Chapter 3: Structured, Pressured, Networked, Supported Starfish Systems of Schooling

Studying education produces puzzles both at the very top and at the very bottom of the quality spectrum. The US and UK together have only 5.4 percent of the world’s population and yet have over half the world’s top universities—ten times their population share—and almost three times as many top universities as all of continental Europe combined. Why? At the opposite end of the quality spectrum, studies show that teachers with far less academic qualifications and no pedagogical training can produce equal or better results in primary schools than their more qualified teaching peers in Africa and India. Why?

These questions about why must confront our usually quite successful way of answering “why” questions using our baby ontology. That is, we divide the world into “stuff” or “agents” and explain outcomes as the result of the behavior of those two categories. While this baby ontology nearly always serves us well, when it comes to explaining systemic differences it can only reach a proximate level of explanation, but not really provides answers to why agents are led to such different outcomes. While schools are better when teachers are better, this is a tautology, not an explanation. Teachers are better on average as a result of the systems into which teachers are embedded.

This chapter develops a descriptive taxonomy of the functioning of educational systems. For example, if we want to know why some cars are faster than others we need ways to describe the parts of a system—engines, transmissions—and ways to describe the features of those systems—size (displacement), gearing ratios. We develop this vocabulary with an eye not towards explaining why some systems work and others don’t—which, as it turns out, does not lead anywhere useful, but rather why some arrangements work better or worse at some goals than others and why some arrangements work better in some social contexts than others.

A fundamental branch in this taxonomy is between directed orders and emergent orders. This fundamental difference in the way connections between agents in any social system are structured has been explored by social scientists of every discipline using a variety of labels and metaphors. Economists contrast “command” economies with “markets.” Political scientists contrast “totalitarian” regimes with “polyarchy.” Organizational theorists compare “tightly coupled” with “loosely” coupled organizations. Sociologists since at least Max Webber have contrasted “bureaucracy” (large, formal, rules driven, hierarchical organizations) versus the “personalistic” modes of organization.

A key difference across all these distinctions is the role of teleology—the intentions of agents—in the explanation of the course of events. In directed orders we explain outcomes as the result of the will of key agents: steel production went up in the Soviet Union because Stalin wanted it to, the Allies invaded on D-Day because Eisenhower order it, Microsoft launched Word because Bill Gates wanted a share of the
word processing market. In *emergent* orders outcomes are the result of the interactions of many thousands or millions of individual agents making decisions that are structured or constrained or shaped—but not directed—by the conditions and pressures of the rule systems they are embedded in. The outcomes and properties of emergent orders are not the result of the will of any given agent.

Of course the outstanding example of emergent orders is natural evolution. The dazzling variety and wonderful beauty and strangeness of the natural world can be explained without anyone willing it so. The elephant has its amazingly useful trunk not because of some Kiplingesque “just so” story or because some extraordinary historical elephant wished it to be so but because of a million of random genetic accidents and the pressure for survival.

Brafman and Beckstrom (2006) discuss organizations that are “directed” versus “emergent” using the metaphor of a spider and a starfish. A spider spins a web (literally) that expands its reach and span of control. But all decision making in response to what happens on its web is first transmitted to the spider, which then makes a decision how to respond and allocate its resources. This is a classic top down organization or system. In contrast, the starfish has no brain. In fact, the starfish as an organism is really a very loosely coupled system so that the individual tentacles respond to local stimulus not as the result of transmitted information and receiving orders, but by responding roughly independently. The “decision” of a starfish to move is a *result* of decentralized actions by its constituent parts, not a *cause* of action.

Spiders are neither better nor worse than starfish. Each, through a process of evolution, has adapted its approach to its circumstances. Similarly with organizations. Sometimes “top down” is used as an insult but centralized control is sometimes essential. These days “bureaucratic” is more often a curse than a compliment, but the order and regularity created by private and public bureaucracies created the world’s prosperity.

The key question is what mode of *systemic* organization is best adapted to a particular challenge. I argue the fundamental challenge facing many educational systems is that their current successes were created by spiders but that their future challenges can only be met through more starfish-like approaches.

But not all starfish are alike, and four elements that distinguish among starfish systems of education:

- How is entry and exit of providers *structured*?
- How are the units of the system *performance pressured*?
- How is the system *professionally networked*?
- How is the system *financially supported*?

I show how this taxonomy can be use to describe systems of education as diverse as American higher education, the industrial organization of instruction, and the International Baccalaureate (IB).
I conclude this chapter by showing how the taxonomy can be used to distinguish the variety of starfish like systems for basic schooling. The point is not that everyone should own the same car and I am going to tell you how to design the perfect car. The point is that there are some basics to a car and the design of any car has to make choices about the features of the car: what type of engine? What type of transmission? What body structure? But, the pieces do have to all fit together into a coherent whole.

In chapters 8 I provide a design for open structured, performance pressured, professionally networked, inclusively supported starfish system of basic schooling based on decentralization to local units of government. In chapter 9 I provide a detailed blueprint of an open structured, performance pressured, professionally networked, inclusively supported, starfish system of basic schooling based on regulated entry of a range of non-public providers (an “extended charter” system).

But before I get to those chapters, chapter 4 describes why the learning profile will not be sufficiently steepened by “business as usual” expansion of known inputs. Chapter 5 argues that spider systems can actually get trapped by their own past success into mechanisms that prevent their further improvement. Chapter 6 explains why nearly all countries are dominated by spider systems. Chapter 7 why nearly all developing countries should look to move to some type of starfish system for basic education because they cannot expect to ride their spiders to success in achieving 21\textsuperscript{st} century learning goals.

I) Puzzles from Top and Bottom of Educational Systems

The United States plus the UK and the EU-27 (less UK) are, in many ways, similar aggregates. They are of similar size in population, with the EU slightly larger, similar magnitude of total GDP, with EU less UK slightly smaller, similar types of governments and capabilities and similar levels of completed schooling.

But these two are poles apart when it comes to the quality of higher education. The Annual Ranking of World Universities (ARWU) published by the Center for World-Class Universities and the Institute of Higher Education of Shanghai Jiao Tang University in China ranked the world’s top universities mainly on their research output and quality as well as how many alumni win prestigious academic awards, a ranking that leans towards emphasis on the natural sciences. What is striking about this list is that of the top 100 universities in the world the USA/UK alone have 65 of the world’s total 100. Continental Europe manages only 23 of the top 100. The USA/UK has 2.8 times as many universities in the top 100 as Europe.

Of course, since any league table of universities inevitably inspires controversy I used three other rankings to be sure this basic conclusion was robust. One done by the Times Higher Education and QS (THE-QS) focuses more on peer and employer surveys, faculty research output, and student evaluation. This showed fewer of the top 100 in the US or UK, but even so, there were 2.5 times more global toppers in US/UK than
continental Europe. A ranking of global universities done in Russia found 60 of the top 100 in US/UK and only 17 in the EU (less UK). Another metric, using a less comprehensive, but more cutting edge indicator is a universities Web presence. On this metric again the US/UK have 76 of the top 100 leading universities in the world and over half the top 200.

<table>
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<th>Table 3.1: The quality of US/UK Universities dominates that of Continental Europe, with more than half of all top 100 universities in the world</th>
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<td>Ranking method</td>
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<td>ARWU</td>
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<td>In the Global Top 100</td>
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<td>Source: Authors calculations based on data from the ARWU (Annual Ranking of the World’s Universities) 2009, the THE-QS (Times Higher Education-QS) ranking 2009, the and the Webometrics ratings 2009.</td>
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While many focus of many rankings on who leads and the few elite schools in the global top 10, what is really striking about US and UK universities is how very deep the bench is. The “middle tier” universities in the USA would be super-stars in any other country. And vice versa, the very top universities in most countries in Continental Europe would be hard pressed to be middle of the pack American universities. Take France, a country with over 60 million people, a glorious history, and a long tradition of academic excellence. Table 3.2 compares the ranking of the four French Universities listed in the THE-QS top 200 or ARWU top 100. The interesting thing is not that France doesn’t have a Harvard or Oxford/Cambridge, its best ranks with Carnegie Mellon (USA) or Bristol (UK). But what is truly amazing is that in the THE-QS ratings the fourth best university in France would be the 43rd best in the USA, just ahead of the University of Virginia or the Ohio State University. By the ARWU ratings the third best university in France would be the 44th best in the USA, tied with University of Rochester.
And the French are among the better of Western Europe in these ratings. Neither Italy nor Spain have a single university in the ARWU top 100, putting their best on a lower ranking than the US universities rounding out the top 100 like University of Indiana Bloomington and Arizona State. In the THE-QS top 200 the top Italian university has a global rank of 174th, and the top Spanish University is rated 171st. Again, it doesn’t surprise anyone that many of the world’s very best universities are in the USA, but that Italy’s and Spain’s best university ranks globally just ahead Texas A&M is probably a shock to most.

