CHANCE, NÉCESSITÉ, ET NAÏVETÉ: Ingredients to Create a New Organizational Form

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A few words situating this work…

This is the first chapter in a trilogy. It uses archival materials and interviews to reconstruct the foundings of the first generation of biotech companies in the late 1970s and 1980s. This is the raw data for an analysis of the *assembly process* by which elements from the worlds of science, finance, and commerce were either recombined or transposed to create something novel - - a science-based private company. The second chapter, with Kelley Packalen and Kjersten Whittington, asks how and why did robust life sciences clusters develop in so few regions in the U.S. when the necessary endowments were present in about a dozen locales across the country? The third chapter, with Jason Owen-Smith, examines field-level network dynamics between 1980 and 2004 to account for the emergence and persistence of an *open elite*, a voracious group of influential organizations that, rather than protect their turf by closing the door to newcomers, were able to spot new talent and usher them into the network.

Motivating questions

Where do new practices and models of organization come from?

- Focus on components of new things – a collection of separable parts that are assembled in novel ways
- "Lash up" (Law 1984; Latour 1987):
  - How do diverse elements become interactively stable?
- Why are certain building blocks, but not others, incorporated into a new organization?
- How do re-purposed practices reverberate back into the domains from which they were borrowed?

Invention: a pragmatist view

- When established routines prove lacking, people search and experiment.
- But people draw on their stock of existing knowledge to cope with situations without precedent.
- Individuals who repurpose old tools are “moral entrepreneurs” or “rule creators” (Becker 1963).
- People who cross formerly separate domains are trespassers - - not boundary-spanners doing import and export - - but amphibious creatures.
- Traffic across social worlds creates new social spaces, which may be unencumbered by the baggage of established practices.

Building on Schumpeter, Nelson and Winter

- Schumpeter (1939: 85): “The making of the invention and the carrying out of the corresponding innovation are, economically and sociologically, two entirely different things”.
- All novelty is “a recombination of conceptual and physical materials that were previously in existence” (Nelson and Winter, 1982: 130).
- We argue it matters a great deal whether recombination occurs on familiar terrain or happens in a new setting where the components are foreign.

Recombination v. Transposition

- *Recombination*: Moving practices from one sector into another where they are recognizable (i.e., computing to digital cameras, Hollywood film to theatre, telephones with video)
- *Transposition*: Moving practices into settings where they are foreign represents a boundary crossing (i.e., science or religion into commerce, a library opening a café, a business – Google – becoming the world's library, a church offering investment classes)
  - Less frequent, and much less likely to be successful
  - But even failures at trespassing can generate "fresh" action that can have profound tipping effects

Data and methods

- Historical multi-case analysis
  - Reliance on accounts made in the 1970s and ‘80s by the founders (in newspapers, magazines, tv interviews, etc.)
  - 1,800 pages of oral histories in UC Berkeley Bancroft Library collection; excellent science journalism that chronicled the era
  - Supplemented with new interviews with founders, board members, and VCs
- Rationale

  “A major source of this difficulty [demarcating an unambiguous start or origin of an activity, industry, or population] occurs, we think, because we lack the analytical framework to identify and describe the early steps in industry or form emergence…As a next step, ***ethnographic and other qualitative research might prove extremely useful in simply identifying and describing interesting relevant cases.”*** Hannan, Polos & Carroll 2007: 58.

Fertile ground for studying emergence

- Life science research breakthroughs outpaced capabilities of established firms.
- Considerable enthusiasm and neo-liberal support for university-industry technology transfer.
- Close 5-4 Supreme Court decision (*Diamond v. Chakrabarty*, 1980) permitted patenting of man-made living organisms.
- ERISA and “Prudent Man” rulings permitted pension funds and endowments to be invested in high-risk VC funds.
- BUT: *poisedness does not imply predictability!* No evidence that there was any blueprint for a new organizational model.

Sample of first-generation companies

COMPANY	FOUNDING YEAR	LOCATION	FOUNDING MODEL (drawn from archives)	CURRENT STATUS
Alza	1968	Palo Alto, CA	" A great place if it were a nonprofit think tank"	No longer in existence
Cetus	1972	Emeryville, CA	Academic playground or "Free Space" ; biotech tools would be applied to a host of problems	No longer in existence
Genentech	1976	So. San Francisco, CA	" Best of both worlds" : serious science and VC funding create a new model for basic research	Subsidiary of Roche
Genex	1977	Montgomery, MD	Low- cost producer: Apply biotech methods to the manufacture of industrial chemicals	No longer in existence
Biogen	1978	Geneva, Switzerland	Transatlantic network of world-class scientists	Biogen Idec
Hybritech	1978	La Jolla, CA	New diagnostic tools for the war on cancer	No longer in existence
Centocor	1979	Philadelphia, PA	Bridge between academia and commercial health care	No longer in existence
Amgen	1980	Thousand Oaks, CA	To become a FIPCO (fully-integrated pharmaceutical co.)	Independent
Chiron	1981	Emeryville, CA	" Get in or lose out" : tired of losing top scientists to biotech ventures, UCSF dept chair starts his own	Subsidiary of Novartis
Genzyme	1981	Boston, MA	Niche collector; " Company of singles rather than home-runs"	Independent
Immunex	1981	Seattle, WA	Academics find a " pugnacious" entrepreneur willing to back " underdog" scientists	Subsidiary of Amgen

