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Entrepreneurship as a science of the artificial

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Abstract

This essay connects four key ideas from Herbert Simon's "Sciences of the Artificial" to recent research on entrepreneurial expertise: (1) natural laws constrain but do not dictate our designs; (2) we should seize every opportunity to avoid the use of prediction in design; (3) locality and contingency govern the sciences of the artificial; and, (4) near-decomposability is an essential feature of enduring designs. The essay is based on a series of conversations and emails with Simon about the empirical findings of my doctoral dissertation that involved a protocol analysis study of expert founder-entrepreneurs.

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1. Introduction

Most of us enter the world of research with perceptions of the scholarly life as a quest for the holy grail. The grand myth of Parsival inspires us even when we might be less than confident about our own potential to equal his achievement. The majesty of being a part of the quest itself inspires us... until sooner or later, the terrible fate of Sisyphus, waking every dawn to push the boulder relentlessly up the mountain, only to have it drop back at dusk and start all over again in the morning, begins to loom as possible reality in our research "careers" – and it becomes more and more difficult to seek meaning and fulfillment in our "quest."

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I had the good fortune to work with Herb Simon, a Parsival if ever there was one in the social sciences, from whom I learned that the key was not to strive to become Parsival, but to "imagine Sisyphus happy," as Camus compels us in his profound essay. Many of my meetings with Simon, especially in the early stages of my relationship with him, began by his asking, "So what do we know today that we did not know the last time we met?" That was *not* an easy question for a doctoral student to answer every other week! But I took it as a challenge and began using the opener to provoke discussions into a wide variety of topics such as: how entrepreneurs think; the importance of "naming" things in how human beings learn; how embryonic cells know how to become particular types of tissues such as lung tissue or bone marrow; Borges' mazes and Lem's constructors; and even deeply personal issues such as what love and death and money meant to him (and to me). Several strands of this wonderfully messy conversation, however, were converging on the notion of the "artificial" – the idea of "design" as opposed to "choice." We had just finished a conference paper based on this particular convergence (Sarasvathy & Simon, 2000), and were in the middle of revising it for a journal, when the curtain came down on his last act. [1]

This essay is spun from the threads of that conversation. It revolves primarily around four key themes that Simon outlined in "Sciences of the Artificial" and illustrates how they connect together in the world in one particular domain: Entrepreneurship. In the following pages, I attempt to tell the story of how we explored the connections as well as try to establish a thesis about the connections.

The story begins with my empirical investigations of entrepreneurial expertise for my doctoral dissertation. Based on the findings of this investigation, I developed the theory of effectuation (Sarasvathy, 2001a) and located its antecedents in Knight's formulation of true uncertainty (Knight, 1921), Weick's conceptualization of enactment (Weick, 1979), and March's technology of foolishness (March, 1982). Only when Simon and I were invited to contribute a paper to a conference in 2000 and he suggested that there might be a connection between my formulation of effectuation and his theory of near-decomposability that I began to see the various threads in the *Sciences of the Artificial* that directly tied together with effectuation (Simon, 1996).

Simon's logic in seeking a connection between the two theories was, as most of his seminal ideas have always been, very simple: "*As near-decomposability is an astonishingly ubiquitous principle in the architecture of rapidly evolving complex systems, and effectuation appears to be a preferred decision model with entrepreneurs who have created high growth firms, we should be able to link near-decomposability to the processes these entrepreneurs use to create and grow enduring firms – whether in an experimental situation or in the real world.*"

Delving into both theories with this new insight led me to realize that the connection lay in the roles that locality and contingency played in each. Locality here refers

[1] When I asked him about death the day after his 80th birthday, he said he could accept that life, like a play, would have a last act and then the curtains would come down.

to the fact that cognitive limitations on our rationality allow us to build artifacts that achieve only local optima at best; yet, our artifacts can endure over time by learning to adapt to contingencies and sometimes even exploit those contingencies for their own survival and prosperity. But I am getting ahead of the story here – to tell it properly, I will first briefly explain (1) effectuation and (2) near-decomposability and then explore the roles that locality and contingency play in each. If I do my job right, the story will have the happy ending that effectuation, together with Simon's work on the artificial can explain the creation of high growth firms; and also, that several interesting sequels can be developed by envisioning entrepreneurship as a science of the artificial.

2. Effectuation: A theory of entrepreneurial expertise

For my doctoral dissertation, I used the protocol analysis method that Simon and his colleagues had used to study experts in a variety of fields (Ericsson & Simon, 1993). My subjects consisted of expert entrepreneurs, founders of firms ranging in size between $200 million and $6.5 billion and including a variety of entrepreneurial experiences in a wide variety of industries. Each subject had to solve a 17-page problem set consisting of 10 typical decision problems that occur in transforming an idea into a successful firm. The logic underpinning the study was: *Given the fact that the subjects are expert entrepreneurs, and have nothing else in common, is there anything common in the problem solving processes they use?* If so, I could then extract those commonalties and create a base-line model of entrepreneurial expertise.

