John Laudun
CONSTRUIT
University of Warwick

Repairing Knowledge: A Case Study in Natural Knowledge Construction

I want to begin by thanking the organizers of this conference for allowing me to be a part of the program. When I came across an announcement for the conference, I recognized that it sat precisely at the intersection of an N-dimensional space with the following axes: the first, and primary, axis is my work as a folklorist to document and to attempt to understand how it is human beings think their way through the world. The second axis is my own attempts to learn how, first, simply to write code, then to work collaboratively with a mathematician and machine learning specialist through code. The third axis is my interest, as a parent of a child who is primarily a world-builder, in finding ways of thinking about thinking and thus thinking about teaching that are conducive to fostering her intellectual, and thus also her emotional, growth.

My field of folklore studies is designed, mostly de facto, to force awkward encounters between the modern and the non-modern. That is its intellectual history. Like other outward-looking dimensions of the nineteenth century's philological project — which also includes certain parts of anthropology, linguistics, and sociology — folklore studies asks that its practitioners go out into the world, spend time among some group of *them*, and then come back to report on how it is with *them*. The explicit contract, and contrast, is that our society, our modern society, is too complex to understand *in toto*, and so if we study primitive or peasant societies, they will, through their smallness and/or their simpleness, offer us the chance to understand how it is human societies in general work. Thus, we seek to understand *them* in order to understand *us*.

Constructing an other is, as we have realized since this mission was founded (starting really before the nineteenth century), not without its problems. Still, folklorists like myself press on, attempting to bring our field and the knowledge it produces more clearly in line with our more nuanced understanding of what it means to create and apply knowledge after Foucault and other post-structuralists necessarily complicated things. So it was with all those qualifications and revisions and concerns in mind that I found myself deciding to spend a number of years seeking to understand how a small network of individuals, working with quite modern materials like steel, aluminum, and hydraulics and with quite modern tools like arc welders, press breaks, and acetylene torches could first conceive and then steadily refine a machine that changed an entire agricultural economy. And they did it all using only what they already knew, whatever that may mean, because then I could call it traditional, and, as it turns out, it was. And so I spent seven years following fabricators and farmers attempting to understand not only the amazing machine they had willed into being but how that machine reflected their own, native understanding of the landscape on which they worked and the world within which they imagined themselves. (For those interested, I wrote an entire book about it.)

There were a number of dimensions to the work but the one I wish to focus on here is how ideas get made in the world. Linguists and computer scientists have long described languages that people use in the world to communicate directly with each other and those they use to communicate with computers as natural languages. Natural languages are distinct from formal languages, such as those used in programming, and constructed languages, such as those developed to standardize communication. It would not be unacceptable to extend the concept of "natural" used in this way to describe natural knowledge construction (or NKC) as the way that humans construct knowledge when they are in communication with each other. Such a description of NKC captures that such knowledge can exist alongside, and often in dialogue with, formal knowledges that users have received either through various formal education protocols and processes: schools and workshops, in particular, play a large role in the agricultural communities in which the current case study takes place.

We have not thought as clearly about the relationships between the kinds knowledge available to us because we have, until this moment, not needed to, both because the varieties of practical knowledge were quite strong and also because propositional knowledge did not, as it does in the age mass distribution combined with automated, well, everything, threaten to make practical knowledge unnecessary.

In any discussion we might have following the case study, it will be worth our while to consider the necessary balance practical knowledge brings to knowledge in general and, in fact, the enhancements it offers to any epistemology. But before we proceed to the case study I must confess that I am blurring two levels of abstraction in my treatment of this matter: it strikes me that there are actually three ways of treating knowledge: as a theory, as a practice, and in between those two lies history. What I offer here is a narrative in hopes of giving you some sense of the operations at work in a very real context.

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The crawfish boat offers us a window onto natural knowledge construction: its recent development and its use of modern materials and modern construction techniques make it a fringe case for studies of traditional knowledge. The diffuse, informal, heterogeneous network which gave birth to it, and its unclear timeline, make it less compelling to historians of technology. Its small economic footprint makes it uninteresting to economists and business theorists, and its lack of formality in its creation also makes it uninteresting to engineers: the first time I visited one shop, in fact, the owner walked me out to one of his CAM machines and asked me what did I want to know? (I told him I didn't care one whit for the machines: that everything I wanted to know was inside his head. This got me a peculiar look, but he let me come back again and again.)