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<tr>
<th>French Rank</th>
<th>Global Rank</th>
<th>Rank of French institution if in the US</th>
<th>Next best US ranked institution</th>
<th>Rank of French in UK</th>
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<td>28</td>
<td>14 Carnegie Mellon</td>
<td>8</td>
<td>Bristol (34)</td>
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<tr>
<td>2</td>
<td>36</td>
<td>19 UCLA</td>
<td>10</td>
<td>Warwick (58)</td>
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<tr>
<td>3</td>
<td>117</td>
<td>39 Case Western Reserve</td>
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<td>Aberdeen (129)</td>
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<td>4</td>
<td>126</td>
<td>43 University of Virginia</td>
<td>20</td>
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<td>ARWU 2009 top 100 World Universities</td>
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<td>32 Penn State (42)</td>
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<td>Edinburgh (55)</td>
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<td>36 USC (50)</td>
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<tr>
<td>3</td>
<td>73</td>
<td>44 U. Rochester (73)</td>
<td>8</td>
<td>Scheffield (77)</td>
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This amazing depth in quality of the US and UK (given its population size) is an intriguing fact because one can immediately rule out several simple explanations. First, we know that the US system of basic education (K-12) does not emerge covering itself in glory in any of the standard ratings of student learning achievement. Second, this is not the result of “first mover” advantages as Harvard was barely a glorified high school when Oxford and Heidelberg were hundreds of years old—not to mention parvenus like Texas A&M, whose origins date to 1876 as the Agricultural and Mechanical College of Texas. Third, it is not “agglomeration economies” that bigger population can support better as the UK has roughly the same population as France or Italy.

How can worse teachers do better? Shifting to the other end of the educational spectrum, Chapter 1 showed the basic education in the poor countries of the world is very, very, basic, with even primary school leavers struggling to master functional literacy or simple arithmetic—much less have conceptual mastery or the ability to apply these to novel situations. The ubiquitous approach to improving this education has been “more of the same”—that is, expanding inputs to have, for instance, smaller class sizes, and improving the formal qualifications of teachers to get “better” teachers. But is better really better?
In the small tribe of economists one part of the small clan called “development” economists have taken the problem of “yes, but” head on. It was long said that economics was a quantitative science, but with no experiments. The difficulty with non-experimental data is that even where one can establish strong associations there are usually too many possible theories of how choices and behavior could lead to the observed outcomes. So most economics seminars consist of long strings of yes buts—“yes, students in smaller classes don’t perform better but maybe worse students are put into smaller classes,” “yes, students in private schools have higher scores but maybe parents choose to put smarter kids into private schools.” Given that all educational outcomes are the result of a long and complicated series of decisions by multiple actors (parents, students, teachers) it is easy to concoct a “yes-but” of your own to nay-say empirical result.

The way around the “yes-but” problem is to actually do experiments. Recently there have been two major experiments concluded by some of the world’s best development economists and both of them have nearly identical findings: “worse” teachers do as well, if not better, at improving student’s test scores.

The first experiment was carried out in Western Kenya in which it was decided to effectively lower class size by assigning extra teachers to class rooms. Fortunately, rather than just operate on the assumption this would work, there were various experiments tried to see which would be the most effective way to improve learning. Some in some instances the extra teacher was a regular civil service teacher and in others the additional teacher was a teacher on contract. The “contract teachers” were, on average, paid much, much, less generously in both wages and benefits than the “civil service” teachers. If “you get what you pay for” one would expect the children to assigned to lower class sizes to learn more (as this reduction in class size is very expensive) and you would expect the children with contract teachers to learn less.

In fact, roughly the opposite happened. Children who were randomly assigned to be in a smaller class with a civil service teacher had achievement that was exactly the same (actually, very slightly lower) than the control group. On the other hand, children who were assigned a smaller class with a contract teacher learned almost .2 effect sizes (the gain normalized by student standard deviation) than the control group students.

How can cheaper be much better? The evidence provides two clues. First, another experiment was to train committees in school based management, to increase the ability of parents to manage the affairs of the school. In those schools, the reduction of class size worked better as well—with both civil service and contract teachers. But the combination was doubly powerful, so that while reducing class size alone did nothing, reduced class size with contract teachers and informed parents produced achievement scores .27 effect sizes above doing nothing.
A much more direct piece of evidence is from the observation the study made on teacher behavior, in which it tracked whether the teacher was physically present in the school and, if present, was engaged in teaching. In the control schools this percent of teachers teaching was about 58 percent. Among the teachers assigned to class size reduction the attendance rate was lower, only 46 percent—but among the contract teachers the attendance was 76 percent. Since the overall attendance of 46 percent is the average of the attendance of the contract teachers and the civil service teachers, this implies that the attendance of the civil service teachers plummeted when assigned to extra classrooms. In effect, when more resources were applied that could either go to improve learning or to reduce effort in the government schools with civil service teachers the choice included effort reduction.
Figure 3.2: Among civil service teachers all of the impact of reduced class size was dissipated in less effort

The beauty of the experimental method is that the results are what the result are. The drawback is that the “external validity”—whether these particular results are specific to Western Kenya or more general cannot be established within the experiment. Fortunately, in the state of Andhra Pradesh in India another, larger scale, experiment also allowed the comparison of contract and regular teachers.

In Kenya the teachers hired by the communities had to have the same qualifications as the regular teachers. In AP contract teachers could be hired that did not meet the same formal qualifications as the regular teachers. Figure 3.3 shows the comparison of the regular and contract teachers in the AP experiment’s “control” schools. Contract teachers have dramatically less formal education and less formal qualifications and training. And, even after they were given a 50 percent raise in the second year of the experiment, they earned only a sixth (1500 rps/month versus 9000 rps/month).

Stop and think what you expect the outcome of the experiment to be. It just has to be the case that children learn more with regular teachers. They have more teaching experience, they have more formal education, they have more teacher training, they are better paid—and each of these gaps is massive. In fact, one advantage of this experiment is that the gaps are so big. This is not a question of whether teachers making 10 percent more or even 50 percent more, the regular teachers make six times as much. If pay makes for better teachers at all this experiment should be able to find the impact.
The Rebirth of Education

Figure 3.3: Contract teachers in Andhra Pradesh India had dramatically less formal qualifications and earned a sixth of the regular teachers


The good news is that there is a large and statistically significant impact on student learning of having been assigned an extra contract teacher (Figure 3.4). It is somewhat reassuring this is of roughly the same magnitude as that found in Kenya (an effect size of .14 in AP, .18 in Kenya). The direct estimate of the impact of reducing class with an extra contract teacher was large and statistically significant.