The intuition based on extant literature suggested there was no such thing. Several studies trying to tie psychological traits of entrepreneurs with firm success did not seem to lead anywhere (see Gartner, 1988, for a good review); entrepreneurs were also found to range all over the risk-preference spectrum (Brockhaus, 1980; Palich & Bagby, 1995); and some economists even theorized that entrepreneurial expertise was nothing but a statistical artifact (see Arrow's comments in Sarasvathy, 2000).

But intuition based on extant scholarship is not the only type of intuition available to us. Another type of experiential intuition has kept entrepreneurship scholars steadfast in their pursuit of the mythical beast "entrepreneur." Meeting and talking with entrepreneurs in person, and interacting with them on a daily basis suggests there is indeed something that ties them together as a species – something in the language they use, the stories they tell, and the way they approach and handle problems and people. Of course, that could merely be a retrospective retelling of an essentially random set of experiences. Hence, the protocol analysis to delve into the black boxes of their cognition.

By the time I got to the 20th entrepreneur in the analysis of the very first problem (identifying the market for a new product), the coders began to agree that a clear pattern had come to light about how entrepreneurs create markets and firms. The key characteristic of this pattern was that it inverted the principles and processes that we teach students in MBA programs on how they should go about identifying the market for their ideas. Since these principles and processes are usually based on a

causal or predictive approach to reasoning, I termed the entrepreneurial approach "effectuation," to emphasize its aspects of being an "inverse of causation." To summarize the results quantitatively, 74% of the participants in the study behaved in accordance with the effectuation model at least 63% of the time, and 44% of them, at least 85% of the time (Sarasvathy, 2001b).

2.1. Brief outline of effectuation

The model of entrepreneurial expertise extracted from the protocols is complete in the sense that it identifies a particular problem space, a solution process, a set of principles and a unifying logic that ties it all together into a coherent whole. Here I will briefly outline the theory. See Sarasvathy (2001a) for a detailed exposition.

Traditional models based on causal rationality operate in a small, comfortable clearing in the woods characterized by: (a) given, well-specified goals; (b) well-understood causes and past histories that enable reasonably reliable predictions about the future; and, (c) an independent environment (such as a "market") that serves to separate the wheat from the chaff of decisions made by individuals and firms. But all around this cozy clearing stretches the vast, relatively unexplored jungle where goal ambiguity, Knightian uncertainty, and endogenous markets dominate the landscape. This is the problem space for effectuation and is best described by Simon in Sarasvathy and Simon (2000): "*Where do we find rationality when the environment does not independently influence outcomes or even rules of the game* (Weick, 1979), *the future is truly unpredictable* (Knight, 1921), *and the decision maker is unsure of his/her own preferences* (March, 1982)?"

An empirical example of this Weickian–Marchian–Knightian problem space is the "suicide quadrant" in Fig. 1. Both expert marketers and experienced venture capitalists routinely avoid this space that involves introducing a new product in a new market. Yet, experienced entrepreneurs know that this is the space within which great

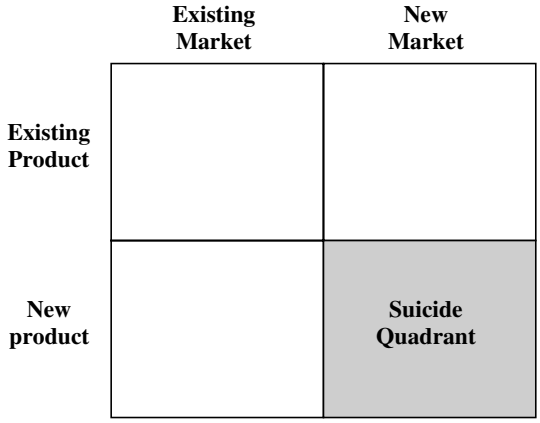

Fig. 1. Example of problem space for effectuation.

companies such as Edison's General Electric, Apple Computers and Medtronics often emerge. The problems in this space, unlike problems involving causal rationality, do not begin with clearly specified goals.

Some examples should clarify the distinction between the two types of processes. Imagine the manufacture of a product. In the case of causal or decisional rationality, the blueprints of the product are provided in advance, together with its costs, and estimates of market demand; the manufacturer needs simply to procure the raw materials and process and assemble them according to the predetermined plan. In the case of effectuation, the manufacturer has a general idea that *might* lead to a product that *could* be marketed profitably. Gillette was looking for something that customers would have to purchase repeatedly (McKibben, 1998). While he was shaving one morning, it occurred to him that a non-permanent razor might fit his specification. He then had to develop a cheap, effective removable-blade razor, generate plans for creating an adequate initial market, search for sources of funds to get started, and so on, always modifying his plans as he gained new knowledge from his initial experiments and efforts. This example involves both causal and effectual approaches at different stages of firm creation.

