we do them to completion before we move onto the “next step”, as there is no “next step” as such, just a set of heuristics employed opportunistically.

- We do as much as we can on one thing, and then move on to something else that we can now make progress on.

- What matters is that we continually preserve certain invariants, or at least continually refine close approximations of them, specifically the relationships between the pieces.

- What’s more, this is an inherently parallel approach; i.e., several people can work on different parts of the problem at the same time.
Please Don’t Conclude Things
I’m Not Saying

- I’m not saying that there’s no sequencing involved in nonlinear activities.
- It occurs at the micro level rather than the macro level.
  - E.g., you can’t place a puzzle piece until you have selected it, for whatever reason.
- The sensible thing to do next is context-dependent, and there are usually a large number of equally “valid” possibilities.
An Idiosyncratic Perspective on Design

- The act of designing entails the making of a system of decisions that when correctly and completely executed are expected to result in some specified (i.e., intended) outcome.

- Ask yourself:
  - Can you design anything without making any decisions?
  - Can you design by making decisions that have nothing to do with one another?
  - Are you designing if you don’t care what the result is?
This is a picture of the HPGM for ITSA solution architecture methodology of what was then HP Professional Services.

At some point in my experience with HPGM for ITSA, I thought of the picture as depicting not a sequence of activities, but rather an information structure.

This in, conjunction with research into the literature on how designers actually design, led to the realization that “linear methods” were not well suited to solving design problems.

I later realized that we too often confuse the way we represent the final state of something with the method we use to achieve it.
Think of the elements of the model (the “boxes”) not as activities but rather as information structures (virtual outcomes), and the lines between them not as sequencing relationships but rather as constraint relationships (e.g., implies, is required by, comprises, …).

Think of the whole set of these information structures (all the “boxes”) as a system that is seeking dynamic equilibrium, where all the constraint relationships (that embody the desired outcomes) “want to be” satisfied.
Patterns and Heuristics

- Do whatever you can, whenever you can, to incrementally grow the system of information structures to completeness while maintaining your best approximation of this equilibrium.

- Do so by applying heuristics associated with recognizable patterns within and across these information structures, to generate or modify elements of these information structures.
Nonlinear Methods

- Think in terms of information structures and the outcomes they represent rather than activities and their discrete “outputs”.
- Populate these information structures:
  - Opportunistically, by
  - Applying contextually appropriate heuristics,
  - Suggested by patterns in that context.
- Continually revise these information structures based on what you learn.
- Don’t fall prey to the “donkey paradox”.
- Be prepared to drive your management crazy.
In the HPGM for ITSA case, the complete set of information structures, which can reference tangible artifacts, and the relationships among them, together provide a complete representation of the architecture of the solution, as “architecture” is defined (most likely implicitly) by HPGM for ITSA.

Too often the relationships between the “output artifacts” of a sequence of activities are left implicit and generic.
A Nonlinear Skills Model of Design Expertise

- A rich set of patterns and the heuristics they suggest.
- The ability to recognize these patterns in a wide variety of contexts.
- The ability to apply these heuristics in a wide variety of contexts.
- The ability to add new patterns and heuristics, and extend the applicability of known patterns and heuristics, based on experience.
- Modulated tenacity (“knowing when to let go”).
The Risk of Inappropriate Linear Thinking

- When linear thinking fails, it fails badly. Sometimes it’s not just a bad approximation, it’s completely wrong.
- Worse, it fosters certain problematic illusions, the most dangerous of which is that it is possible to de-skill an expert capability. Being able to follow a recipe does not make you a professional grade chef.
- Another problem is that the identification of some consideration as “the best” or the “most important” can lead to the inappropriate dismissal of other considerations, thus oversimplifying a situation that is inherently complex.
The Risk of Inappropriate Linear Models

- While it’s often easy to describe and teach a linear process, and describe the desired outcomes of each step, it’s rarely possible to provide foolproof methods for achieving those outcomes. The net effect is the worst case of “left to the reader as an exercise”.

- The canonical example: “have a good idea, now”.

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Wikipedia
Acknowledgement
Thank You

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