But what was the impact on learning of having a contract teacher versus a regular teacher? There was absolutely no difference. No matter how one slices up the data or estimates the impact—e.g. using all schools in the study or only treatment schools, controlling for student background or not, adding school effects, adding student effects—the result is that there is never a statistically significant negative impact of students having a teachers with, on average, enormously lower formal qualifications. Figure 3.4 shows a the range of estimates, with their associated statistical uncertainty, sometimes the estimate is positive, sometimes negative, but always very near zero. In fact, the impact of reducing class size by the same amount using a regular teacher was much smaller (.19 versus .32).
Figure 3.4: Having an additional contract teacher raises learning achievement—by as much or more than an additional regular teacher

Again, at least one source of this puzzle of how less qualified and less well paid teachers do better is not hard to find. The absence rate of regular teachers is 26.6 percent—on any given day one in four regular teachers does not there, and is 10 percentage points lower for the contract teachers. What is even more striking is that the regular teachers in the schools that received an extra contract teacher as part of the experiment were even more likely to be absent than those in the control schools—so regular teachers used the extra resources to shirk even more.

II) Escaping Baby Ontology: System explanations

Why is it that American higher education has such a depth of high quality institutions? Why is it that worse teachers can do better? But wait. Before you form an answer to why anything might be so, I want you, as a reader, to pause and ask yourself:

“why do babies love balloons?”

If understand why babies love balloons, then you understand baby ontology and if you understand baby ontology that forms a deeply wired part of all of our brains then you understand why most answers to “why” questions are going to be powerfully attractive, to you and others, but fundamentally incomplete.

Howard Gardner’s classic *The Unschooled Mind* discusses the differences between the way experts think and the way the “man on the street” thinks, even when that “man on the street” may have a fair bit of schooling. He recounts showing people the picture of a Nerf gun that shoots out balls of a barrel. In studies people are shown a picture of a Nerf gun with a corkscrew shaped barrel and then asked draw what the trajectory of the ball will be when it emerges from the barrel. I will admit that, even
reading the book knowing this was an illustration of man on the street misconceptions, I would have drawn a spiral pattern. The “natural” thing seemed to me that the ball, once out of the barrel, would continue to do what it did when it was in the barrel, spiral.

Turns out I was in numerous, but not good, company. Experts on trajectories of Nerf ball, that is, physicists who have acquired through many years of training and practice in domain specific thinking about physical objects, answer correctly. They understand that the “natural” thing, and what the ball actually does, is for the ball to travel in a straight line once it is out of the barrel. What Gardener found most interesting about the process of schooling is that even many students with years of excellent courses in physics from prestigious universities drew spirals just like my unschooled mind.

The most unschooled mind of all is a ba by, but even babies have “models” about the world, that is, they are constantly forming causal narratives of the world and using those to predict what is going to happen. Baby psychologists (that is, psychologists who study babies) have devised clever ways of studying what they (babies, not the psychologists) find interesting by tracking what babies look at and for how long. They find that babies look much longer at situations in which physical objects are doing anomalous things. For instance if a researcher has a stack of three blocks and pulls out the middle block and the top block does not fall, even very small babies will find this puzzling and look at it longer than normal behavior of blocks.

I argue baby ontology (the question of the fundamental types of things) consists of two very different kinds of things: stuff and agents. Stuff is acted upon. That is, stuff is subject to physical laws that determine how it behaves and nothing like will or volition or any interior mental states (wants, desires) affect its behavior. While some physical laws are very complex and fool me (like spiral barreled Nerf guns) others are pretty simple, some ways that stuff behaves babies learn really well, like object permanence—stuff stays where it is unless something else happens to it. Not surprisingly given the millions of years of evolution that went into the creation of the human brain, it learns the basics about stuff very early and, over the relevant domains required for survival, very well.

Agents act. This is the other half of baby ontology. Babies learn very quickly that there is a fundamental distinction between stuff and other things that impinge on them. These other things behave in ways inconsistent with the laws they are quickly learning about stuff. They move around without any visible external forces. This sets babies on acquiring models about other agents. This turns out to be much more, I would say, casually, infinitely more, complex than the rules that govern the relevant domain of stuff. Acquiring successful models of agents, both ourselves and others, and takes a lifetime of learning (and there are many failures, people who just fail to acquire minimally adequate mental models of the relationship between their actions and the behavior of other agents.

The important thing is that is all there is to baby ontology: stuff and agents.

Things are funny when they are unexpected. My sentence above: “Baby psychologists (that is, psychologists who study babies)…” was meant to be funny as an
unexpected disambiguation—none of you encountering the phrase “baby psychologist” thought of little babies in lab coats or wearing tweed jackets with elbow patches and bow ties. Hence my disambiguation of the phrase “baby psychologists” was unexpected and meant to be funny.

This is my theory of why helium balloons are nearly universally associated with babies, small children and fun—state fairs, birthday parties, tourist traps. They behave in ways that are unexpected at a fundamental baby ontology level: a balloon is obviously stuff but behaves in ways that only agents do: stays suspended in mid-air and moving around without obvious external forces. Says the baby in me, when I release this thing that is clearly stuff it moves away from me in ways that only agents move when I release them, it goes up. Balloons are just so damn cool because they are a fundamental challenge to my baby ontology (that was me speaking, not a baby).

Now, back to the question: Why does the UK have so many world class universities? With baby ontology there are only two possible ways to answer that question: stuff and agents. One kind of answer is a narrative of relationships between stuff, as proximate determinants, and outcomes. The UK has better universities because cutting edge physical research requires complex laboratories and equipment and the UK has been physical facilities for research. Or, the UK has better universities because cutting edge research requires big libraries and the UK universities have big libraries. Much of research into the determinants of educational outcomes associates stuff like measures (like class sizes, books per pupil, physical infrastructure) with outcomes. But nearly everyone recognizes these narratives, while they may reveal important connections, are incomplete as the stuff did not act on its own. Except in Harry Potter novels, the books are not in libraries because of books.

The answer to “why” questions consistent with baby ontology are stories about agents. Things are the way they are, why the UK has many world class universities, for instance, because people willed them to be so.

Similarly, one can explain the differences between contract teachers and regular teachers by the actions of agents—the contract teachers tried harder.

Here is where the expert and man on the street part company (and nearly all of us are the “man on the street” nearly all of the time about nearly all subjects). Experts in many domains of the social sciences explain outcomes in terms of in many domains of the social sciences explain outcomes in terms of systems. System explanations explain outcomes as the result of interactions of agents and stuff within the context of what have been variously called “structures” or “institutions” or “rules of the game” or “norms” or “patterns of behavior” or sometimes “culture.”

In complex adaptive emergent orders the system can have outcomes that no agent in the system intended. Two examples of complex adaptive systems in which outcomes emerge are evolution and economics.
If one asks questions today about the natural world, like “why does an elephant have a long trunk” the answer will be that it is the result of a process of evolution. This is a short-hand way of describing a system in which there is (a) a source of variation, (b) a mechanism that essentially evaluates variation, in that variants are more like to replicate than other variants. No central planner even designed an elephant’s trunk based on its optimality criteria. No elephant even chose their trunk size. The explanation of the wonders of the animal kingdom are that it just happened that way: stuff at the basic biological level (e.g. genes) interacted with system constraints and the outcome was elephant’s trunks and birds that don’t fly (penguins) and mammals that do fly (bats).

The essential insight of economics is perhaps still best expressed by Adam Smith’s two passages:

*Give me that which I want, and you shall have this which you want, is the meaning of every such offer; and it is in this manner that we obtain from one another the far greater part of those good offices which we stand in need of. It is not from the benevolence of the butcher the brewer, or the baker that we expect our dinner, but from their regard to their own interest.*

*As every individual, therefore, endeavours as much as he can both to employ his capital in the support of domestic industry, and so to direct that industry that its produce may be of the greatest value; every individual necessarily labours to render the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.*

When this is simplified into mathematics, economists can show that some equilibrium allocations have a property called “Pareto-optimality” (after an Italian named Pareto) which is that the allocation is “efficient” in the sense that there is not other allocation that makes everyone better off without making someone else worse off. The most important point is not defending “markets” in the real world but the deep conceptual point that one can formally model complex adaptive system and show that the system has properties, desirably properties in the this case, that no agent in the system intended or sought. This is an emergent property of the system itself, and cannot be “explained” in baby ontology categories of why things happen.
I am going on at length about this because this book is about systems and system explanations just have no appeal to people, myself included. Agent centered explanations are powerfully appealing to us, on a deep level. “Daddy, tell me a story.” Believe me, if your child asks you this he/she wants a story with agents, heroes and villains. Even economists when they try and explain Pareto-optimality resort to making the ontological unfamiliar seem plausible by invoking “an invisible hand”—and hence making seem familiar. “Oh”, say sophomores when given the invisible-hand metaphor, “like an agent with a hand willed it. I get it” and hence deeply don’t. But even as an economist who loves system explanations in the domain of my expertise am bored silly by historians who tell the stories of structures and institutions and geographic constraints (I have never been able to make my way through any small part of Braudel, for instance, though I often think that I should) and I love a good yarn about American independence that does not involve the carrying trade but does involve George Washington and his bravery.

