National Alliance for Physician Competence Discovery Workshop

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Context

- In this round of work half the group heard a talk by Norman Johnson on Strategies in Ecosystems while the other half of the group heard a talk by Curt Lindberg on Positive Deviance.
- **Download:** Norman's Powerpoint slides. In order to view the movies (the simulation) you might need to also download the movie files. They can be found here.)
- **Download:** A paper by Norman entitled The Development of Collective Structure and Its Response to Environmental Change.
- **Download:** A paper by Norman entitled Interplay of Adaptive Selection and Synergistic Performance: As an example of natural selection and self-organization
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Strategies in Ecosystems

Norman Johnson

Let's do some discovery. What's happening on the screen? This is a loop of a computer simulation. Looks like a lot of random motion. Here it is starting from the beginning. What is happening now?

This is a simulation about ants. They exploit one food source and then started looking for other food. This is a simulation of ants foraging for food. There are two food positions - close and far away. Notice the closer food source is exploited first.

Why would ants exploit the closer food source? They don't have any rules that tell them to do this. (They only have three rules: take food to the nest if you have it and lay a pheromone trail, search for food using the collective pheromones if present, otherwise search randomly.) How does this happen?

The answer discovered from the group is that closer food sources have stronger collective pheromone trails and it takes less time to exploit a food source. Hence the simple individual rules create a collective process between their interactions that is greater than the simple rules.

This exploitation of the closer food source is an emergent property of the collective – it's only observable in the whole and you can't predict it from knowledge of the individuals. This just doesn't happen for ants, many social phenomena that we rely on are emergent properties.

What if I had a food source that is really far away and the pheromones evaporate? The collective will fail, because they lose their communication system.

Who saw Lauren Buckley's presentation? (about half) She looked at competitive strategies in changing environments. On the first slide she used these are the networks that exist in these wonderful places. Imagine taking the different organizations in the Alliance and drawing a line between each of the individuals or groups that communicate with each other? You will get a different network diagram from each of them. You can tell a lot about them from looking at these networks – about their performance and their robustness/resilience.

Before we look at nature, let's identify first what is different about nature and human systems – do we don't jump to analogies that may not have meaning.

First: Human systems have mass communications and ecologies don't. In those networks only close neighbors "talk" to each other. Human communication results in tighter and tighter coupling than these ecosystems. Which leads to strong collective behavior – like best seller's list, fads, irrational behavior on a huge scale, possibly even wars.

Second: Human systems have parts that are constantly speeding up – like communication, computer processing, social change, technology change, etc. While I can speed up my brain by 20% with caffeine, I'm pretty much stuck with this processor – no 100-time-faster upgrade for me. Ecosystems change too – but it is mostly a change of relationships, and the actual entities don't change that much (evolution is a SLOW process).

There are a lot of people that try to sell you biologically-inspired ideas but the influence of these two differences - mass communication and speeding processes - makes human systems a bit different.

Now let's go through Lauren's main slides. What is a one line summary of the paradox of the plankton? What was observed is that you had many species all apparently competing in the same niche and that just isn't observed to be stable – yet it was. What is the solution to the paradox? Different species exploited different spectrums in the light so they weren't competing across species - they were only competing within the species. They did indeed have their own niche (of light). That is an example of finding a niche that allows you to exist.

Next slide. This is the beak size versus time graph. It shows adaptation to environmental change. The beaks changed to adjust to the seed size over time – particularly as droughts change the average size of the seeds available.

Next slide. This shows the evolution from an open field to a dense forest. There is a totally different competitive strategy being employed at each end of this chart. The early strategy is a reproductive strategy.

The species that can reproduce fastest in the early stages wins – independent of performance (think of the early dot-com days). The strategy in mature systems is just the opposite: focus on a few of high performance. These nature-inspired strategies map very well over to human systems, and they illustrate how important the stage of development is to the strategies you make!

We (the experts) don't have a clue what's going to happen in some of these systems when change comes.

Next slide. This was the pacific coastal ecology before otters were killed off. What happened? The food web changed and the network changed. What was surprising was that abalone didn't thrive when sea otters were removed. We (as experts) don't have a clue what's going to happen in some of these systems when change comes. Sharks started eating sea otters because humans wiped out the large fish that they preferred and that is what started the whole thing.