There was no blueprint for a science-based company

- **Brook Byers, VC backer and first CEO of Hybritech:**

  "We were naïve. I think if we had known everything about all the potential huge competitors, we might not have even done it. One of the benefits we had, I suppose, was some combination of naïveté and ambition and this desire to do something on our own…I think there was a feeling of a green field, and that we were the first. We didn't know all the answers, but we had time to figure it…We did not have the business model mapped out, or the ultimate value proposition, which are all things that we do today in doing a startup. We're much more sophisticated now. Back then, we didn't have any of that."

Tom Perkins on financing of Genentech

"What was so different about Genentech was the astonishing amount of capital required to do all of this. If anyone had whispered into my ear that, 'for the next twenty years you will be involved in raising literally billions of dollars for this thing,' I might not have done it. But in 1979, it occurred to me that for something of this importance, that there was enough money out there for us to do whatever we needed to do. I always viewed my role - - my ultimate responsibility - - was to make sure that the company didn't run out of money. That was my job. Swanson's job was to make sure the company deserved more money, at ever increasing prices. It worked for a long time. Hence, all the different things that we did - - the private rounds, the research partnerships, the public rounds, and all the deals. It was always more capital than I anticipated. It dawned on Swanson before it dawned on me. I can't remember at what point it dawned on me that Genentech would probably be the most important deal of my life, in many terms-- the returns, the social benefits, the excitement, the technical prowess, and the fun. By 1979 I was a total Genentech junkie."

The organizational model of a DBF

- A business model that operated according to different principles from the traditional vertically organized corporate hierarchy, common in pharmaceutical and chemical industries. Also looked quite different than traditional corporate or government R&D labs. Among its key components were:
  - Strong commitment to publishing research results in top science journals
  - Horizontal structure of information flow; project-based organization of work
  - Porous organizational boundaries; a strategy of pursuing innovation through collaborative ventures
  - A heavy reliance on intellectual capital
  - New instruments developed by venture capital to provide funding

In sum, an odd intermingling of science and finance that proved disruptive (*not* a settlement)

The DBF is a composite, not an ideal type

- **No company had all of the elements of the eventual model, and it is unclear if any of the participants were aware that they were creating a novel organizational form.**
  - **Some chafed under the constraints of existing practices.**
  - **Others wanted to experiment with new conditions and rules.**
- **Novelty flowed from "improvisational trespassers" who inserted new tasks into the confines of existing settings until such arrangements no longer proved viable.**
  - **Genentech: a virtual company for two years, operating out of labs at UCSF and City of Hope hospital (locked refrigerators, eventual lawsuit).**
  - **Biogen: first breakthrough came from the lab of one of its founders at the University of Zurich (research seminars as explosive board meetings).**
  - **Centocor: began by licensing a patent for a monoclonal antibody developed by two of its founders at the Wistar Institute on the University of Pennsylvania campus (lawsuits, governance fights).**

Table 2: Distinctive features of early biotech firms

	Alza (1968)	**Cetus** (1972)	**Genentech** (1976)	**Genex** (1977)	**Biogen** (1978)	**Hybritech** (1978)
SCIENCE	♦ All-star science advisory board ♦ Campus-like setting near a major research university	♦ All-star science advisory board ♦ Campus-like setting near a major research university ♦ "Free space" for scientists ♦ Scientific founder stayed at university full-time, consulted with company	♦ Insisted that staff scientists publish and contribute to public science ♦ Scientific founder stayed at university, consulted with company ♦ "Virtual" start-up: all initial research conducted by contract with UCSF and City of Hope Hospital	♦ All-star science advisory board ♦ Scientific founder stayed at university initially	♦ International consortium of top academic labs (i.e., science advisory board was the company) ♦ "Virtual" start-up: all initial research conducted in founders' labs ♦ Scientific founders stayed at their respective universities full-time	♦ Scientific founder stayed at university full-time, consulted with the company ♦ Key founding role for talented lab assistant ♦ Campus-like setting near a major research university (UCSD) and research institute (Salk)
FINANCE	♦ Went public with no products, breakthroughs, or revenues ♦ Used research partnerships with big pharma to generate funds	♦ Used research partnerships with diverse array of large corporations ♦ Record-breaking IPO in 1981	♦ Meager funding until scientific "proof of concept" ♦ Invented "milestone payment" form of incremental financing ♦ First biotech IPO (1980): gene dreams for Wall Street ♦ Used research partnerships to share costs and risk	♦ Numerous research contracts with large companies	♦ Modest initial VC funding ♦ Out-licensed early breakthroughs to big pharma	♦ Venture capitalist was first CEO ♦ First company to commercialize mono-clonal antibody techno-logy for diagnostics
COMMERCE	♦ Founder went on to start numerous biotech firms	♦ Wide range of commercial applications for biotech	♦ Swing for the fences – focus on blockbuster medicines	♦ Pursued low-cost, high-volume strategy (e.g., biotech production of industrial chemicals) ♦ Early investment in manufacturing plant ♦ Scientific founder went on to start additional biotech firms	♦ Targeted blockbuster medicines ♦ Scientific founders ran the company for first seven years	♦ Scientific founders became serial entrepreneurs and/or VCs ♦ Recruited senior exec from Baxter to run the company ♦ Focused on diagnostic products; avoided long clinical trials