This is because nearly all of our success as organisms is driven by understanding stuff and agents. Just as none of us really need to understand quantum mechanics or general relativity to live our whole lives as successful, fulfilled, productive individuals, the number of times any of use need to understand systems is vanishingly small. You can have a successful professional career without understanding systems, you can have a happy marriage without understanding systems (perhaps more likely in fact, trying asking your spouse some time questions about the system of marriage like, “why did monogamy triumph over polygamy?” and see how that works for you), you can raise lovely children, you can contribute to your society.

You just never need to really understand systems, until you do. Because even though life is always really about agents, it is really always about systems.

III) Systems: Spiders versus Starfish

Suppose a girl shows up at the door of the school today, ready, anxious and able to learn. What has to happen for this girl to have a successful schooling experience that will produce an education that prepares her to meet the challenges she will face in her adulthood (that will last until almost the 22nd century!)?

There has to be a place to learn, and that place can be more or less conducive to learning. There has to be learning materials of various kinds, from desks to chalk to textbooks to material to work with in experiments. There has to be a curriculum, people have to know what the learning objectives for this girl are, what is it that she should learn. There have to be teachers who have command over the material to be taught, who have some pedagogical knowledge about how to teach someone, and these teachers have to be motivated to teach. There has to be some way of assessing the girl’s progress and using that feedback to dynamically shape her learning experience.

Even at this incredibly schematic level of description this is already an awfully lot of things, involving on one way or another lots of different people with lots of different skill sets. Some people have to know how to build buildings, some people have to know how
to make books, some people have to know how to measure learning, some people have to
know how to teach, some people have to know how to teach other people to teach.

How things are going to get done involves some specification of who is going to do
what and why. Table 3.3 is an illustrative table use for discussions in India of the various
functions and activities that go into a school system. Whether the system is allocation
across levels of government in a scheme of fiscal federalism (as in the chart) or between
the public and private sectors, there is some implicit or explicit allocation of
responsibilities.

Table 3.3: A system is defined in part by the allocation of responsibilities across actors

<table>
<thead>
<tr>
<th>Function</th>
<th>Activity</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Central</td>
</tr>
<tr>
<td>Standards</td>
<td>Curriculum design</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Learning achievement standards</td>
<td>Yes</td>
</tr>
<tr>
<td>Planning</td>
<td>Plans for physical expansion</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Plans for quality improvement</td>
<td>Yes</td>
</tr>
<tr>
<td>Asset Creation</td>
<td>Social Capital</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Physical Capital</td>
<td>Yes</td>
</tr>
<tr>
<td>Operation - Non Teacher</td>
<td>Beneficiary Selection</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Choice of students for targeting programs</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Enrolment</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Recurrent</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Textbook choice/purchase</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Learning materials</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Maintenance</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Maintenance of school buildings/facilities</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Monitoring of school processes</td>
<td>Yes</td>
</tr>
<tr>
<td>Operation - Teacher</td>
<td>Hiring</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Salary</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Supervision</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Dismissal</td>
<td>Yes</td>
</tr>
<tr>
<td>Monitoring and</td>
<td>Tests of learning achievement</td>
<td>Yes</td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Pande and Pritchett 2006.

There are two fundamentally different approaches, each with many names.
Following Brafman and Beckstrom (2006) I am going to call one type of system a
“spider” and one kind of system a “starfish” but as this distinction is so fundamental it
has been discovered and re-discovered in many different domains (economics, politics,
sociology, organizational behavior, public administration, management) with many
different names and nuances.
Table 3.4: The fundamental divide in approaches

<table>
<thead>
<tr>
<th>One mode</th>
<th>Another mode</th>
<th>Authors and domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiders</td>
<td>Starfish</td>
<td>Brafman and Beckstrom (2006) Organizational Management</td>
</tr>
<tr>
<td>High Modernism</td>
<td>Metis</td>
<td>James Scott Politics</td>
</tr>
<tr>
<td>Planners</td>
<td>Searchers</td>
<td>William Easterly Development</td>
</tr>
<tr>
<td>Hierarchy</td>
<td>Polyarchy</td>
<td>Elinor Ostrom Politics</td>
</tr>
<tr>
<td>Managerialism</td>
<td>Owner operation</td>
<td>Alfred Chandler Economic History</td>
</tr>
<tr>
<td>Legal/Rational</td>
<td>Charismatic/Value</td>
<td>Max Weber Sociology</td>
</tr>
</tbody>
</table>

The starfish is an amazing organism, a baby ontology bending creature. It has every appearance of being a single agent: it is in one place, it moves around without external forces with apparent goals. But actually the starfish is more like collective. It is a radically decentralized organism with no brain, only a loosely connected nervous system. In some species of starfish this means that a single cut-off arm can regenerate into an entirely new starfish. So when one sees a starfish move the usual description that “the starfish decided to move” is only roughly true. Each individual tentacle was responding to the local stimulus it received. The net result was that the physically contiguous object we name as starfish named Fred moved. But did Fred the starfish “decide” to move?

Brafman and Beckstrom (2006) is about organizations not systems, and they propose nine questions to distinguish organizations that are spiders from starfish: (1) is there someone in charge? (2) is there a headquarters? (3) if you thump it on the head does it die? (4) is there a clear division of roles? (5) if you take out a unit is the whole is harmed? (6) is knowledge and power are concentrated? (7) is the organization is rigid? (8) are units are funded by the organization? (9) can you can count the participants? and (10) do groups communicate through intermediaries?

Note that one dichotomy that does not appear in the list of “spider-starfish” distinctions is “private” versus “public” sectors or “market” versus “government” which is often a red herring. The business historian Alfred Chandler’s has shown that the rise of the “modern” spider organization in America was driven in the private sector. As he shows in The Visible Hand and Scale and Scope many of the features of modern spider organizations originated as responses to the potential scale economies and need for tighter organization in what were then privately owned industries like the railroads, steel, and oil. Well into the 20th century government in America were much more like starfish,
localized, less formalized, more “bottom up” while business was leading the charge into bureaucracy.

The legacy systems of basic schooling around the world look very similar because they are almost exclusively large, government owned, spiders as both organizations and systems.

The dominant way of organizing basic education is to fill out the functions chart entirely with the direct employees of a single ministry—and then the system of basic education is a dominant spider organization and other providers that are starfish. In this case the system of public support to education is exclusively a spider system and there is little or not support of any kind flowing out from the spider organization to the other schools in the system. These spider systems of schooling can be national or federalized but nevertheless remain very large. Typical school systems in large countries employ tens of thousands of teachers, with centralized responsibility for hiring and allocating these teachers.

The choice between “spider” and “starfish” mode of organization is not clear cut: it depends on what is being done. Some activities are perfectly suited to a spider mode of organization, so that whether done by the state or done by private actors, similar organizations emerge.

The state-run post-office is a modern marvel of centralization, and when the private sector delivers mail it often does so through huge centralized organizations as well. While the United State Postal Service has 785,000 employees, the United Parcel Service has 425,000, FedEx 240,000. The centralized organization is amenable to the activity of delivering post, as there are economies of coordination and delivering the mail can be carried out with just an address: a single piece of hard, easily encoded, third party verifiable, information about the intended recipient. Everything but the address (name, location) can be invisible to the delivering: whether the address is a huge office building, a tiny box, a mansion, a hovel, whether the addressee is tall or short, nice or mean, rich or poor, or for that matter even a person and not a church or a corporation. The ease with which all of the relevant information can be transmitted plus economies of scale in coordination leads postal services to be huge organizations as it is productively efficient and organizationally viable.