But for the purposes of clear theoretical exposition, a simple, but highly dichotomous example might serve to anchor the arguments better. Imagine the contrast between a chef to whom a specific menu is presented, and who only has to list the needed ingredients, shop for them, and then cook the meal (causal decision); and a chef who happens to find some ingredients in his cupboards, and some utensils in the kitchen, from which he imagines and produces a delicious meal (effectual design). In the one case, the givens are assembled, in the other case, they are constructed in a constrained environment through imaginative agents in an ebullient pursuit of interesting (and hopefully valuable) possibilities.

For a more complex example from entrepreneurship, we can contrast the actual history of an internet company such as RealNetworks (leader in the real time audio and video streaming industry on the Web) with how we teach entrepreneurship students to develop a business plan. If a student came up with the idea of starting an interactive cable TV channel with progressive content (which was what Rob Glaser, the founder of RealNetworks originally set out to build in 1994), we would advise them to proceed as follows: carry out market research to estimate size, growth rate etc. of key target segments; come up with financial forecasts; write a business plan; raise funds needed; test market the product and then implement market strategies to capture as large a market share of the target markets as possible. And the student would most probably never come upon the idea of giving voice to the "mute" web. In contrast to this, a close examination of the actual history of Progressive Networks (later renamed RealNetworks) tells a fascinating story of effectuation with contingent twists and unpredictable turns, relatively unplanned plunges into proximate markets, and a relentless endeavor to shape and control the standards in an emerging industry. See Sarasvathy and Kotha (2001) for a detailed analysis.

Effectuation is not a process of choosing among given alternatives, but of generating the alternatives themselves, and simultaneously discovering and assessing desirable and undesirable qualities of several possible ends. In this sense, effectual

processes involve design (including the design of alternative goals), not just choice. Entrepreneurship, involving effectuation, has proved an elusive target for economic theories, mainly because those theories have, with rare exceptions, been limited to choices among given alternatives, applying pre-specified criteria, to achieve predetermined goals.

2.2. Means available for effectuation and the solution process

Entrepreneurs begin with three categories of what I have called "means." They know who they are, what they know and whom they know – their own traits, tastes and abilities, the knowledge corridors they are in, and the social networks they are a part of [2]. Starting with these means, the effectuator asks herself, "Given who I am, what I know, and whom I know, what *can* I do? What types of effects *can* I create?" Contrast this with causal reasoning that focuses on questions such as, "Given the particular goal I want to achieve, what *ought* I to do? Which particular path *should* I take?" Causal reasoning tends to begin with a universe of all possible alternatives and seeks to narrow the set of choices to the best, the fastest, the most economical, the most efficient etc. Effectual processes seek to expand the choice set from a narrow sliver of highly localized possibilities to increasingly complex and enduring opportunities fabricated in a contingent fashion over time. One important example of this process, that of entrepreneurial marketing, is represented in Fig. 2.

Causal models of marketing prescribe that the entrepreneur begin with a market defined as the universe of all possible customers; then divide this universe into relevant segments based on rigorous market research; choose a target segment after analyzing predicted returns and risks for each segment; and finally design marketing strategies to capture the target market. The effectual model suggests the entrepreneur should find a customer or a partner searching very locally, just someone from within their personal social network or through garbage can processes; then generalize the initial customer or partner into a segment; add segments over time in a contingent fashion; and eventually define the market for their product/firm.

Causal models are based on a predictive logic: *To the extent we can predict the future, we can control it.* Being able to predict the size, growth rate and potential trends of target segments, for example, allows the entrepreneurial firm to secure its own financial future.

2.3. The logic of effectuation

Effectuation suggests a rather different logic for the choice process: *To the extent we can control the future, we do not need to predict it.* How does one control an unpredictable future? The answer to this seemingly paradoxical question lies in the re-

[2] At the level of the firm, the corresponding means are its physical resources, human resources, and organizational resources, a la the resource-based theory of the firm (Barney, 1991). At the level of the economy, these means become demographics, technological capabilities, and socio-political institutions (such as property rights).