Table 2: Distinctive features of early biotech firms (cont.)

	Centocor (1979)	Amgen (1980)	Chiron (1981)	Genzyme (1981)	Immunex (1981)
SCIENCE	♦ Aggressive in-licensing of research from public science ♦ Initially located in a business incubator on Univ. of Pennsylvania campus ♦ Close relationship with research institute (Wistar)	♦ All-star science advisory board	♦ Founders stayed at universities initially ♦ Skills of academic administration applied to business ♦ Insisted that scientists publish and make contributions to public science ♦ Transfer of founder's existing research grant from university (UCSF) to company ♦ Used research partnerships with pharma and universities as a mode of exploration	♦ Transfer of founder's existing research grant from university (Tufts) to company ♦ Key founding role for talented lab assistant ♦ Hired science advisory board intact (i.e., Bio-Information Associates, a consulting firm of MIT and Harvard profs)	♦ Insisted that scientists publish and make contributions to public science ♦ Founding scientists resigned from academic jobs to avoid conflict of interest ♦ Campus-like setting near a major research university (U. of Washington) and research institute (Hutchinson Cancer Center)
FINANCE		♦ IPO as salvation, despite no products, or patented breakthroughs.		♦ Used tracking stocks to compartmentalize risk ♦ Grew through numerous small acquisitions	♦ Out-licensed early patents to large pharma, then later reacquired them
COMMERCE	♦ Bridge between academic labs and big-pharma manufacturing/ marketing ♦ Recruited senior exec from Corning's medical products business to run the company ♦ Focused on diagnostic products	♦ Recruited senior exec from Abbott's diagnostics division to run the company ♦ Novel decision-making process for allocating resources to projects	♦ Focused on large potential market underserved by big pharma: vaccines ♦ Scientific founders ran the company	♦ Founder was serial entrepreneur from the packaging industry ♦ Focus on niche markets and orphan drugs ♦ Recruited senior exec from Baxter to run the company	♦ One of founders was a proven executive and turn-around artist

Table 3: Science vs. commerce model

(culled from analysis of the distinctive elements; note that pattern is neither chronological nor geographic)

DOMAIN	**Cetus** 1971	**Genen-tech** 1976	**Biogen** 1978	**Chiron** 1981	**Immu-nex** 1981	**ALZA** 1968	**Genex** 1977	**Hybri-tech** 1978	**Cento-cor** 1979	**Amgen** 1980	**Gen-zyme** 1981
SCIENCE											
Insisted that scientists publish their findings	X	X	X	X	X	X					
Campus-like setting near a major research university	X	X		X	X	X			X		
Founder(s) continued at or returned to university or institute	X	X	X	X			X	X	X		
All-star science advisory board	X		X			X	X			X	X
FINANCE											
Research contracts with large corporations	X	X	X	X	X	X	X	X		X	
Scientific founder(s) *became* VCs or angel investors		X		X	X		X	X			
Active VC involvement in early management		X						X			X
IPO with no products or predictable revenue stream	X					X				X	
COMMERCE											
Founder(s) already had entrepreneurial track record	X			X			X		X	X	X
Early hiring of senior exec from health care or pharma						X		X	X	X	X
Initial emphasis on non-therapeutic applications	X					X	X	X	X		

Table 4: The creation of novelty, step-by-step

	SCIENCE
Established routines prove lacking . . .	Traditional corporate R&D model is too insular and proprietary for biotech's purposes; in addition, top-flight researchers are unwilling to leave the academy unless the *research* (not just economic) opportunities are abundant.
. . . so founders draw on existing knowledge . . .	Scientific founders import the invisible college into a corporate setting, minus the grant-chasing and tenure struggles.
. . . and scan their social worlds for cues . . .	Top scientists look to each other for validation of commercial involvement, and judge legitimacy of new model using their customary criteria: quality of scientific output (i.e., publishing). At the same time, they assess the "new" world of commerce, and realize the importance of patenting prior to publication.
… forging unique elements of a science-based organizational form.	R&D becomes a porous, networked endeavor whose results are published in the top journals. New career paths are established for academic life scientists.