In contrast, nearly all organizations providing services, especially professional services, are extremely small organizations. The largest law firms in the United States have less than 4000 lawyers (the largest in all of Latin America has 444). Most dentists have traditionally worked in practices of one or two dentists. A survey of architects in the USA showed three quarters worked in practices with five or fewer partners. In contrast, in occupations or sector (or even products within sectors) in which the quality of the service provided requires detailed adaptation to a specific case, such that the quality of the service provided is based on information that is complex, difficult to encode, hard for a third party to verify, then managing organizations with large numbers of employees becomes very difficult. Hence unless some other positive economies of scale are
sufficiently powerful to offset this, organizations will tend to be small, with relationships handled without complex and rigid rules or organizational policies (including human resource policies), with performance assessed directly, and high powered incentives easier to create (e.g. small business owners).

But the spider-starfish distinction in systems is even more complex, as many times the entire chain of production requires multiple activities, some of which have larger economies of scale, scope, or coordination, while others are best done very locally. This can lead to different organizations making different choices. Some organizations might increases to the efficient scale of the activity in the production chain that requires the largest size, at the risk of losing effectiveness in the activities best done at a smaller scale, but decreasing the costs of coordination across organizational boundaries. But when a system is open, other organizations may remain small and deal at arms length with other, larger, spider, organizations doing the activities with economies of scale.

This chapter is just laying out the descriptive characteristics of systems, not attempting either explanation, critique, or alternatives, but these will come in future chapters.

IV) Systems: Characteristics of Starfish Systems

The essence of a starfish system is that it is a loosely coordinated collection of smaller autonomous units. But just having small autonomous units is not, in and of itself, ensure a system that produces positive results. The overall or ecosystem within which those individual units operate will determine the outcomes. At this stage all I am trying to do is describe starfish systems in terms of their basic elements and properties in terms that apply generall, not just to schooling. My objective here is not to argue, much less prove, what is the “optimal” configuration of starfish systems for the particularly activities associated with basic schooling—but that will come.

The four features of starfish systems are:

- **Structure** of entry, how can new units come into the system
- **Pressure** for performance, what determines which units will survive, thrive and expand, which will shrink or exit
- **Network**, while the starfish mode implies the units are not linked hierarchically, the units can be connected in a variety of ways
- **Support** in starfish systems the individual units could just rely on what resources they can mobilized, but they can also have other forms of support.

IV.A) Open structured starfish systems

The first characteristic of a starfish system is the structure that determines the available sources of variation. How open is the system to novelty? How many new genetic variants are produced in each generation? How likely is it that any incumbent firm will face a challenger?
To illustrate how different descriptive characteristics of starfish systems play out in determining outcomes we’ll use some very simple numerical simulations. These are not meant to “prove” anything, just to illustrate how simple changes in system structure can lead to very different dynamics.

So imagine a grid, a checkerboard, that is a simple space and on each square of the grid there is (for simplicity, we’ll relax this in a second) just one school. To initialize a scenario we choose a school quality for each square on the grid as a random number from zero to 1 and the left most graphs show the resulting array of school quality. Naturally, red squares are bad schools (less than .33), yellow are mediocre schools (between .33 and .66) and green are the better schools (above .66). The left most graphs show the same base case, with an equal mixtures of bad, medium, and good schools randomly distributed over the grid.

What is the dynamic of this grid? Our first thought experiment is that in each year, each grid either faces an entrant or not with the same random probability (not depending on the quality of the existing school). If a school does face an entrant, we assume the entrant then chooses a random draw—that is, we are not assuming that “entrants” are on average better than incumbents for any reason. But the update rule is that if the entrant is better than the incumbent, then the entrant replaces the incumbent in that period. The next period the same thing happens.

Figure 3.5 shows the same simulation, in which the only thing changes is the probability that an incumbent school in a given grid faces an entrant. When the structure is closed, that is, the entrant probability is low, then the graph changes very slowly, and even after 10 years looks scattered with red, yellow and green.

The second row of graphs raises the chance that any given school faces a challenger from 5 percent (each year) to 25 percent each year. Starting from exactly the same distribution of school qualities and without assuming that new entrants have any intrinsic advantage just the mere fact of updating old schools with new ones if the new one happens to be better produces an entirely different trajectory. Of course on the assumption that potential entry is very rapid—half of all schools face an entrant in each period—the pictures looks very different with the red schools practically disappearing and only a few even mediocre schools left.
Figure 3.5: Dynamics of structure of entry on system

Note: All assuming zero retention of low quality school.

While this characteristic of “openness” versus “closed” as the likelihood of potential updating is perfectly generic to systems, a key feature of schooling is that no school system is going to operate like a “free market” with very low limitations on entry and exit, even in a starfish system.

The question is, what is the structure of “entry”? Who can open a new school, particularly one that receives any type of governmental report? There are three, potentially related, set of criteria:

Entry regulated based on “quality” only allows entrants who meet a set of criteria to start new schools. While this seems like an attractive form of regulation, but “protecting” parents and children from “risky” or “fly by night” schools, as we will see in the next chapter, this is potentially the most dangerous form of the regulation of entry, for two reasons. First, the regulations are almost inevitably controlled by incumbents, and incumbents, whether in the private or public sector, have every incentive to use quality of entry regulation to thwart entrants. Second, “quality” regulation almost inevitably limits the range of innovation by imposing input isomorphism. If there is a “conventional wisdom” about what “good schools” look like then this orthodoxy, even if it has not solid
grounding in empirical evidence, can block entrants. As we’ll see this input based orthodoxy is particularly pernicious when it blocks novel disruptive innovations.

Entry regulated based on “ownership.” The most common type of entry regulation is based on ownership. The essence of the “government” approach is that only the public sector is authorized to open schools which are eligible to receive public support, and the essence of the “spider” nature is that the level of government at which new schools are opened (or closed) is usually a very large jurisdiction. This hierarchical control is justified both as control of socialization (chapter 2) but then is also rationalized by the need for “rational” planning. As with many other areas of endeavor by governments, the problem with limiting entry to only government schools usually comes with the fact that governments are very reluctant about exit. A problem the world over, but particularly in weak institutional systems is that bad schools never close. And, since a bad school is never closed, there is never “space” for opening a new school as it appears irrational to build a new government school where one already exists.

Entry regulated based on “ideology.” As a key concern of governments (and in democracies) with providing public support to schooling is the reluctance to provide “third party” support (that is “vouchers”) because of the risk of insincere teaching of ideologies either the regime, the state, or the society at large finds objectionable.

For instance, in the USA suppose one were to have thorough going “voucher” scheme that allowed entry of anyone into schooling who met exclusively “input” requirements (e.g. buildings, teacher qualifications, playground safety, etc.). Suppose that demand for private schooling had two dimensions: parents who wanted better learning quality on standard measures of skills (e.g. reading, science) and parents who wanted a schooling socialization for their child different from the mainstream socialization. Depending on the configuration of beliefs in the population and the quality of public schools the first uptake of the use of vouchers would be parents who wished to use publicly provided funds to place their child in a “fringe” ideology school—where that “fringe” could be either White Supremacist, Afro-Centric, Marxist/Leninist, Nazi/skinhead, Polygamist Sects. The problem is that the inculcation of beliefs is not third party contractible so, if the school and the parents/children have the incentive to subvert the desired socialization it is going to be very hard to regulate this. The main regulator is at entry, not allowing entrants based on ideology. How to do that in practice depends on the nature of the starfish system and some starfish systems, like “community” systems are naturally limiting (at least on certain dimensions of ideology) while other systems are harder to control.