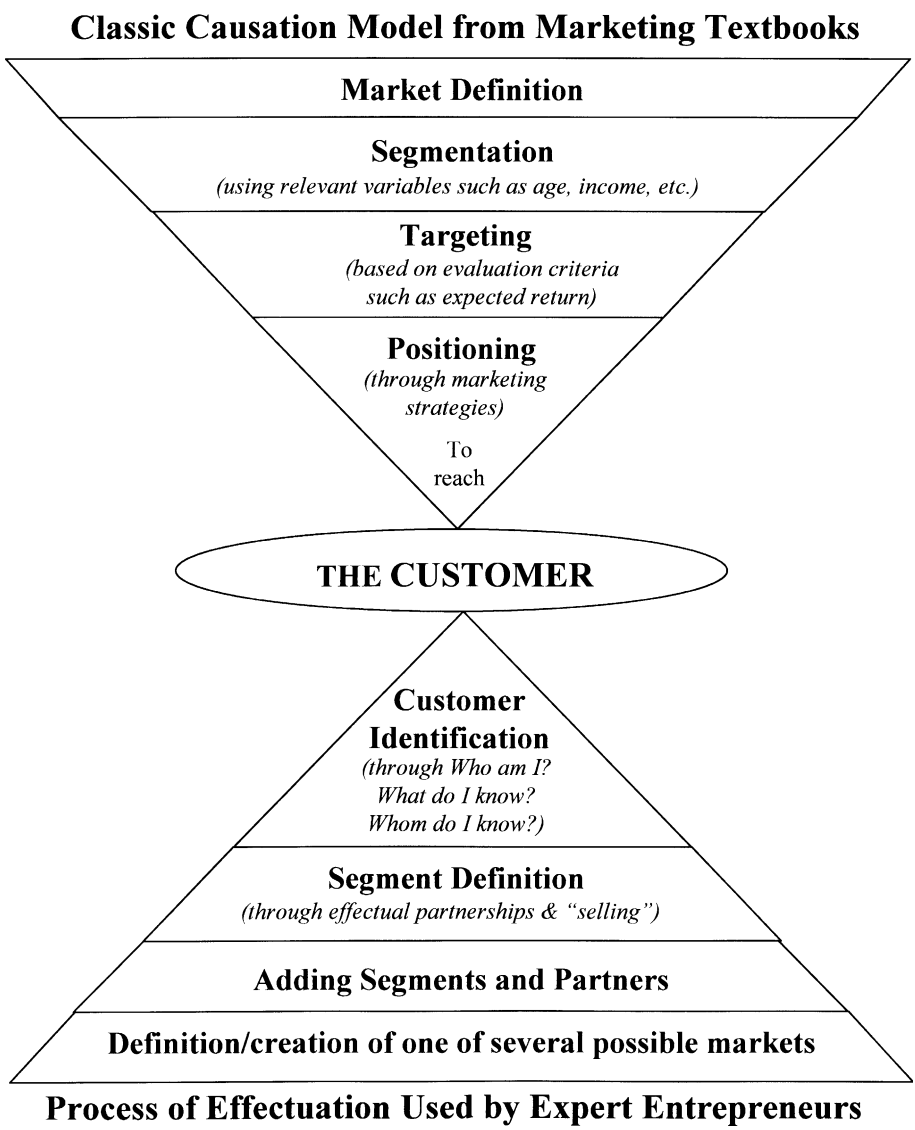

Fig. 2. Effectual market creation contrasted with causal marketing.

alization that a large part of the future actually is a product of human decision making. By bringing on board key stakeholders who can "deliver" the future, the entrepreneur need not waste time, resources, or effort on prediction. Of course, such a view may express hopes rather than realities, and many entrepreneurs in the real world do fail. This fact does not negate the hypothesis that they are often more concerned with molding, or even creating, the part of the world with which they are concerned than with predicting it and reacting to the prediction.

This particular logic of control is embodied in three principles that together form the core of effectual reasoning:

1. *Affordable loss rather than expected returns*: Causal models focus on maximizing the potential returns for a decision by selecting optimal strategies. Effectuation pre-determines how much loss is affordable and focuses on experimenting with as many strategies as possible with the given limited means. It prefers options that create more options in the future over those that maximize returns in the present. The extreme case of this is the zero resources to market principle. This principle destroys uncertainty by pre-digesting the down side.
2. *Partners rather than competitive analyses*: Causation models such as the Porter model in strategy, emphasize detailed competitive analyses. Effectuation emphasizes partnerships through pre-commitments from stakeholders as a way to reduce and/or eliminate uncertainty and erect entry barriers. Pre-commitments from key stakeholders make uncertainty irrelevant by "delivering" a future that looks very similar to what was contracted for.
3. *Leveraging contingencies rather than avoiding them*: When pre-existing knowledge such as expertise in a particular new technology forms the source of competitive advantage, causation models might be preferable. Effectuation, however, would be better at leveraging contingencies that arise unexpectedly over time.

This principle makes uncertainty a friend and an asset, eliminating the need to overcome it.

Effectuation has at least one major implication for the success/failure of entrepreneurial firms. While firms created through effectual processes may not reduce the *probability* of failure, they do reduce the *costs* of failure. They allow failures to happen earlier and at lower levels of investment, while keeping open the upside option of making larger investments should early successes begin to cumulate.

That is because the logic of control overcomes the problems of prediction by keeping investments to the utmost minimum, continually negotiating with key stakeholders, and learning to *use* contingencies to create new ends or adapt better to achieve old ones. The idea of using a logic other than that of prediction is extremely important for the creation not only of firms, but of any enduring human artifact. As Simon puts it in his book, *Sciences of the Artificial* (1996, p. 147): "Since the consequences of design lie in the future, it would seem that forecasting is an unavoidable part of every design process. If that is true, it is cause for pessimism about design, for the record in forecasting even such "simple" variables as population is dismal. If there is any way to design without forecasts, we should seize on it."