Next slide. What about this one? This shows there is a sweet spot with the amount of disturbance in a system that allows for diversity to thrive.

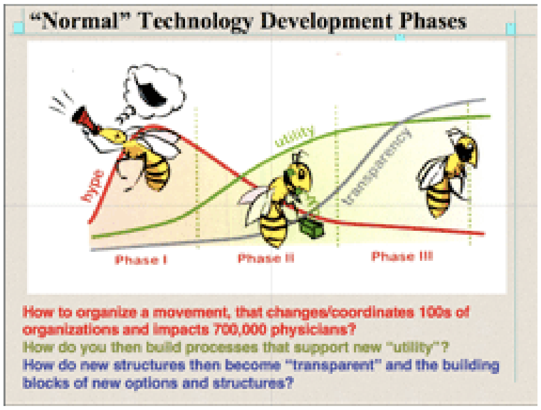
Here's another lesson that Lauren did not talk about: Who is the most genetically different diverse ethnic group on the planet?

Native Americans? No. Australians - Aboriginal Australians. The reason for that is they are the oldest human species so they have more time in a stable environment to diversify. This is a general rule: newly evolved species have low diversity – but as you mature your relationships to the surrounding expand and greater diversity can be supported. This is exactly where the organization in the Physicians Alliance are – many organizations with lots of different approaches.

On the phone call someone commented that professionalism is a systematic way to reduce diversity and survivability. An uncomfortable question. Is that true? Does it reduce survivability or diversity? Well, as we'll see, mature systems (as for professionalism) can create lots of diversity, but the diversity may have very few options because of all the rules and regulations. Again, we see that developmental stages are important to understanding your strategies.

Next slide. This shows two evolutionary trees, before and after genomic sequencing told us how evolution really happened. I've met researchers that have written papers for 40 years about the left diagram. They were pretty sure they knew what was happening. Then along came massive genome sequencing where you can determine when there was an exchange of information in the system. This produced the figure at the right – many more connections and exchanges. The world they thought was stable and understandable all of a sudden went out the window. It's even worse that this. Do you remember Lamarckian evolution – the claim that traits learned during your lifetime are inheritable? This was used as a major and embarrassing example of the failure of Russian science. We are finding he was right in some ways. There is a way to let the genome learn (methylation) that gets passed on to later generations!

Next slide. Back to the ants. Suppose all the ants initially took the same path in searching for the food? There would be no diversity. Could they find the shortest path to the food then? No! The shortest path solution only happens because there is diversity in the ant colony. This is a major observation of how the synergy (rather than selection) of diversity leads to better solutions. We'll come back to this.



This chart introduces the idea that there are different stages in a self-organizing system – here, specifically technology adaptation: hype/discovery stage, utility stage, and transparency stage. The transparency stage is where the technology becomes transparent in its use – like phones today. This development process very much applies to your undertaking. You are struggling to develop a movement that influences 100s of organizations. You are asking about developing new and different ways of producing utility. You would like utilities to be the building blocks and be transparent.

An example of this is telephones. Telephones started in rural America. There was a point they became useful but not so easy to use - they weren't transparent.

Let's try to connect come ideas. The next slide shows a variation on the ant simulation we saw at first. There is an infinite food supply and more and more agents get into the collective process. Next slide. If you plot the total amount of food obtained over time there are a couple of break points in the shape and these correspond to stages that develop. At the end there is a long tail of constant production, a less productive time in the middle and an early random time.
The first stage is about individuals discovering things and discovering new structure. The second stage is the structure starts to overlay - no one ant finds the shortest path – but the collective does. The last stage is an optimized system where almost all of the individuals are exploited the emergent solution (the shortest path) and it's now transparent.