The birth of the crawfish boat was a moment of opportunism, relying upon the fact that crawfish are native to Louisiana and that the creatures had long been easily caught in any low-lying area prone to flooding. There are oral histories that report crawfish migrations that shut down roads because the sheer volume of the animals made the roads too slick to pass. A great aunt of mine reported grabbing crawfish out of flooded fields with a slotted spoon and an old pot. In her account, the children would give them to the poor people, and in the early twentieth century crawfish were seen as a lower-class food. Post-depression and later war-time nutritional programs touted the crawfish as a valuable, abundant, and cheap source of protein, and that message was redoubled during the cultural renaissance that took place in south Louisiana beginning after the war and taking place alongside the Civil Rights movement. By the late fifties, the town of Breaux Bridge had started its annual Crawfish Festival.

Much of the early commercial crawfishing was done in the nearby Atchafalaya swamp, which had been formalized into a flood basin by the federal government following the 1929 flood. The boats and traps used there required little modification from boats and traps used in other applications. At some point in the sixties, however, farmers and landowners started playing with the idea of harvesting crawfish out of flooded fields. To some degree, this was a natural development of people looking for flooded land to crawfish, and there are some anecdotal accounts, perhaps apocryphal (and by apocryphal I mean backward-looking explanations), that it was an outgrowth of some of the fierce hurricanes that inundated Louisiana in the late fifties and in the sixties.

By the seventies, rice farmers were regularly allowing people to crawfish otherwise unused fields for pennies on the pound of crawfish. (The economics of crawfish were, from the start, a cash crop that was un- or under-assessed and that made profitable use of fields otherwise lying fallow.) Slowly, it became clear that more money could be made if the farmers harvested the crop for themselves, and it was during the late seventies that a great deal of experimentation occurred. At first, farmers themselves, or often their children pressed into service, ran the fields by placing traps along the perimeter and walking from trap to trap with two five-gallon buckets, one for bait and one for harvested crawfish. Ramping up such an enterprise, and attempting to work inside a cut often involved pulling a bulky boat or, in many cases, towing a bright-blue children's pool, an image the farmers themselves recall with wry grins.

As yields increased, farmers began to want to scale up the process, to bring the same kind of power they enjoyed farming into crawfishing. These were men, as will be discussed in a moment, who were comfortable with a wide variety of farm gear, and, just as important, most had some knowledge of and experience in making or modifying an implement in their own shops or equipment sheds. What happened next is not entirely clear. Memories in the present must reach back forty years and try to piece together, through reference to other events— often to when a child was born or to what grade they were in— that otherwise blend together as part of "life on a farm."

The first boats that were built were mechanically driven, with a small engine, five horsepower by most accounts. What exactly they were driving is not immediately clear. A number of folks have described a variety of pulley-and-cable systems that seem better suited to steerage than to powering a boat. More than once I have heard them labeled contraptions, as if that was all there was to say on the subject. Whatever the form of those first few protoboats, they seem to have had the drive unit in the back, similar to the contemporary boats.

Out of this initial period of experimentation emerged, in the very late seventies, the “tiller-foot” boat. Like its predecessor, it was built on lightweight boat hulls that were commercially available with the addition of a most extraordinary assemblage: the lower part of a garden rotary tiller driven by a five-horsepower engine separated by a long boom, made in place. At first one steered the machines with a tiller attached to the assembled drive unit, much like you would the outboard motor of a boat, but eventually someone adapted the power-steering cylinder of a car so that steering could be handled more remotely.

The tiller-foot boats were used for a number of years, but the fact that the drive units were assembled from such disparate parts meant the units were short-lived: the transmission gears, often made of brass, were not intended for such intensive use and would typically fail within a year’s time. The widespread availability of the machines from which the parts came, garden rotary tillers, and their relative cheapness, a hundred dollars or so, kept tiller-foot boats in use for a while. It is also possible, it should be noted, that another possible dimension of the boat’s longevity, despite its mechanical failings, was that many of the tillers came with warranties, and it was not unknown for a failed transmission to be put back into its original box and returned for replacement. In this case, it is possible that one of the factors that contributed to the demise of the tiller-foot boat was that local store owners and equipment dealers eventually caught on to the practice and began to refuse to replace tillers that had exceeded their intended use.[1]