3. Entrepreneurship as a science of the artificial

Sciences of the Artificial is one of the most exciting pieces Simon has ever published. In an oeuvre of over a thousand publications, that is saying a lot. But it is also, in my considered opinion, one of the most irritating. It bursts at its seams with

brilliant ideas and mouth-watering possibilities for scholarship and pedagogy, but does not develop many of these into something readers can sink their teeth into, especially in the domains of management and economics. One is left with a sense of the enormity of work to be done, but not quite sure where to begin. So when we were invited to write a paper for a technology entrepreneurship conference in 2000, and Simon suggested in a quietly provocative voice that we should try and link effectuation with the notion of *near-decomposability* that he had outlined in the book, I was rather skeptical. But rolling up my sleeves and digging into the fertile loam of ideas that is *Sciences of the Artificial* made me realize how close my ideas generated through my empirical work were to his ideas culled from a lifetime of trying to understand human artifacts.

3.1. Near-decomposability [3]

Near-decomposability is a pervasive feature of the architecture of the complex systems that we find in the world, both inorganic and organic, ranging from elementary particles to social systems (Simon, 1969). A complex system is nearly decomposable if it is comprised of a number of interconnected subsystems in such a way that elements within any particular subsystem interact much more vigorously and rapidly with each other than do elements belonging to different subsystems. There may be a whole hierarchy of systems, subsystems, sub-subsystems, etc., where this same property holds between any two levels. In such systems, (1) the short-term (high-frequency) behavior of each subsystem is approximately independent of the other subsystems at its level, and (2) in the long run, the (low-frequency) behavior of a subsystem depends on that of the other components only in an (approximately) aggregate way.

We should note at this point that near-decomposability is not the same as complete decomposability. The key to understanding near-decomposability is that in this architecture, what constitutes a good design for a component is nearly independent of the designs of other components. With correlated components, good design involves a space of kn possibilities (n being the number of components and k being the number of subassemblies). With complete decomposability, it involves *search* in the space of $n \times k$ possibilities, and with near-decomposability, it involves *approximation* in the space of $n \times k$ possibilities. The human body is a good example of a nearly, but not completely, decomposable system. On the modularity continuum, nearly decomposable systems are stably balanced between synergistic specificity and separability (Schilling, 2000).

The structural property of near-decomposability has two implications for the evolution of complex systems:

First: If we begin with a set of simple elements that are capable sometimes of forming stable combinations, and if the combined systems thus formed are themselves

[3] In this section, I borrow chunks of my conference paper with Simon (Sarasvathy & Simon, 2000) and so at least parts of it embody his voice as well as mine.

capable of combining into still larger systems, then the complex systems we will observe after this process has proceeded for some time will almost all be nearly decomposable systems. The universe as we observe it today provides ample evidence for this claim. The gradual evolution of the elements from primeval fundamental particles and hydrogen, then the evolution of successively complex molecules and living organisms – has observably produced nearly decomposable systems with clearly defined particle, nuclear, and atomic levels, and a whole sequence of molecular levels above the atomic. Moreover, it has been shown that the time available for evolution of living organisms on earth is sufficient to produce organisms of the complexity that is actually observed (say, bacterial complexity) if the organisms and their subsystems are nearly decomposable, but not if they must be completed by an uninterrupted sequence of unions of elementary components (Simon, 1996, p. 189).

And second: If we begin with a population of systems of comparable complexity, some of them nearly decomposable and some not, but all having similar frequencies of mutation, the nearly decomposable systems will increase their fitness through evolutionary processes much faster than the remaining systems, and will soon come to dominate the entire population. Notice that the claim is not that more complex systems will evolve more rapidly than less complex systems but that, at any level of complexity, nearly decomposable systems will evolve much faster than systems of comparable complexity that are not nearly decomposable.

The connection between near-decomposability and rapid evolution is simple and direct. In nearly decomposable systems, each component can evolve toward greater fitness with little dependence upon the changes taking place in the details of other components. Simple mathematics and recent simulations by Marengo, Frenken, and Valente (1999) have shown that, if and only if these conditions hold, natural selection can take advantage of the random alterations of components with little concern for countervailing cross effects between them. Such a system is like a defective safe that clicks whenever one of its dials is set correctly, independently of where the other dials are currently set.

In other words, in nearly decomposable systems failures may be contained as *local* events, without disastrous system-wide consequences. Thus nearly decomposable systems survive not because they make fewer mistakes, but because they can control the damage locally. Yet, the system as a whole can cumulate the benefits of learning over time precisely because it is not completely decomposable. It is the tension between the interdependence of parts and their approximate independence that gives an evolutionary advantage to nearly decomposable systems. In this particular characteristic, they echo the implications for success and failure suggested by the theory of effectuation.

3.2. Locality and contingency in near-decomposability and effectuation

In *Sciences of the Artificial*, Simon shows that the phenomena that constitute the artificial are imbued with and driven by locality and contingency, both in structure and movement.