Robert Swanson: on publishing at Genentech

“Boyer’s philosophy, which I agreed with, was that you gain more from interaction with your academic peers than you give up by telling the competition where you are. So with interaction you can move quicker; you gain more people willing to collaborate with you. We knew then we weren’t going to have all the best ideas, and we said, where do the academic scientists go when they have an idea that they think needs to be commercialized? We want them to think of us first. We want them to come to Genentech first, because this is a group of scientists that are well published and that a university scientist would be proud to collaborate with on a scientific basis, and where I know they can get this product developed and make it available. So that was a goal from the very beginning.”

Steve Gillis: Immunex

"We encouraged scientists within the company to publish their findings, to speak at meetings. We made reagents freely available to investigators who wanted to play with things that we had invented; again, we weren't totally stupid about that, we had them sign material transfer agreements. But that resulted in spreading the influence of the company, and actually allowed us to get collaborators who otherwise might not have been open to collaborating with us.

"It was kind of interesting that Genentech, who was obviously the pioneer biotech company, would publish in their annual report the number of times their articles were cited by other scientists. They would have a graph of how many times Genentech scientists were cited versus other companies. And they were proud that they were always in a leadership position. But we were always either second or third. That was something that gave us pride, and, believe it or not, in the early days, Wall Street analysts looked at that, too. Obviously, those days are long gone."

Table 4: The creation of novelty, step-by-step

	FINANCE
Established routines prove lacking . . .	Existing VC approach (i.e., provide small amount of startup capital, increasing as product goes to market, followed by IPO) is ill-suited to the funding needs (in terms of quantity and duration) of biotech development.
. . . so founders draw on existing knowledge . . .	VCs realize they the key issue is how to signal commercial progress in the absence of products. Without such signals, the biotech ventures will fail to attract continued investment.
. . . and scan their social worlds for cues . . .	At the intersection of academic science and commercial drug development, VCs seize on two novel opportunities for demonstrating a biotech venture's worthiness for additional investment: (a) research partnerships with big pharma (validating the eventual product potential of the venture's core science) and (b) the sheer scientific performance of the venture (including stature of founders and/or SAB, and publication record of scientific staff).
… forging unique elements of a science-based organizational form.	This results in a flowering of inventive financing mechanisms: milestone agreements; research partnerships; initial, second, and third public offerings without any commercial products; tracking stocks; etc.

Tom Perkins:
"There had to be a lot of financial engineering"

"We didn't have a clue how to price the stock. We knew it was going to be a hot issue, and oversubscribed. But Swanson, the board, the management, the investment bankers - - we were all caught somewhat by surprise. We could have sold less stock at a higher price. It came out at thirty-five, shot up to eighty-five, then drifted back down. But that spread brought world-wide publicity. Everybody knew about Genentech. It was fantastic. It established the idea that you could start a new biotechnology company, raise obscene amounts of money, hire good employees, sell stock to the public. Our competitors started doing all of that, so much so that it became an impediment for us to hire and retain employees. We started to lose employees to other biotech startups. Our employees had originally acquired our stock as common stock. We were able to justify a ten-to-one difference in price. So if the preferred stock was at thirty-five a share, then employees got common at three-fifty a share… But you can only do that once. Once it becomes a public stock, the preferred shares convert to common and everyone is on the same platform. So how are we going to continue to attract these people? Continue to hold these people? It was a big problem" (Perkins, 2002: 10).