IV.B) Performance pressured starfish systems

Built into the previous example of structure was already the notion that the way in which a new school was judged was some simple and easy measure of “school quality” and that if a new school had higher quality that is completely displaced the incumbent. This meant the system was highly performance pressured—the survival rates and coverage of individual units was dependent on their performance—on that key number.
Evolution describes a pressured system. The *performance pressure* is reproductive ability. Organisms with higher reproductive performance grow in number, those that are ill-adapted or cannot adapt decline.

Already one can see a huge difference between spider systems and starfish systems. Pressure for performance does not lead to everything being the same. The performance pressured system for animals has produced millions of species that run the gamut from single celled bacteria to whales and elephants. The order that includes the insect beetles contains almost half a million distinct species. The surviving species share nothing in common: not size, color, shape, diet, mode of reproduction, or survival strategy. The only thing they share is that they do survive the pressure of limited resources and have found some niche in their eco-system.

Figure 3.6 provides another simple simulation, using the same evolution of the checkerboard as earlier, but this time, it shows how simple differences in the measure of how much “performance pressure” systems are under makes a difference in the evolution of the system. In this simulation there is a new entrant whose “quality” is revealed, if it is lower than the incumbent then no students move. If it is higher than the incumbent, then we can systematically vary what the “incumbent” advantage is by changing what fraction of students stay in the incumbent school. As Figure 3.6 shows, if the incumbent has a powerful advantage and hence can be resistant to performance pressure the system evolves very slowly. If the more productive entrants get half the students, the dynamics already improve.
Figure 3.6: When the incumbent is not pressured (retains students even when lower quality) the dynamics of improvement are slowed

Note: All assume the "medium" entry scenario of $P(entrant)=.25$ per annum.

Especially in the United States with the heated debate about “high stakes for the school” top-down testing created by the No Child Left Behind legislation the words “performance pressure” are fighting words. But standardized tests are only one measure of performance and “high stakes for the school” is only one modality of pressure. In thinking through systems the questions are what are the metrics of performance and how do those functionally create pressure on the agents in the system.

Pure Parental/Student Preference, with low academic performance information or salience. In pure “choice” mode where “money follows the student” performance pressure would come from school trying to attract and keep students. This may, or may not, create pressure for better academic performance. If parents have little or not information about a school’s performance—particularly how much “value added” they have then choice systems can lead to parents choosing schools based on reputations and social signals about the student body.

Parental choice with high stakes for the student standardized (homogeneous) tests. Some educational systems create performance pressure through high-stakes for the student testing. For instance, many East Asian countries have rationed entrance into university based on a exam that is essentially life chance determining. This leads to
extraordinary effort on the part of many parents and students to do well on the exam. At
the highest levels of pressure this translates into essentially two tracks of schooling, with
massive levels of tutoring. Tutoring essentially displaces the public system at the higher
levels and the pressures from “choice” is over private tutors.

**Parental choice with high academic performance information and salience.** Another
possibility is the creation of standard examinations that are low stakes for students but the
results are published and disseminated at the school level. This increases the salience of
academic performance and creates complex incentives for schools. Complex, because if
the tests are reported as just school averages then, given the overwhelming importance of
student background, the school averages mainly reveal the socio-economic background
of the students in the school and actually say very little about the quality of the
instructional experiences in the school. In contrast, “value added” measures control for
this—but are very complex, not always robust, and harder for parents to use.

### IV.C) Networked starfish systems

A starfish system is characterized by have looser, less hierarchical, connections
among the constituent elements than a spider system—but a starfish is an organism that
does have connections. Even if schools are treated as the individually autonomous units
of a system of schooling, they are still potentially connected, particularly through the
voluntary association of the people in the schools, both administrators and teachers.
They can learn from one another through observation and communication. The number
and type of communications between units is another important characteristic of a
system.

Figure 3.7 illustrates the power of connections by taking the same basic set-up used
before of a grid of individual schools. This time, however, in each period of the
simulation, before the school faces the potential entrant the school looks at N randomly
chosen other schools. The schools observes which of these is the best and then, through
some learning process, I assume it moves 10 percent of the distance from its quality to
that of the best school it observed. The key number in this simple simulation is the
density of connections. If there are no network connections, each school is an island, the
system behaves like the previous simulations, depending on entry and pressure for
improvement. However, when schools are linked, even modestly, then performance
percolates across the system.
Figure 3.7: A simulation in which schools improve by emulating the schools they are connected to, the pace of improvement depends on number of connections

Note: all simulations done at low entry $P(Entry)=.05$ and low pressure, retention=.90.

Networks can be a powerful force, but they can be negative as well as positive. The assumption that schools look at their network and emulate the best is only an assumption. A different assumption would be that schools looked at the schools they were connected to and only improved if they were the worst and “slacked off” if they were the best—so that their comparisons to other schools bred complacency. In this case there would be actually a negative tendency towards homogeneity at the middle.

But, as has long been recognized, professional associations that create common professionally identities and aspirations can be a powerful force for improvement.

IV.D) Supported starfish systems

The model for restaurants, as one example of a localized non-tradable service, is a relevant example of a structured, pressured starfish system. People choose whether to either “home produce” their meals (with a huge array of choices of “in home” value added, from cooking from raw ingredients to buying prepared meals that just need to be
heated) or eat out\(^1\). When they eat out they can choose from a huge array of choices, from high end restaurants to “family style” to “fast food.” Even in the budget or “fast-food” segment of the market there are choices both between franchises and locally owned and operated and between competing franchises. About the only structure to this starfish system, besides the constraints that affect all business of registration and land-use planning that affect location, are standards on hygiene to protect the public from food borne illness. Within this system individual restaurants come and go, the same location will often host several different chains in a few year span, local “mom and pop” hold their own against franchises, and whole new cuisines rise and fall. While this results in enormous heterogeneity in the “quality” of food consumed, both across individuals based on their tastes (mine, it is alleged, are particularly low) and across people and households based on their ability to pay. No one worries particularly about either this heterogeneity or this particularly dimension of income inequality.

Schools are not restaurants. As education, the preparation of children for their adulthood necessarily goes deeply to core social values, no one can be indifferent to inequality in education. In schooling based education systems, this means it cannot be a matter of indifference that children from poorer households or with parents with less educational preparation receive lower quality educations.

Support can flow from the public sector directly or indirectly to the parents and students to make the choices they find best. The structure of this support will determine how the overall starfish system will operate. There are other ways of supporting parent/student choice: subsidizing transport.

Obviously, support and pressure and tightly linked. If schools are responding to financial support (which will be true of non-for-profit schools as well as they need resources as well) then how the support flows will determine what pressures they feel. If the support flows as grants from the state then their eyes will be on pleasing those who make the grants, if support follows enrollment, their eyes will be on enrollment, if it follows some metrics of performance, this shifts pressure to those metrics.

Flows of public sector support through starfish systems can address the problems of inequality. But as with the other characteristics of a starfish system, it depends on how support is structured: does it flow to all students? to only targeted students (and if so, how targeted)? Can schools that receive student support from the state “top up” their fees with other charges to parents?

But there may also be support directly to schools. For instance, farming is an activity that is usually organized with many small autonomous farmers. One could provide support to farming by subsidizing prices but many countries have run programs of agricultural research combined with extension services. These extension services provided support to producers to adapt and adopt new innovations. In a starfish system there could be support directly to schools of a variety of types to help them innovate,

\(^1\) Fast food marketers focus on “share of stomach” to emphasize that the main choices are not necessarily between franchises but between home production and other.
learn from other schools, receive training, etc. This could also include support to the
teachers, for training, skill upgrading, external “supervision”, peer monitoring, etc.
These type of activities are organized within spiders, but can also be provided in a
starfish system—but this support is more complex.

IV.E) Ecological versus organizational models of system learning

The amazing power of starfish systems emerges from the fact that the overall
performance can increase, even without any existing organization improving. All the
examples in the figures showed this paper. If one started with a set of schools then even
if no school was able to “learn” how to improve its overall educational performance the
overall system performance could improve over time.