In designing artifacts, human beings are confined within rather narrow local limits in terms of space, time and knowledge – primarily because of the bounds on our cognitive capacities and the natural limits on our internal information processing system:

- First, we can attend only to a limited number of things at a time.
- Second, our planning horizons tend to be short run rather than long run.
- Third, the stock of knowledge at any given point in time exists dispersed across individual experts and specialized knowledge corridors that are not always easily accessible to all decision makers.

Ergo, most artifacts for most purposes are only locally adaptive. In other words, they survive well only within particular domains and short-run periods during which the knowledge stock remains relatively unchanged. As Simon observes, "The world of economic affairs is replete with local maxima. It is quite easy to devise systems in which each subsystem is optimally adapted to the other subsystems around it, but in which the equilibrium is only local, and quite inferior to distant equilibria that cannot be reached by the up-hill climb of evolution." (1996, p. 47).

Enduring artifacts, however, have to incorporate a way to deal with changes in local environments over time, whether these are changes in technologies or preferences or other contingencies that reshape the environment. That is why artifacts that incorporate the property of near-decomposability in their structure endure better since they allow parts of the structure to be modified, or even destroyed and rebuilt, while retaining the rest of the entity relatively unchanged. Nearly decomposable systems are very good at exploiting both locality (necessitated by the limitations of the inner environment) and contingency (necessitated by the changing complexities of the outer environment).

That brings us to the question of how effectual processes can create nearly decomposable artifacts. Here the analogy of a patchwork quilt is very useful. Using effectual processes to create firms and markets is somewhat like making a patchwork quilt. Quilters begin the process with a random assortment of fabric patches and seek to create a meaningful and pleasing pattern in the quilt they make with them. In the beginning the quilter could try different combinations of patches that suggest possible patterns and pictures in the finished quilt. While the availability of the particular assortment of patches constrains the design, it does not determine it. A good quilter can create intriguing and even meaningful patterns with the most chaotic of initial assortments. Furthermore, as the quilt begins to take shape, quilters might seek out particular patches outside their initial endowments, say from friends and garage sales. Contingent upon the patches they find, they might change their initial designs as new possibilities emerge and they imagine better visions for the finished quilt.

It turns out, therefore, that such effectually created patchwork quilts can be rather good examples of nearly decomposable systems. While particular patches have to work with other patches to create an interesting pattern, sections can be re-worked without redoing the entire quilt as the quilt grows larger. A causal analogy to this effectual quilt would be a jigsaw puzzle, where the picture is already there, and the pieces are merely to be assembled "correctly." The patchwork quilt, however, has no pre-determined pattern and depends almost entirely on the imagination of the

quilter and his or her mother wit in transforming unexpected contingencies into opportunities. In general, while causal models are tethered to goals, effectuation is unmoored from specific goals enabling the effectuator not only to change particular goals, but to create multiple new ends that could not have been foreseen at the beginning of the process.

So too the effectual entrepreneur begins with who she is, what she knows, and whom she knows, to discover at least one customer or partner who is interested in a product or service she can offer. Thus the first stable configuration of product/stakeholder/environment comes into existence (perhaps after several aborted starts). But the first stable configuration changes the means now available to her – her knowledge corridors expand, her social networks grow larger and even her identity is enhanced, through reputational and legitimation effects for example. Depending on who the first stakeholder is and what he or she is interested in, the effectuator starts expanding the initial configuration and adds new configurations in a contingent (and usually path dependent) fashion. Throughout the process, she seeks to tie the different pieces together through innovative yet meaningful themes that get embodied in mission statements, business plans, marketing brochures and press kits. While the bottoms-up building block by building block process reduces costs of failure, the continual effort to create a unified identity allows successes to cumulate, learning to occur and competitive competencies to be forged.

In this way, effectuation too creates nearly decomposable artifacts. Firms cannot be completely decomposable or 100% modular, if they are to have a strong identity that inspires loyalty and trust with internal stakeholders. Yet, they need to be somewhat decomposable, so negative feedback from a variety of stakeholders can be incorporated to re-work parts of the firm as it grows and endures in the marketplace. It is this particular opportunity to perceive and harness advantages both from the interdependence of parts and their independence that gives effectually created nearly decomposable entities a peculiar edge in evolving faster and enduring longer.

In the spirit of one of Simon's favorite storytellers, Borges (1980, p. 107), who said, "I've observed that people tend to prefer the personal to the general, the concrete to the abstract," I will now provide an extract from one of the protocols in my study. The extract lucidly illustrates how effectuation stitches together nearly decomposable firms. I use the extract, not as evidence for the existence of effectual processes, but merely as an illustration of how they *may* build near-decomposability into economic artifacts. Here the subject has been asked his opinion as to the growth possibilities for an imaginary firm that begins with a single imaginary product, a simulation game of entrepreneurship. Notice how he begins by not showing much faith in the product, but gradually imagines himself into the vision of a great company (see phrases in bold font). Notice also that at least thrice during the protocol he strives to tie together the different bits and pieces he is imagining through a common theme or an "identity" of sorts (see italicized phrases).