In the fall of 1982 two men who farmed and would also later teach agricultural shop held the first crawfish field day, a homegrown version of the larger field days held by state university agricultural colleges throughout the U.S. In addition to getting people to see if sharing ideas wouldn’t make everyone’s lives better, they invited a Texan inventor to show off his crawfish buggy, which looked a bit like a lunar rover set down in a muddy rice field. The operator sat in the middle of four large wheels that tracked through the shallow water reasonably well. He drove right up to a crawfish trap, grabbed it and emptied it to one side. It was an amazing machine, but it appears to have been eclipsed that day by a machine that turned up at the last moment, an off-the-shelf aluminum fishing boat that had a cleated steel wheel hanging off the bow that was driven by a hydraulic pump powered by a small-bore engine. When one of the organizers, Maurice Benoit, saw Ted Habetz’s boat, he turned to his friend and said, “That’s my boat.” What he meant by that is a tale of two men working simultaneously fifty miles, and years of experience,

[1] The boats and traps co-evolved, but I’m leaving the history of the latter out here.

apart. Both had roots in agriculture; both had professional degrees; and both had had experiences beyond their education and beyond their agricultural roots. As divergent as their educations and experiences were, their convergence on the same solution at the same moment in time suggests that there was a certain inevitability to the idea, that it was, as Kevin Kelley has observed, "what the technology wanted." Habetz ended up taking orders for four boats that first year. Against his own judgment, Benoit took a check for two boats.

The pair became the first makers of the modern crawfish boat, which standardized around an aluminum hull mated to a steel drive unit. The drive unit is powered and manipulated by a hydraulic system, allowing the boats, using only one pump, to go forwards and backwards, to steer left and right, and to life the stern of the boat both to clear levees and to travel on roads, making them an indigenous amphibious vehicle. Over time, as the boats became powerful enough to drive over the small levees that separate one cut from another within a rice field, the wheels moved from the front to the back. As the power of the boats increased, so did the stress on commercial hulls, driving all the makers to make their own hulls. The result is a vibrant eco-system of manufacturers, each with their own particular hulls and drive units as well as particular systems for mating one to the other — those who have seen the hydraulic press channel on Youtube are familiar with the power of hydraulics to slowly transform almost anything from one shape into another.

The men who made the boats are as varied as the boats themselves. By and large, they do not consider themselves inventors; rather, among themselves, they are equipment repairmen, fabricators, welders, and/or farmers, with each man possessing some or all of the skills of these roles to varying degrees. And so the construction of the boat as both a particular object as well as a generalized idea takes place within a larger network of ideas and practices with which all the individuals are familiar but to which they have different kinds of access and with which they have different experiences. Any particular individual could be strictly a farmer, a farmer who fabricates on occasion and only for himself, a farmer who actively fabricates for himself and others, a fabricator who farms or is a member of a farming family, or strictly a fabricator. Out of this assortment of abilities and interests flows a steady stream of innovations and adaptations in response to particular problems: side plows, PTO (power take-off) ditchers and other powered machines attached to tractors, fixed and mobile pumps, small boat hulls (for airboats, hunting boats, and hand-pushed boats), and, in an adjacent network, surface-drive engines.

Within this network, nodes are seemingly isolated: each man works alone, separate from the other builders. At the same time, he is also working in dialogue with them. They see each other's boats. They know what their customers think of the strengths and weaknesses of each design. They recognize imagination in each other, and, in that way, share their creativity. It's not unlike a guitar player hearing a run or riff, liking it, and including a version of it in his or her next performance. Listening, even indirectly, is what creates an artistic field. Out of that field comes creativity, as artists and craftsmen spur each other on. (Speaking of copying, these men are aware of intellectual property: they just aren't interested in patents. Rather, they invested in what we now think of as the open source model of reputation.)

The network grows and shrinks according to individual interests and abilities of men, and occasional woman, who think best in three-dimensional shapes, in mathematical ratios, and in stress factors. There is room within the network for those who simple want to be workers, as there always is, but the nature of this network is such that there is also room for individuals who want the freedom to construct things of their own imagining. And if there isn't in one shop, there will be another, or if there is none to be had in the present moment, then some will open shops of their own. Most of these men work alone or with a small collection of trusted others. Often this group is composed of members of their family: brothers, wives, sons. Each man works on that combination of things that interests him and also pays the bills. One likes to design workflows. Another likes anything aluminum. And yet another likes difficult repair jobs. So a landscape filled with a seemingly repetitive series of shops, each possessed of various congregations of men with grease under their fingernails, is actually quite varied.

From this heterogeneous network emerged a remarkable consistent, or normalized, product, with various innovations introduced at one node spreading to other nodes, often tweaked to fit within a larger design philosophy. Two examples will suffice: the first is the front wheels and the second are the rodded cleats.