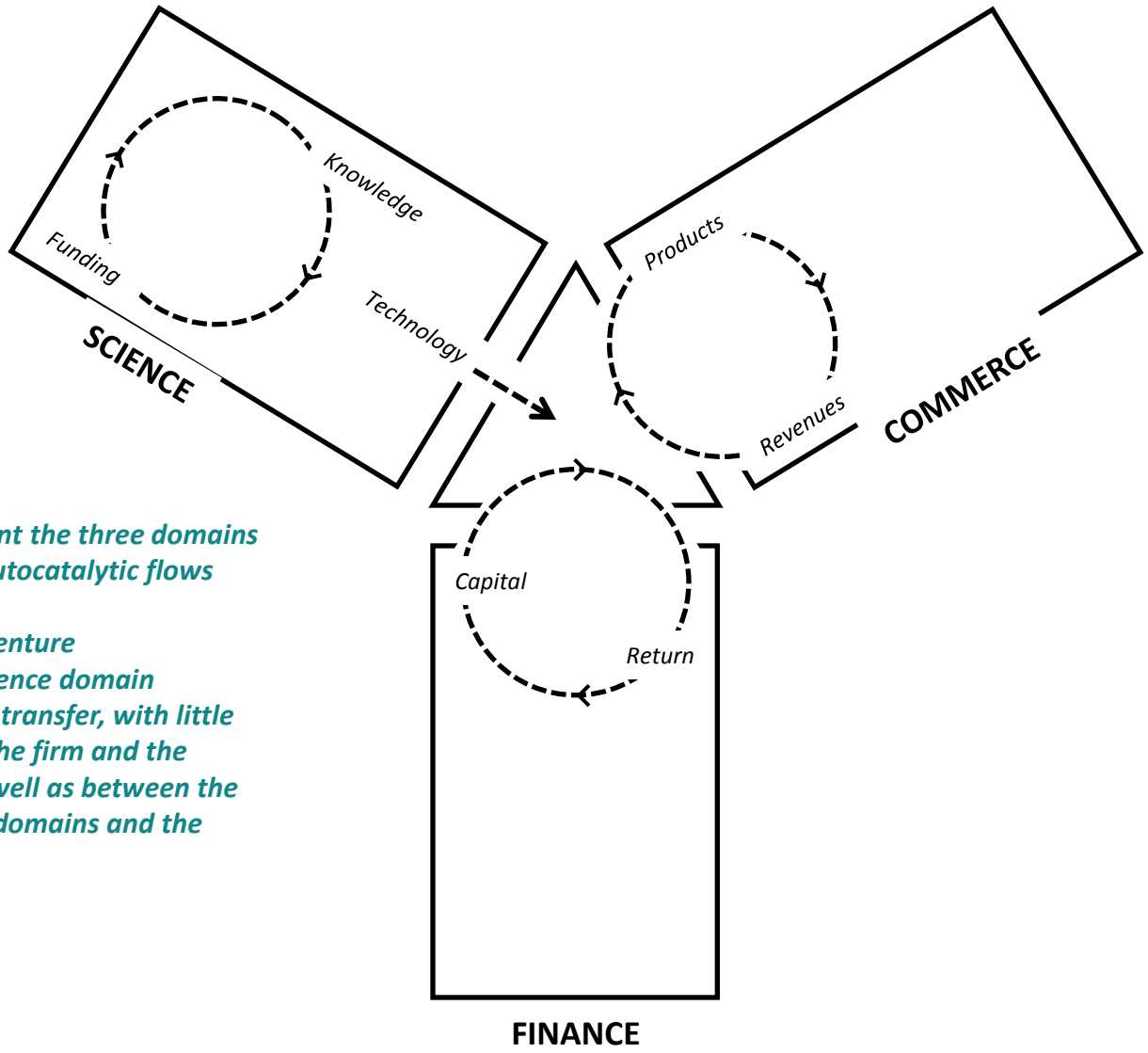
Perkins, continued…

"We got an opinion from the accountants that this stock was only worth one tenth of what the regular common stock was worth, and we called it junior common stock. It would convert to ordinary common stock in case of certain events. We picked specific events into the future such as: Genentech had to be earning a certain amount, or some product had to be achieved…events they had to work towards which have a risk factor. By diddling that formula over about four years, we were able to use that form of stock to attract and hold key employees. We were the first company to ever have such a thing. My name and fingerprints were all over it. We were very careful to run these plans through the SEC. They approved it. We never had to retract any of that stock. However, the idea was stolen by all of our competitors and so grossly abused that the SEC made most of our competitors retract and eliminate those stock plans. We were prevented from issuing that stock again, but we could play out what we already had in place" (Perkins, 2002: 11).