Moreover, this doesn’t even require that somehow the new entrants are equipped with
some new technical knowledge or formula. In all of the simulations the new entrants
took a random draw from exactly the same distribution of productivity of the existing
schools—there was no “technological progress” that only the new entrants could take
advantage of. They were just like the old guys.

What makes the power of evolution or emergent order or “creative destruction” work
is just that the more productive are more likely to survive and to thrive (take on larger
shares of the task). The power of “trial and error” alone can lead the overall sector to
progress, even with no technological change and even if, every school, once launched,
congeals and cannot improve.

This power of ecological learning is important, because, as we shall see more in
chapter 4, organizational learning is often very difficult. After all, successful
organizations are often successful because they hit on a formula that matches a particular
context and then just perfect themselves at the formula they have and build that formula
into the very fabric of the organization. If that formula ceases to work with the context, it
is often next to impossible to change the organization’s “culture”—and new
organizations come along that embed the new formula into their new culture and thrive.

This can be seen again and again in the experience of markets. It is hard now for
anyone to remember just what an admired and feared firm Sears once was. Sears re-
made retailing in America, taking advantage of newly available logistics systems to use a
combination of stores and mail-order delivery to transform access of rural America to
goods. Eventually Sears was displaced, in part through competition with new discount
retailers like Kmart. Eventually, the entire retailing industry was affected by the rise of a
firm out of a small town in Arkansas. Walmart now has over a million employees world
wide, driving Kmart into bankruptcy, and ironically almost, after Kmart emerged from
bankruptcy it acquired Sears itself in 2005.

A huge amount of the increase in the productivity in the American economy has come
from improvements in the productivity of retailing—but these improvements did not
come from the biggest and best large firms using their best and brightest brains to invent
and reinvent themselves. Rather, it came through classic “creative destruction” where new entrants built organizations around new ways of doing things, and then convinced people to come buy from them.

The silly take-away, but one not so silly that it doesn’t line the pockets of management consultants, is that “schools should learn from Walmart” and then trying to make one organization learn from another. The real question is how to build a system in which school operates so that successful practices at promoting the desired learning outcomes can be discovered and move to scale.

V) The Varieties of the Starfish Experience

Back to the opening section: higher education in the USA is a structured, pressured, networked, starfish system. There is no “spider” inside the US success: there is neither strong centralized decision-making with strong direction over the system nor is there any single organization who dominates the overall system. The industrial organization of higher education is that the top quality organizations have incredibly small shares of the overall enrollment.

Higher education has an open structure. There are a variety of private and public universities. The private universities can decide which areas to specialize in, which faculty to hire, their enrollment size, how their courses are to be taught—they are completely autonomous. Moreover, entry is open and there is space for new entrants, both overall and in each domain. While there are huge economies of scale in some research activities that make it difficult for new entrants, at the low end of the market there is more openness. Phoenix University is a for-profit university that was founded in 1976 and now has over 300,000 enrolled and more than 200 campuses.

Higher education is a pressured system, in a complex way. Students have complete choice over where to apply, and for the most part, where to attend, college. They can attend a prestigious four year residential college or a local junior college; they can do vocational training or a liberal arts degree. They can attend part time to full time, adults can enroll in classes piece-meal. All of this creates pressure to attract and retain students. This creates pressure for information and so there is a thriving business in ranking and providing information about student’s choices, both in overall rankings as through college counseling provided both by high schools and for-profit. All of these pressures create both excesses such as gaming the ranking systems, but also real concern about those dimensions of quality that create pressure.

The system is highly networked, in a variety of ways. Professors in each discipline are often closely associated with a professional association—such as the American Economic Association, the Population Association of America, the American Political Science Association, etc. These serve a peer and reference groups and nodes for dissemination of ideas about the discipline—and about providing information about conditions at various universities. The universities themselves are part of accreditation networks that provide periodic assessments that institutions voluntarily participate in.
Higher education is also supported, in a variety of ways. Part of the support is that individual states operate their own universities that receive public support—but these are always in competition and comparison with the local private counter-parts. A large part of the support flows directly to students through targeted grants and a regulated loan program that ensures financing to any student (including for very low quality institutions).

This system has produced exactly what would expect a starfish system to produce—a huge array of variety and a constant stream of innovation as the pressures of the drive to enroll students cause individual schools and individual programs to wax and wane. At the same time, it is very difficult to point to exactly why American higher education is successful—which of the design bits of the starfish system account for it, or is it how the pieces work as a whole?

V.A) The Organization of Instruction: Applications of Starfish Principles

You, dear reader, know how to do many things you did not learn in formal schooling. Many people have mastered skills that take years to acquire proficiency: play a musical instrument, participate in a sport, speak a foreign language, often with instruction outside of school settings. Moreover, key parts of education and socialization happen in voluntary associations: religion being the most obvious example, in which specialized knowledge and beliefs necessary are passed from one generation to another, sometimes in schooling, but often in instructional settings outside of schools.

While basic schooling has some unique features, it also has much in common with other forms of instruction—“schooling” is an extended, coordinated, sequence of instructional episodes. Before turning to the starfish principles analysis of basic education, it is worth staring with the variety of instructional experiences.

Piano lessons have a completely open structure. Suppose you want to learn to play the piano. There is a huge array of options. You can take private lessons from an independent private teacher, who comes to your house or your child to her/his. You can arrange lessons from at a local music school. You can take group lessons. You can buy a book and teach yourself. You can go onto the Web and take an online course. You could just buy a piano and tinkle around. There is definitely a completely open structure starfish.

The pressure on the system is for each of the possible providers of piano instruction to attract students. But how do you know if your child has good instruction? You can find out about piano teachers by word of mouth among your social network, or trial and error, or, now, on the internet. I hated my piano lessons, but my parents were insistent I should learn enough piano to at least be able to play the hymns in church. So I switched instructors, four times. Turns out, I just hated piano lessons.
Piano teaching is loosely networked. There is little or no public sector support for piano lessons of any type.

There are few “spider” organizations in the actual giving of piano lessons. But, there are interesting features. First, the production of the books from which to give piano lessons are, as a result of market forces, much more concentrated than the giving of lessons. Second, there are particular “schools” of piano pedagogy—such as Suzuki.

The result is that piano lessons are widely available, but with heterogeneous quality (large numbers of children begin and drop out without learning much), and strongly stratified on class and status.

Piano lessons are just one example of a completely open structured, weakly performance pressured, weakly networked, publicly unsupported starfish system of instruction. Similar analysis would apply to other musical instruments, other cultural activities (e.g. dance, singing). Huge numbers of children participate in sports, with a mix of learning on their own, participation in instruction through organized leagues, and private instruction. This also applies to instruction for adults, such as learning a foreign language (a mix of tutors, classes offered by a range of providers, self instruction with tapes or Web).

Interestingly, the public sector is often indirectly involved in markets for instruction, through licensing requirements, but does not actually produce any instruction. So for instance, in the USA for a young person to get a driver’s license they not only have to pass a test but also demonstrate before taking the test, they have completed a mandated course of instruction. But the actual instruction is done through a starfish system of large numbers of small, independent driving schools.

Vocational licensing often has the same structure, with public sector requirements for both passing an examination and having completed a given number of hours of instruction and/or training. Again, the state imposes the requirement and controls who are accredited providers of training, but not produce. This leaves a large body of small, independent, raining providers who are pressured to attract students.
Table 3.5: Different types of instruction available in the USA

<table>
<thead>
<tr>
<th></th>
<th>Piano Lessons</th>
<th>Sports</th>
<th>College Test Prep (e.g. SAT)</th>
<th>Religious (Sunday School)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure?</strong></td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Open (across denominations)</td>
</tr>
<tr>
<td><strong>Pressured?</strong></td>
<td>Informal</td>
<td>Informal</td>
<td>Highly pressured on a single demonstrable outcome</td>
<td>Multiple actors (parents, children, religious organization) and goals</td>
</tr>
<tr>
<td><strong>Networked?</strong></td>
<td>Modest</td>
<td>Modest</td>
<td>No</td>
<td>Some “spiders” but mostly strong networking within denominations</td>
</tr>
<tr>
<td><strong>Supported?</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Cross-subsidy to training of youth within the denomination</td>
</tr>
<tr>
<td><strong>Result</strong></td>
<td>Multiple modes of instruction (including self), heterogeneous quality, mixed results (high drop-out)</td>
<td>Spider organizations (e.g. Kaplan) dominate, many smaller competitors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The exception to the very decentralized, starfish, nature of instruction in the United States might be test preparation. Organizations like Kaplan may capture a significant fraction of the market for paid test preparation (though not in a “share stomach” approach). But in some ways, this is the exception that proves the rule. By creating a very narrow set of performance expectations the tests (like SAT) themselves narrow the variability in demand from parents/children—people who do test prep want better test scores, full stop.