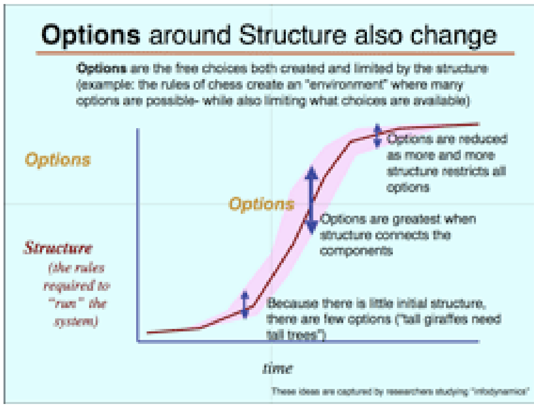
This slide summarized the three different stages of self-organizing systems: formative, synergy, optimize. If you look at the individuals actions in each stage, they are very chaotic in the beginning but predictable in the end. Early on the performance is due to diversity but it starts to change as you get later in the cycle and the last phase is all due to the optimized collective. Diversity grows, but at the end there are few options and they aren't changing very much.

Note that when I talk about Diversity it could be different strategies.

Next slide – This is a plot of how structure increases over time. For example, the pheromone trail is a structure and it grows little in structure at the beginning (all the ants are just wandering around) then it increases rapidly as the collective finds synergy and then the structure levels off . There is a limit to how many individual paths you can put on top of each other and create new structure.

As an ecosystem gets older there is no more room for more restrictions. At a certain point you would break the system if you put in more rules.

As an ecosystem gets older there is no more room for more restrictions. At a certain point you would break the system if you put in a bunch more rules. Think of what would happen if you added more and more rules to a chess game? At some point it would be unplayable.



The rate of structure development declines towards the end – even though there might be a lot of structure in the end. In nature, this structure can be related to diversity. In Australia – the most stable ecosystem in the world (until recently because of climate change) - there might be one type of butterfly that only pollinates one type of flower – making for loss of apparent diversity, but that means there are no other options for that butterfly. Hence not only do you have to have diversity, but it must be expressed and they must be flexibility such that new synergy can be found.

Now let's add the options onto the structure. Initially structure creates options (tall plants mean tall animals – giraffes). Then there is an explosion of options at a certain level of structure. There is a sweet spot for options in the middle and then as you put more structure on it you get less options. Where is your system? How many options and how much structure do you have? (Answer: there is lots of structure – maybe too much and too few options.) Robustness comes in the middle. The end is not robust and the beginning is fairly fragile.

Next slide. Here's a plot of the utility of an expert as a system becomes more complex. At very low complexity, everyone can solve the problem and you don't need an expert – they have no utility here. While more complexity you can hire an expert to tell you how to optimize it. But if the problem becomes too hard, even experts fail – such as in the stock market.

Now add the utility of the collective to the figure. What we are finding is that if the problem is too complex you need the collective to solve the harder problem to go to optimization.

Next slide. Let's look at what can go wrong when the system is changing – which really is the world we live in now – more change very day – and it's only going to get worse.

This is the same simulation that we saw in the beginning. Towards the end of the previous simulation, I've re-introduced the two closer food sources.
Before we saw that the system exploits the closer food source, but now – because of the prior structure - they are enamored with the food source that is further away and the emergent property is not an option. This is an example of how structure can be mal-adapted in changing times, so it takes the solution away from what is more optimal. Let's look into this much deeper.

Next slide. We are going to take a source of food and move it in a circle. What happens when it moves slowly? The colony does a fairly good job of adapting. Before the scouts (innovators) didn't really do much but now they play a very important role in finding the new food source, so that the collective can exploit the resource. If you graph this you can see the production in the collective versus the individual.

How can you reduce the bust? Make more scouts!

What if we move it 50% faster? What happens? This amount of change creates a boom and a bust cycle. Look how the productivity collapsed.

How can you reduce the bust? Make more scouts! You can increase the performance by 40%: If you reduce the strength of the pheromones by making it evaporate faster, you can create more scouts. Hence, there is a tradeoff between performance and robustness. A major lesson to learn is that busts are so bad that removing busts from the system by lower your performance during good times can greatly increase the time-averaged performance – 40% in the above example.

If we move the food really quickly all the productivity is happening from the innovators. What about the collective? Does it help or hinder? The collective never gets food in this case. It takes up valuable potential innovators.