> "**This company could make a few people very rich, but it cannot**... **I dont think it could ever be a huge company**. The basic concept is a business simulator... startup simulator... so... in the same way in a jet simulator you

can hop in and fly something electronically and not blow it up... so you can hop into a business situation and practice and get a lot of reflexes built up and thought processes built up up front. So... a successful launch of the first product with a big marketing sales push to penetrate as many different markets as we could... might have a successful second product. For example, you could have a product which is how to succeed, prosper, grow and get promoted within a large company. Making an equivalent product for the quote organization person as opposed to the entrepreneur would give you market of everybody with aspirations at IBM, AT&T, Exxon etc. etc. so... That product could be a follow-on product... the research would be similar, the product development would be similar, and so the production part would be equivalent and some of the same marketing channels would also work. You could make another product, would be, for students. How do I graduate in the top 10% of your class at Stanford, or Harvard or Yale. And there... you could simulate the learning process in the classroom. and research traits that tend to make you successful or not. study habits that tend to make you successful or not. and... a lot of how to be a good student is teachable. A lot. In my case for example, I took – So there are studying habits that I'm aware of and you can do research on successful students and you could develop a profile that the... marketing pitch of which should be... students who graduate in the top 10% of a college class aren't just smart in an accident. They have different habits and ways of doing business that cause them to be successful and those are neither genetic nor intelligence related... they are learnable. So there's your... now you got a product that can... you can sell to every student in the country. uhm... so we talked about entrepreneur business, big business, students, *so we're really talking about any learning in an interactive situation where simulation is a benefit*. So you got... next there is negotiation... there are books on negotiators... how to negotiate... famous books... here you could... in reading a book about negotiation would be less effective than having an interactive 3D game about negotiation. So there you could practice being a good negotiator. And that would work. There's not a salesman in the United States who wouldn't buy one of those. How to sell you know so you got you know another learning situation where how you act and how you push people can can help you sell better. so... there is sales. So I guess you could go on and on and then you could generalize the thing *to any situation which requires some sort of technical knowledge*... technical knowledge of negotiating... technical knowledge of bio-molecules... which also involves human organization... people you have to deal with... both outside the company to get them to help... to work with them and inside the company to get them to understand what is the company's methods objectives etc. *So an organization in a learning situation with technical requirements*. That simulation that had those traits so now you can... I gave four five endeavors... you can

> expand that so... maybe I'm gonna change my opinion about the growth potential for the company... The company could.. it is easy to see how within an hour you could name ten products and the ten products would address huge markets like all employees in Fortune 500 companies that.. who are rich enough to pay hundred dollars for it. So now all of a sudden you can see it's a software that could be a... could be a hit on the scale of Lotus.. what Lotus was to the spreadsheet world. **And therefore you could see a several hundred million dollar company coming from it**.''

To summarize the exposition so far, both effectuation and near-decomposability exploit locality and contingency in the evolution of the artifact. Just as effectuation creates rapidly evolving artifacts that leverage the *interdependence* of parts to exploit locality and contingency, so near-decomposability in the structure of such systems leverages *independence* of parts to exploit the same locality and contingency. While effectuation stitches together pieces of entrepreneurial fabric into economic quilts that continue to make sense in an interactive and dynamically changing environment, near-decomposability identifies lines of ''tearing'' so that pieces can be re-worked in synchrony with the overall pattern as the needs imposed by the environment change.

Together they can provide a convincing explanation for the creation and growth of the firms that we see in the real world. One way to substantiate such an explanation would be to analyze the historical evidence already available to us. For example: Wedgwood Pottery (Koehn, 1997), General Electric (Baldwin, 1995), U-Haul (Silver, 1985) and AES Corp (Waterman, 1990) all contain evidence as to how effectuation processes have built large and rapid-growth firms with built-in near-decomposability in their organizational structures. More general histories of the spread of ''divisional'' architectures through American industry can be found in Drucker (1947) and Chandler (1962). Today, we can see numerous new examples of companies that grow through franchising, joint ventures, and more recently, through ''affiliate'' programs pioneered by internet companies such as Amazon.com.

3.3. A vision for the effectual artifact

My research had already shown that entrepreneurs (rightly or wrongly) did set out to *design* firms and to a considerable extent, even markets for their firms through the logic of control. In this sense, entrepreneurship is a science of the artificial. But as Simon points out in his book (1996, p. 113), ''The previous chapters have shown that a science of artificial phenomena is always in imminent danger of dissolving and vanishing. The peculiar properties of the artifact lie on the thin interface between the natural laws within it and the natural laws without. What can we say about it? What is there to study besides the boundary sciences – those that govern the means and the task environment?''

He then goes on to explain what the contents of a science of the artificial might consist of, ''The artificial world is centered precisely on this interface between the inner and outer environments; it is concerned with attaining goals by adapting the for-

mer to the latter. The proper study of those who are concerned with the artificial is the way in which that adaptation of means to environments is brought about – and central to that is the process of design itself.'' It is here that entrepreneurship builds on Simon's formulation of a science of the artificial and moves it toward new horizons. I would like to argue that the design of entrepreneurial firms in general might involve something more than adaptation of the inner environment to the outer; it might involve *negotiation* between the two. That is because, more often than not, the environments of entrepreneurial firms (as well as markets in general) consist of the contingent decisions of other human beings.