Table 4: The creation of novelty, step-by-step

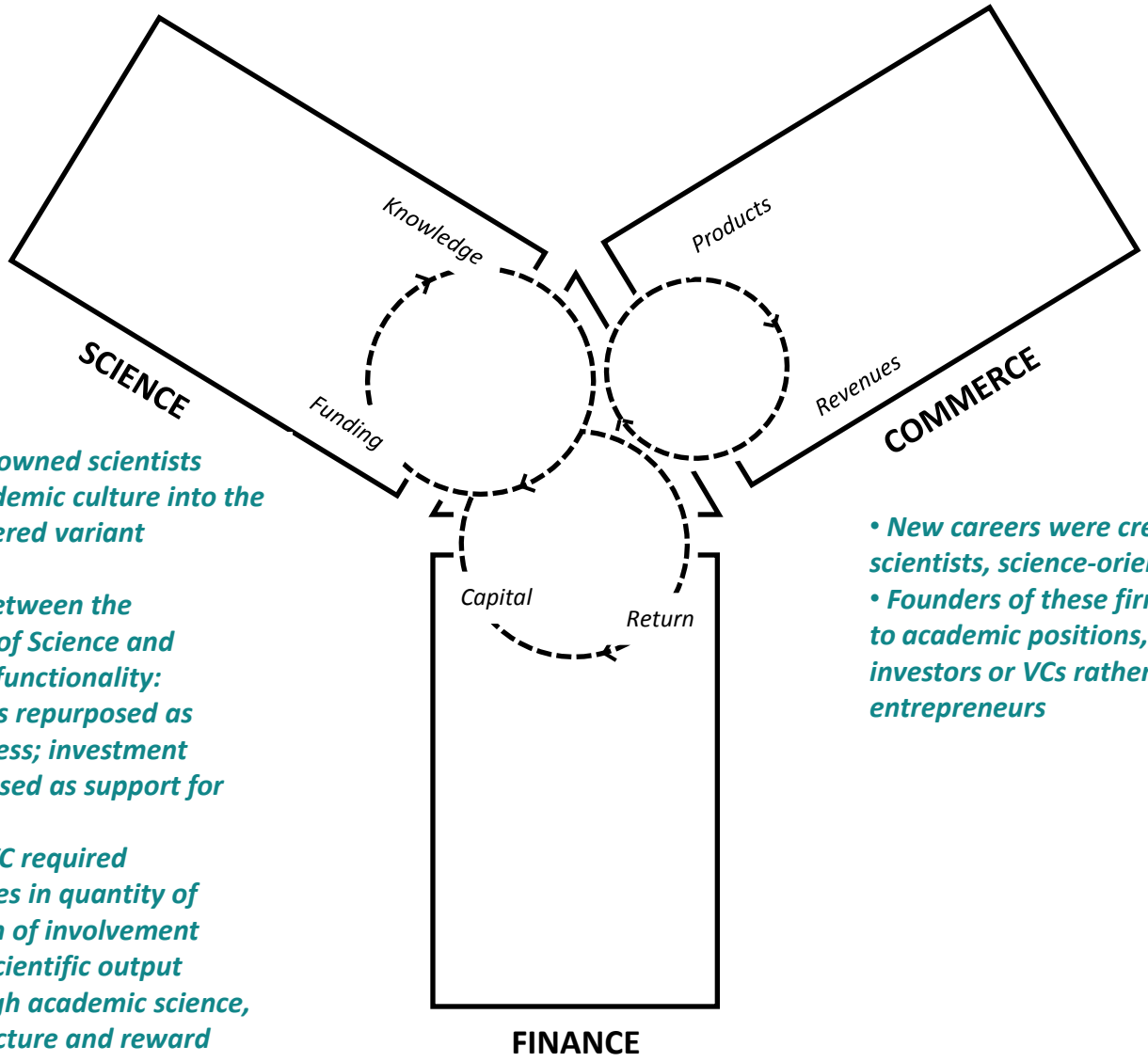
	COMMERCE
Established routines prove lacking . . .	Barriers to entry in the pharma business are formidable: clinical trials, FDA approval, creation of distribution channels, scaling up manufacturing. Traditional "bootstrap" model (i.e., start small and channel early revenues into growth) was not feasible. There is no such thing as a credible "low-budget" clinical trial, and cutting-edge life-science production processes could not be outsourced to low-cost contract manufacturers.
. . . so founders draw on existing knowledge . . .	Biotech founders import a proven commercialization model from the world of academia: technology transfer. In the new setting, tech transfer is between two for-profit entities with resource asymmetries: biotechs have crucial knowledge that big pharma lacks, while big pharma has commercialization capabilities.
. . . and scan their social worlds for cues . . .	To remain viable as commercial entities, however, fledgling biotechs must aggressively negotiate the terms of such technology transfers. Access to legal counsel (typically via their VC's network) becomes crucial, as biotechs learn to "sell" their scientific advances to pharma partners without jeopardizing their future independence.
… forging unique elements of a science-based organizational form.	As a result, a wide variety of partnerships are created between small, science-rich biotechs and large, wealthy product-driven pharmaceutical companies. Many of these bargains prove Faustian, as biotechs forfeit ownership and control in exchange for resources.

Representation of a traditional technology-based firm



- ***Rectangles represent the three domains***
- ***Circles represent autocatalytic flows within the domain***
- ***Triangle is a new venture***
- ***Arrow from the Science domain indicates a one-way transfer, with little exchange between the firm and the Science domain, as well as between the Finance/Commerce domains and the Science domain***