In systems of instruction predominantly spider systems or even systems dominated by a few large spider organizations Organizing the process of teaching and learning as a spider—a large hierarchical organization with multiple units—is an anomaly in the world of instructional services.

V.B) The IB program

The International Baccalaureate (IB) is an educational organization based in Switzerland and started in 1968 with the goal of supporting the growth of and providing a

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2 This section draws on materials prepared by Danny Smith.
common structure for students preparing for higher education in international schools around the world. The IB has experienced significant growth since that time and is now associated with over 3,000 schools in nearly 140 countries that currently offer its programs to more than 850,000 students. The initial focus of the IB was on their two-year Diploma Program (DP) for students from ages 16-19. Since 1994 the IB has introduced the Middle Years Program (MYP) and Primary Years Program (PYP) that provides structure, assessment tools, networking, and support for their programs students as young as age 3. With its early work done predominately in private international schools, the IB has now expanded its reach to a broader range of institutions. Over half of the schools now authorized to offer one or more of the three IB programs are state schools.

While all of these schools have a program associated and approved by the IB there is also a great amount of diversity in the size, structure, philosophy, and other important educational elements of the many institutions that can officially be called an “IB World School.” The process of entrance, a common expectation of assessment and performance, access to information and guidance from the IB organization, and support through professional development and other networked resources are all common among schools using an IB program. These elements provide a certain amount of organization and guidance but each school is also very independent in its own governance regarding many other elements of school life and can even make many decisions about the ways that the IB program will be administered at their school. To better describe how the IB program fits this model it may be helpful to describe more specifically what the IB does do and what it does not do.

The IB does have requirements for admission but they are based on the implementation of a certain set of educational objective and standards for learning and assessment and little else. A school hoping to implement one or all of the three IB programs goes through a thorough evaluation process. This includes facilities, faculty, etc… The IB does not make significant requirements beyond this. Schools are free to define their missions and communities in many other ways allowing it to fit well into large schools, small schools, public schools, private schools, parochial schools, charter schools, single-sex schools, along with many other unique features. Some schools elect to provide the IB program for students of all ages while other implement only one or two of the three programs and may simultaneously be involved in other curricular or assessment models such as the College Board’s Advanced Placement or a particular country’s own educational objectives. A broad educational mission allows the IB flexibility to work within a very expansive group of educational environments and philosophies.

The IB does provide a clear evaluation metric for its school that is objective. These metrics are helpful in providing consistent feedback for individual students from year to year. While providing significant guidance and support for objective evaluation, the IB does not tell teachers and schools exactly how every element of assessment should take place. Particularly in the PYP and MYP there are very few standardized tests created, graded, or even evaluated significantly outside the individual school community.
However, the IB provides significant support regarding the curricular objectives, proper assessment tools and best methods for various grades levels and subjects.

The IB does require that certain staffing roles be filled. A coordinator is required for the Diploma Program and its accompanying Community, Actions, and Service requirement. Likewise, the school should designate a coordinator responsible for evaluation, professional development, assessment, and other activities. The IB does not specify exactly who should fill these roles for each school and provides significant freedom to individual schools meet these needs. At larger schools there may be administrators taking on IB roles and objective as their full time duties while smaller schools may have an IB coordinator that is also teaching classes or fulfilling a variety of other duties not associated with the program.

What the IB program does is create clear, concrete, measureable, standards in each academic domain (including art and music), provides objective external assessment of the extent to which students have met those objectives, and makes available support to schools and teachers instruction in how to meet those standards. Participation by a school is voluntary and all aspects of day to day operation and implementation is completely in the control of the school. In short, the IB program is open structured, performance pressured, professionally networked, starfish system.

VI) The Varieties of the Starfish Experience: Basic Schooling

Adopting a starfish system approach doesn’t mean making basic education look more like piano lessons, it means basic education more like an open structured, performance pressured, professionally networked, inclusively supported starfish system. These approaches can be a means to producing a dynamic system of education that can provide universally the quality of educational outcomes youth need for the 21st century. But these do not create a single blue-print. As we show in even more detail in coming chapters, starfish systems can come in many overall designs.

It also raises the right set of questions—which are about aspects of the system.

- Is there too much or too little structure in determining the range of potential providers? Is entry too easy? Is exit too hard?
- Is the type and amount of pressure in the system furthering the right set of objectives?
- Are the elements of the system networked to provide distributed learning and ecological scaling of innovations?
- Is the amount and pattern of support into the system well designed? Is funding directly to students too much based on income and not enough on merit or vice versa? Is too much support going directly to providers and not enough through
students? Is support for university based research too concentrated or too diffuse? Is research too commercially oriented to too much to basic science?

Table 3.6: Spiders and Different Possible Starfish Systems of Schooling

<table>
<thead>
<tr>
<th>Starfish Systems</th>
<th>Less Central Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pure markets for instruction (e.g. tutoring)</td>
</tr>
<tr>
<td>More Central Control</td>
<td></td>
</tr>
<tr>
<td>Government owned spiders</td>
<td></td>
</tr>
<tr>
<td>Locality level de-centralization</td>
<td></td>
</tr>
<tr>
<td>Charter schools (only public sector entrants)</td>
<td></td>
</tr>
<tr>
<td>Community controlled schools</td>
<td></td>
</tr>
<tr>
<td>Private (for and/or not-for profit entrants)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structured</th>
<th>Pressured</th>
<th>Networked</th>
<th>Supported</th>
<th>Starfish (autonomy at school level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td>Mixed</td>
<td>Hierarchy</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Entry only by localities</td>
<td>Mixed</td>
<td>Regionally</td>
<td>Yes</td>
<td>Mixed</td>
</tr>
<tr>
<td>Entry by designated organizations</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Yes</td>
<td>Mixed</td>
</tr>
<tr>
<td>Entry only by locally organized groups</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Yes</td>
<td>Weak</td>
</tr>
<tr>
<td>Open entry</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Completely open entry</td>
<td>Depends on metric</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What would a structured, pressured, supported starfish system for basic education look like? There is no one way to put the pieces together and there are fundamentally different ways to think about the structure.

- **community controlled** schools in which groups of parents, affiliated with the local-most level of government, were free to open their own schools (subject to some requirements) and attract students to the school.

- Allowing **private providers**—both for profit and non-profit—to provide schooling, with some formula for how public sector mobilized resources follow the student.

- Allocate control to very **small governmental jurisdictions**—not quite school by school autonomy, but something close to that.

- Use of “**charter schools”** in which entry is strictly regulated, but schools (still within the government sector) are allowed much greater autonomy.
But all of the starfish-like systems must have several features in one way or another to be truly starfish. First, the locus of control of the direct management of the operation of the school is pushed as low as possible. This is not to say each school in the system gets to do whatever it wants, as many aspects of the system will remain centralized, but the school (or small set of schools) becomes the primary focus of control, identity and management. Second, schools must be allowed to enter and schools must be allowed to innovate and establish their own identities and education strategies. The emergence of diversity is key to improvements. Third, the pressure in the system—what encourages new schools to enter and existing high performance schools to expand and poorly performing school to exit—is key to the improvement in performance. In an starfish system everyone acknowledges that performance of the system emerges as a result rather than anyone imagining they have teleological control over outcomes.