Without belaboring the point too much, I am not alone in my thesis that markets are not ''natural phenomena'' based upon economic inevitability or even human necessity. However much economists might argue that *de gustibus non disputandum est*, there is considerable historical and other types of evidence that marketers and entrepreneurs do succeed in their efforts to shape the preferences and tastes of their customers. As early as 1939, Schumpeter pointed out, ''It was not enough to produce satisfactory soap, it was also necessary to induce people to wash'' (Schumpeter, 1939, p. 243). More recently, Carpenter and Nakamoto (1989) theorize based on empirical data that the practice of branding is essentially the formation of new preference structures in the psyches of consumers. In a recent book, Koehn (2001) chronicles several entrepreneurs from Wedgwood to Dell who created highly successful enduring brands. Other economists too have argued against our assumptions of markets as something exogenous to the economic process, or something to be assumed as a ''given'' in our analyses. Olson and Kahkonen (2000, p. 1) put it as follows, ''The fourth primitive of economic thought – and of most lay thinking on economics – is so elemental and natural that it is usually not even stated explicitly or introduced as an axiom in formal theorizing. It is the half-conscious assumption that markets are natural entities that emerge spontaneously, not artificial contrivances or creatures of governments.'' Finally, Arrow (1974, p. 8) admits, ''Although we are not usually explicit about it, we really postulate that when a market could be created, it would be.''

Therefore, if we do not take markets as completely exogenous to the economic process, and view them instead as preferences being formulated and decisions being made by a set of human beings that can be influenced by the actions of the entrepreneur, the effectual artifact of entrepreneurship (e.g. the firm) does not just adapt to its external environment (''the market''). Instead it has the option of *negotiating* with its environment, to shape the environment at least partially in its own image, just as it adapts other aspects of its internal self to effectively reflect the environment.

One might of course argue that negotiations too are a form of adaptation. That would raise the question, ''Adaptation to what?'' Effectuation is fundamentally different from other forms of adaptation such as those involved in biological evolution. While the effectuator does adapt to changing circumstances outside his control, he also actively seeks to reshape his environment through those parameters that do submit to his control. Effectuation, therefore, includes adaptive techniques such as improvization, socio-psychological techniques such as bracketing and enactment, and aggressively effectual techniques of negotiation such as lobbying the government,

participating in standards bodies, and obtaining pre-commitments from influential stakeholders etc.

Understanding the role of such negotiations between inner and outer environment, whether as part of an adaptive process or in parallel to it, should form one of the core areas for research in entrepreneurship. Another key area for research suggested by the formulation of entrepreneurship as a science of the artificial consists in the role of firm failures in allowing entrepreneurs to understand limiting properties of the artifacts they create in relation to the environments with which or within which they negotiate.

In sum, the theory of effectuation suggests that entrepreneurship is indeed a science of the artificial and that it builds on at least four key ideas in *Sciences of the Artificial*:

1. Natural laws constrain but do not dictate our designs – i.e., within the constraints of natural law, our designs are contingent on our imagination; there is nothing intrinsically "inevitable" about them. *Implication for entrepreneurship*: Given who we are, what we know, and whom we know, we can build a variety of effectual artifacts by focusing on what we *can* do, rather than continually worrying about what we *ought* to do, given pre-determined goals.
2. We should seize every opportunity to avoid the use of prediction in design. *Implication for entrepreneurship*: Designing without final goals allows us to free ourselves from the pitfalls of prediction so we can use other mechanisms such as the scientific method, or the garbage can (Cohen, March, & Olsen, 1972), or the effectual logic of control.
3. Locality and contingency govern the sciences of the artificial. *Implication for entrepreneurship*: Contingencies can be viewed as opportunities to be exploited rather than as misfortunes to be avoided; while successes and failures are always local, cumulative learning is still possible.
4. Near-decomposability is an essential feature of enduring designs. *Implication for entrepreneurship*: Effectual processes that exploit locality and contingency through both interdependence and independence of parts are more likely to result in enduring firms.

4. Conclusion

When I came up with the first draft of the conference paper, Simon had some difficulties with my cooking and quilting metaphors. He was used to watchmakers and clicking safes. But eventually as we talked and emailed back and forth, and particularly when we started discussing the role of locality and contingency in the two theories, he began to see that the quilting example was particularly apt for what we were trying to establish in the paper and admitted to me in an email that he was "more persuaded than before of the effectiveness of the cookery and quilting metaphors."

It was one of those treasured moments when I was able to surprise him in answer to his familiar question, "So what do we know now that we did not know the last

time we met?" He will always live in that question for me, and I am filled with gratitude I got to explore it with him so many times. Rest assured, Herb, I will keep trying to catch you by surprise one of these days.

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