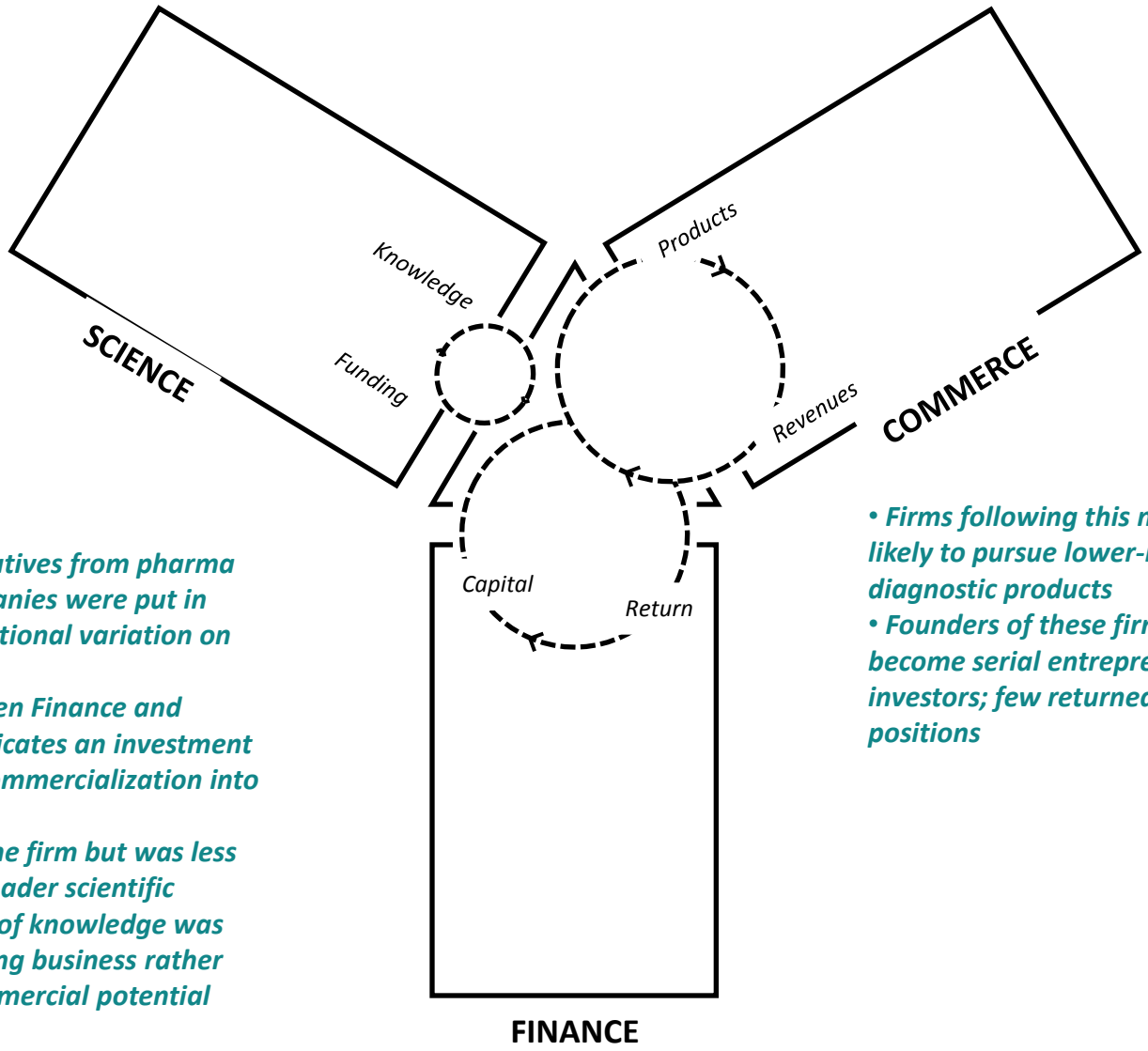
The science-centered variant



- *In firms where renowned scientists transpose their academic culture into the firm, a science-centered variant developed*
- *The intersection between the autocatalytic flows of Science and Finance suggests refunctionality: scientific output was repurposed as investment worthiness; investment capital was repurposed as support for basic research*
- *Refunctioning of VC required fundamental changes in quantity of capital and duration of involvement*
- *Refunctioning of scientific output reverberated through academic science, influencing org structure and reward systems*

- *New careers were created: amphibious scientists, science-oriented VCs*
- *Founders of these firms tended to return to academic positions, or become angel investors or VCs rather than serial entrepreneurs*

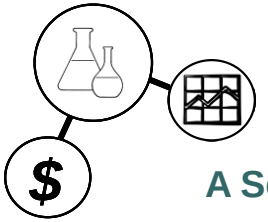
A commerce-centered variant



- *Where senior executives from pharma or health care companies were put in charge, a more traditional variation on the DBF resulted*
- *Intersection between Finance and Commerce flows indicates an investment strategy based on commercialization into profitable markets*
- *Science stayed in the firm but was less connected to the broader scientific domain; production of knowledge was seen as a cost of doing business rather than a signal of commercial potential*

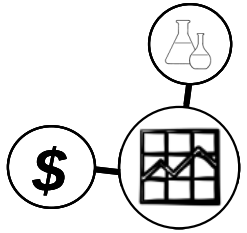
- *Firms following this model were more likely to pursue lower-risk, quicker-return diagnostic products*
- *Founders of these firms tended to become serial entrepreneurs rather than investors; few returned to academic positions*

Table 5: Two variants of a new form



A Science-Centered Variant

- Science is central, supported by funding and management
- Renowned scientist-founders straddle domains, often occupying key executive and academic roles simultaneously
- Scientific Advisory Board does peer review
- Strong commitment to publishing research results
- VCs invest "scientifically": minimal funding of initial experiment (proof of principle), followed by increasing investments
- Investors place bets on proven scientific accomplishments
- Academic headwaters: William Rutter's interdisciplinary UCSF lab
- Commercial headwaters: ALZA Corp.
- Exemplars: Genentech, Biogen, Chiron, Immunex
- Failed attempt: Cetus (lacked strong scientific leader)
- Mechanism of genesis: *transposition*