The addition of front wheels was an extension of a series of developments. Given rudimentary steering systems, the first hydraulic boats had the drive unit stationed at the front, because boats that are pulled from the front require less active steering than those pushed from the back. (To this day, most farmers will tell you those old boats simply tracked better.) As the powered boats became a larger feature of farm operations, and farmers dedicated more and more cuts and fields to crawfishing, there were a variety of mechanisms that had to be developed to get a boat over a levee, a difficult proposition when the thing that powers your movement is hanging two to four feet in the air as you go up a levee. One fabricator introduced a reversible boat — it had not only a valve that reversed the hydraulic flow to the motor but also a sloped bow and stern — and with that the ability for a boat to push itself across a levee was introduced.

Once boats could cross levees under their own power, it was not long before farmers were pushing their boats over other obstacles. As one maker remembered: "Farmers kept bringing their boats back with the bottoms wore out. It happened again and again," he said. "So I finally asked one of them what was going on. They were going down the road with the thing. Just plowing along a road with it." Most of the roads between rice fields are dirt lanes, but some have gravel on them, which could hardly be good for a sheet of aluminum bearing hundreds of pounds of man, machinery, and crawfish. There is also, of course, the blacktopped highways that run throughout the region, which are also used by farmers to get from one field to another. The result was an incredible amount of wear in a short amount of time, something that at first perplexed Olinger until he hit upon the solution. "So I figured as long as they were going down the road, I'd give them wheels."

The wheels were readily adopted by other makers in the network, though, again, each adapted the construal to fit within his own particular design philosophy. Where the original maker had built a box to contain the wheels and then cut a fender into the side of the hull to make accessing them easy, one maker who focuses on the simplicity of design bolted the wheels outside the boat, while another who focuses on the sprung nature of his hulls completely internalized the wheels.

A decade later, the boats' success had led to their slowly spreading geographically, and in so doing, facing somewhat changed environments. In particular, as the boats moved westward along the Western Gulf Prairie, the soils in which they operated were increasingly sandy, leading to the hardened-steel cleats wearing down rather quickly. Some of you will recognize the solution proffered of one maker, who chose to add a length of steel rod along the edge of each cleat. An unanticipated result of the addition of this wear bar was that the boats, which had long been accused of digging ruts into fields, were digging less aggressively.

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The iterative process through which the crawfish boat first fluoresced and then solidified is largely one that folklorists would know as *tradition*. Tradition, like the more contemporary coinage *vernacular culture*, is useful term, but we as a field too often stop at the notion of face-to-face or person-to-person communication and fail to explore the cognitive dimensions that our approach to the world highlights. In *The Amazing Crawfish Boat* I slowly built a cognitive model, sketched out somewhat above, that I felt adequately accounted for the many variables inherent in even the small eco-system of ideas, experiences, and desires that produced an indigenous amphibious agricultural machine.

It was only after the book was done, that I realized I had been watching my daughter, who is, in some ways, more like the makers in the book than she is like her academic parents, suffer through an instructionist paradigm. Where her parents, either through idiosyncratic preference or through years of careful cultivation, have come to expect, even (perhaps unnecessarily or even dangerously) depend upon tight ontological schema that encompass everything at a sufficiently abstract level before we proceed to do anything else, she just wanted to be able to do something, and to figure out what she needed to figure out as she went along.

Fortunately, for her (and me), along with writing a book about guys who during slow moments in the shop like to attempt to calculate how much horsepower it takes to get out of chair or who can tell you the volume of rainfall based on the amount water rises in a field of a given acreage, I was also teaching myself how to code. (Python, if you want to know.) I bought myself several books and despite the numerous small examples sprinkled early and often, proceeded to read them, as if understanding object types, attributes, functions, and methods was something you could simply "read up on." They aren't, of which everyone in this room is well aware.

At the time, focused mostly on finding ways to engage my daughter in matters I thought were important, especially math, I picked up a copy of Seymour Papert's *Mindstorms*. The book is, of course, a marvel of suborning argument: you read it thinking you will get some theory to apply, when in fact its purpose is to re-shape the way you think about thinking. Later, I came across Papert and Idit Harel's "Situating Constructionism" which holds that building knowledge structures "happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity" (Papert). This seemed to me a very clear way of saying what folklorists mean when we talk about performance as "fundamentally … a mode of spoken verbal communication consist[ing] in the assumption of responsibility to an audience for a display of communicative competence." Folklorist Richard Bauman goes on to note that "Performance involves on the part of the performer an assumption of accountability to an audience…" (1975: 293).