Here's a slide that summarizes everything we just learned. If systems change slowly, they go to an optimized developmental stage. But as change happens faster, the final development stage push to less developed systems. Also you conclude that you force the system to go back to earlier stages of development by increasing the rate of change. Can you make observations about your system as the rate of change increases?

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Let's quantify the effect of the collective on responding to change. Structural efficiency is how well the collective produces food. What we see is that for low rates of change the structural efficiency is positive and large, but as change increase, the structural efficiency declines and goes negative. The collective is actually hurting the efficiency. Hence in times of fast change, the self-organizing collective must be carefully managed so that it doesn't reduce system productivity.

Social trends can stress the development of resources (remember the comment earlier about professionalism), reduce diversity and make you more susceptible to tragedy. The Feds goal under Greenspan was to keep robustness in the system and not necessarily to optimize the system.

Conclusions: You are much better off keeping a system robust in times of fast change.
Mass communication is the ultimate pheromone trail for humans – While the collective might be able to prevent the bust cycle through diversity, the downside is that if mass communication results in a fad (reducing diversity) it could make the system more susceptible to boom and bust – lowering overall performance.

Summary - if there is no change in the environment you go from formative to synergistic to optimized stages – each with its own dynamics and performance process. If you have a slower change innovators become more important but production is similar. If you change more quickly you will never get to be optimized. If you change faster than the individual can adapt you get force the systems to a formative stage.

Structures come in different flavors. Because we have options to change structures, it's good to know the flavors they come in. They can be superficial and not really effect outcomes (some say many of the colors in nature are of this type – diversity not for a purpose but because the diversity generation engine just didn't know when to stop) or they can be something like hydrogen bonding – which will always be present – no matter how many times you replay the tape, even if you tried to change it. And then there are structures in between. Would we get the same specific DNA coding if we played the tape of evolution again? Likely not, but we still would get some type of digital coding.

Don't focus on structures in the system you can't change.

Conclusion: Don't focus on structures in the system you can't change. Don't focus on structures that don’t influence the outcomes.

This is the curve of time versus production we saw before – for a very slowly changing food source. It looks just like the curve with the food not moving.

What would happen if I said let's make the strongest pheromone structure permanent? This is like saying, lets take our best ideas and make them law, never to change again. If we have a little change in the system it drops production and there would be death. The environment is changing and they aren't adapting.

It turns out that largest companies (with a few exceptions) are not the best performers because they cannot adapt (there is no Creative Destruction). Any system has to creatively destroy part of itself in order to keep alive and evolving. Capitalism is like that. Recommend the book: Creative Destruction by Foster.

Here’s a fun surprise when I originally did the simulations with the ants. I made the food incrementally speed up just to see it go through all the stages in one run. That was cool, but after a certain speed it was all about the innovators and I lost interest. All of a sudden the ants came up with a solution that I didn't expect. They oscillate. They get back to the food and it's like oh, it never left. “Damn them” I said, and even made it harder by changing the radius of the food as it went around – And they still figured it out. I admitted defeat – they are smarter than I was.

They discovered with a moving food source they could have a great strategy.

Focus on process not product.

Conclusions. Lauren talked about competitive strategies but it's also important to talk about synergistic strategies – these are more common in mature systems you deal with. Bust are catastrophic, and you should focus on robustness before performance. Different types of structures have different reproducibility – so pick your battles against structure wisely. You need to learn about creative destruction. Focus on process not product in times of fast change – a good process will never become obsolete, where product (or specific rules) will always become obsolete. Emergent solutions cannot be planned (we don’t understand these system well enough yet) but they can be enabled by diversity.

There needs to be a balance between performance and structure.

There needs to be a balance between performance and structure. The formative stage is good for building structure but it's a fragile time.

What if you had alliances between different organizations that are in different stages of structure?

Think of that chain of information that gets passed on between the different stages of the process – how you’re are interdependent. As long as they are communicating with each other – you can adapt. If one component implements a bad strategy and fails, they could bring the whole system down. Increased local (between parts) communication can go a long way to improve your adaptability and robustness.

Bryan

Your assignment hasn't changed but you are going into your group and you will report at 5PM.

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