A Commerce-Centered Variant

- Commerce is central, supported by funding and science
- Scientifically-trained business play crucial early roles
- Scientific Advisory Board is a signal of approval
- Publishing is not encouraged
- VCs invest traditionally: focus on markets, products, etc.
- Commercial headwaters: entrepreneurial divisions of health care or pharma co.s (Baxter, Abbott, Corning)
- Exemplars: Hybritech, Centocor, Amgen, Genzyme
- Failed attempt: Genex (lacked strong commercial leader)
- Mechanism of genesis: *recombination*

Table 6: Publication and citation count data

(for 10-year period following initial public offering)

COMPANY	YEAR OF IPO	TOTAL PUBS	AVG PUBS/YR	TOTAL CITATIONS	AVG CITES/PUB	H-INDEX[1]
Alza	1969	116	11.6	2,608	22.48	26
COMMERCE						
Genex	*1982*	*163*	*16.3*	*12,262*	*75.23*	*51*
Hybritech	*1981*	*272*	*27.2*	*5,678*	*20.88*	*36*
Centocor	*1982*	*250*	*25*	*15,677*	*62.71*	*61*
Amgen	*1983*	*798*	*79.8*	*55,950*	*70.11*	*122*
Genzyme	*1986*	*235*	*23.5*	*15,064*	*64.10*	*59*
SCIENCE						
Cetus	1981	1,000	100	107,469	107.47	146
Genentech	1980	1,656	165.6	198,608	119.93	218
Biogen	1983	623	62.3	54,272	87.11	115
Chiron	1983	905	90.5	86,453	95.53	141
Immunex	1983	710	71	61,616	86.78	133
t-test (1-tail)		0.009		0.009	0.004	0.003

[1]The h-index is a measure of publication quality and quantity. To derive *h,* each company's publications are listed in descending order by times cited. The value of *h* equals the number of papers (*N*) in the list that have *N* or more citations. Source: ISI Web of Science®.

Feedback dynamics:

Repurposing of scientific values into commerce catalyzed changes in the conservative halls of academy and industry

- **Into industry:**
  - **Demise of insular internal R&D lab in Big Pharma; much greater dependence on external sources of knowledge; creation of corporate nonprofit institutes to do collaborative work; funding of postdocs; encourage publishing**
  - **Campus-like settings to attract the creative class**
  - **Entrepreneur-in-residence programs at venture capital firms**
- **Into academy:**
  - **Embrace of academic entrepreneurship; remaking of departments and schools to focus on translational research; adoption of metrics to evince innovativeness; industry jobs no longer frowned on (even encouraged as more attractive!)**
- **In both:**
  - **From discipline and department to projects**
  - **Not a settlement but a continuing disruption, most notably in careers and rewards**
- **Paradoxically, recombination proved a more robust business model, but transposition had much more far-reaching consequences.**

Implications

- In the short run, *Actors make relations*. This is a story of pragmatic search, where the tools of everyday practice were used in unfamiliar circumstances, at a time when there was a green field.

- In the long run, *Relations make actors*. In those settings where science was re-purposed, the tools and new interactions concatenated to form new entities with effects that extended far beyond their initial intentions.

- Some tools are more malleable than others; some regimes of worth allow more ambiguity; some solutions to problems are less specific to particular contexts. The principles and practices of open science both enroll and mediate, undercutting some of the hierarchy of the corporate world, and challenging some of the privileges formerly reserved for the academic priesthood.

What happened to the first generation?

Alza	Ahead-of-his-time founder creates a prototype for future biotech firms. Acquired by Johnson & Johnson in 2001.
Cetus	First-mover advantage doesn't hold due to lack of focus; acquired in 1991 by Chiron.
Genentech	Science married to finance creates a new model for commerce. Despite resistance, became a fully-owned subsidiary of Roche in 2009.
Genex	Low-margin business model becomes unsustainable without investment by corporate partners; acquired in 1991by Enzon.
Biogen	"World class research seminar" makes corporate governance challenging; licensing model proves robust. Merged with IDEC in 2003.
Hybritech	Entrepreneurial scientist finds world-class VC, who recruits a pharma escapee to run the show; bred for eventual sale and acquired by Eli Lilly in 1986.
Centocor	"Academic scavengers" almost lose their company due to FIPCO aspirations. Acquired by Johnson & Johnson in 1999.
Amgen	Savvy VCs set out to "do biotech right" by recruiting stellar SAB and putting talented pharma escapee in charge; a biopharma titan is born.
Chiron	Scientist-entrepreneur moves the invisible college to a business setting. Became a wholly-owned Novartis subsidiary in 2006.
Genzyme	Venture capital group goes shopping for a new venture; builds business around orphan drug opportunities.
Immunex	Despite stellar scientific record, business success comes late. Acquired by Amgen in 2002, resulting in the loss of local "Immunoid" culture.