The way natural knowledge construction as we have glimpsed it in the development of the crawfish boat works, as Papert would say, is to put one thing in play and see how it plays out, and the playing out here, like the verbal performances that were the focus of Bauman in his articulation above, is not purely a matter of function but of success within a socio-pragmatic milieu with multiple individuals bringing their own affinities and aversions to the mix. Papert's objects seemed to me always to occupy an interesting mixed space of both psychological satisfaction and social acceptance. After all, Papert's definition of constructionism "extend[s] the idea of manipulative materials to the idea that learning is most effective when part of an activity the learner experiences as constructing a meaningful product" (Sabelli 2008).

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Scholars like Sennett and Ferguson, and a host of others (including many in my own field of folklore studies), are not alone in wishing to re-assert the connection between making and thinking. As Mike Rose notes, there is has been an extensive effort to re-connect hands to heads:

> There is an extensive philosophical and sociological literature on the meaning of work, and running through much of it is the notion that work provides human beings with a means of engaging the environment, putting their impress on the world. If we accept this notion—and it seems to resonate within a Western cultural context—then we have to acknowledge the ever presence of mind in the work people do, at the least, the monitoring and directing of one's behavior that enables even the simplest of tasks, and the motives one brings to a task, the reasons for doing it—from economic to social to aesthetic—that affect the execution of it.

Historically, much of the effort has focused on re-claiming the skill and intelligence to be found in the trades. There is nothing new about this claim: it seems self-evident. But consider the ways our industrial history has violated it and our social distinctions continue to diminish it. No one doubts the importance of having our houses wired, or plumbed, correctly, nor do they doubt the value of good carpentry, and yet how often are we willing to pay the difference between a cracker jack tradesmen and someone good enough? Do we imagine it as the same kind of difference in value between granite and veneer countertops in our kitchen? Do we, as Mike Rose wonders, seek out the good enough surgeon or the one with "great hands"? And yet the carpenter and surgeon undergo similar kinds of training, typically apprenticing themselves to a master skilled in the trade they wish to ply. Both trades involve, as Rose points out, predictable sequences of steps; the ability to respond to variations in the material being worked, be it a patient's body or a slightly twisted piece of wood or metal; as well as the ability to respond to one's own missteps. The result is "not only a repertoire of skillful routines but also a developed sense of how to modify routines to gain a desired effect, a technical suppleness" (154).

While a lot has been written about the existential dimensions of making and its ramifications for personal development or aesthetic accomplishment, business scholars Gary Pisano and Willy Shih worry that the loss of making on an industrial scale weakens any nation that lets making get too far away from thinking. The personal computer industry is but one example of what happens, once you divorce making from thinking. Up until Apple's recent announcement to make certain parts of its computers in the United States, no personal computers were made here. The loss of jobs began with outsourcing of the most basic components, printed circuit boards, to specialist contractors, but slowly those contractors grew to offer more and more capabilities, which American computer makers gladly consigned, holding back for themselves the seemingly more intellectual realms of design, marketing, and customer service. Unfortunately for them, even those functions became outsource-able, and there are now less than a half dozen American computer companies who can claim to have a significant hold on their own supply chain.

What gets lost, and what is harder to recover than simply a factory, is the entire eco-system of thinking that is slowly eroded. What made Silicon Valley so important in its day, according to Pisano and Shih, was that software designers and manufacturing engineers would rub elbows at places like restaurants or events like parent-teacher organization meetings. Notes, ideas, and insights could easily be exchanged in a casual atmosphere which might then become instrumental in some product or process innovation. Just as important as those conversations were the conversations engineers would have with men and women on the factory floor, who could point out design ambiguities, and there are always some, as well as potential efficiencies that could not be glimpsed from a CAD screen but can, quite literally, be seen when someone watches a conveyor belt move parts forward. As Pisano and Shih note: "much technical knowledge, even in the hard sciences, is highly tacit and therefore more effectively transmitted face-to-face."[2] What we need to focus on, they argue, are industrial commons, places where ideas can move around and have a high likelihood of falling on fertile ground. Put more simple: proximity is crucial.[3] And yet the last several decades have witnessed the shipping out of manufacturing as a commodity component within the larger chain of "value creation" that is the work of modern corporations.

[2] Pisano and Shih 2009: 117.
[3] Lee Fleming — need reference.