Historical Roots of the ABTOF Model at GSIA

Mic Augier
Stanford University
70 Cubberley
Stanford, CA 94305-3096
augier@stanford.edu

Michael Prietula
Goizueta Business School
Emory University
Atlanta GA 30322-2710
prietula@bus.emory.edu

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Mie Augier
Stanford University

Michael Prietula
Goizueta Business School

Abstract

A Behavioral Theory of the Firm by Richard Cyert and James March is one of the most influential works in organizational science. An important element of that work was a computational model of a duopoly, which was arguably the first computational model that instantiated organizational constructs within a substantial theoretical framework. We suggest that the academic environment within which this theory and model grew was instrumental in its emergence. Furthermore, an examination of the model itself (by triangulating on the verbal descriptions, the flow charts, and the code) reveals innovative embodiments of organizational attention, organizational learning, organizational memory, routines, meta-routines, aspiration level adjustments and computational experiments. In this paper we examine the historical roots of the model – the concepts, culture, and characters at Carnegie Tech and GSIA. Although causality is difficult to assess historically, we suggest the significance of a strong research-based, inter-disciplinary culture at a time when innovative (and often computational) concepts and theories were emerging within the contexts of computer science, economics, and psychology.
It is the purpose of this paper to explore some of crucial influences that led to a computer model of a behavioral theory well known to organizational science, *A Behavioral Theory of the Firm* – ABTOF (Cyert & March, 1963). Of course, this is a risky venture as any attempt to isolate, or even circumscribe, causal links from idea to idea is fraught with a host of difficulties. Yet, as academics, we are generally prone to forgiveness (or at least tolerance) if we can reasonably assemble the components of our arguments to form a substantial substrate. Thus, the architecture of our argument may be given a measure of structural integrity. Here we describe the general intellectual environment within which the model was developed and examine some of the key artifacts that emerged. The artifacts we examine are varied – memories (written and verbal) of the participants and witnesses; notes, memos, reports and papers of the times; and a variety of strains of software that were crafted in the era.

Though we will not discuss the model (C-M) itself, we see five factors of uniqueness and relevance of C-M. First, it defined a set of *behavioral constructs* in terms of a coherent, general model of a firm’s price and output decisions in an oligopoly setting. In essence, it described a market and how firms make certain economic choices in that market, influenced not by pure economic goals, but by aspirations resulting from conflicting goals, variant structures, established routines, negotiations, political coalitions, and constrained resources within the confines of bounded rationality. Second, it was a form of a *process model* that provided internal organizational mechanisms to account for the output decisions within the context of specific organizational and communication structures. Third, several of those mechanisms are of interest today: aspirations, goals, routines and meta-routines, organizational attention, organizational memory, and organizational learning. Fourth, it was decidedly an *interdisciplinary* theory, crossing boundaries and integrating constructs from economics, administrative behavior, social psychology, cognitive psychology, and (what was to become) computer science. Finally, the fact that the model was crafted as a computer program, a *computational model* if you will, tied to a particular theory and used to conduct a series of computational studies was remarkably
innovative. The book and the contained theory were unquestionably popular and influential in organization science.

We provide an examination of the background context for the model – Carnegie Tech and the Graduate School of Industrial Administration (GSIA) at Carnegie Tech, circa the late 1950s and 1960s.¹ Who was there at the time? What were they doing? What was the culture? What was special about the zeitgeist at GSIA that supported the melding of a variety of disciplines into an innovative theory? Next we examine the influential themes regarding the use of computers. What were the conditions at GSIA and Carnegie Tech that allowed the idea of such a theory to be crafted in a computer model? We conclude with speculations on how this model has (and has not) impacted research methods in organizational science, relying on the reviews of the original edition and the reflections of key individuals. But where did GSIA come from?

A New Type of School

Despite innovative beginnings, most business schools in America eventually followed a path that precluded them from being considered as serious participants in the world of evolving academic scholarship and intellectual pursuits (Augier, March & Sullivan, 2005; Augier & March, 2006).² They often defined their role primarily in terms of codifying and communicating good business practice, as exemplified by business case writing and teaching. Despite the efforts of some deans and faculty to migrate towards more academic pursuits, most schools emphasized

¹ At the time, Carnegie Mellon was known as the Carnegie Institute of Technology, or simply Carnegie Tech. When Carnegie Tech merged with the Mellon Institute of Research in 1967, it was renamed Carnegie Mellon University. GSIA, founded in 1949, was renamed to the Tepper School of Business in 2004. For historical purposes, we will generally retain the names that were operative in the time frame, Carnegie Tech and GSIA.

² The first graduate school of business in the United States was actually a rather innovative 3/2 program at Dartmouth College in 1900, whereby the students’ fourth year of undergraduate work was the first year (of two) in the graduate program. Initially, the graduate effort resulted in a certificate, but by 1903 it was decided that they be granted a Master of Commercial Science (MCS). Being a strong liberal arts college, the first year of the graduate program consisted of modern history, economics, political science, sociology, English composition and a foreign language (German, French or Spanish). The second year added focus courses such as diplomacy, organization and management, statistics, insurance, law, political science, and a thesis requirement (see Broehl, 1999).
practical, not theoretical courses; applied, not basic science; and the contributions of faculty were more often publishing in practitioner magazines than in academic journals. Thus subsequent validation of the practice folklore was rarely either engaged or encouraged.

The early post-war period was a period that saw the glorification of big science (Leslie, 1993; Zachary, 1999). Social and behavioral sciences became more quantitative, more analytical, and more committed to scientific principles. A Ford Foundation commissioned report by Robert Gordon at Berkeley and James Howell at Stanford (Gordon & Howell, 1959), often referred to as the Gordon-Howell Report, defined a turning point in business education when it advocated the adoption of analytical approaches to management education. At the time, they noted that schools of business in America sought to “…search for academic respectability, while most of them continue to engage in unrespectable vocational training” (Gordon & Howell, 1959, p. 4).

Spurred by this study, the Ford Foundation subsequently dedicated more than 35 million dollars during the 1960s to successful efforts to reform business schools (Schlossman, Sedlak & Wechsler, 1987). Research had to be scientific; embodied in the Ford Foundation’s understanding of the behavioral science concept was “its emphasis upon the scientific approach to problem solution.” And it had to be practical, to some extend at least, given the foundation’s interest not in knowledge per se, but in “knowledge which promises at some point to serve human needs.” Furthermore, it explicitly encouraged interdisciplinary research.

At that time, both GSIA and MIT had graduate programs in business that led to a Master’s degree other than an MBA, which was not especially uncommon for engineering schools. What generally differentiated these two schools was the background of their students and the schools’ emphasis on research. This, it turns out,

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3 MIT’s School of Industrial Administration began with a grant in 1950 from another titan of business and alumnus, Alfred P. Sloan, Jr. and, in fact, had goals similar to GSIA’s in that it “sought to correlate the complex problems of management in modern technical industry with science, engineering, and research” (http://mitsloan.mit.edu/about/b-history.php). In addition, when MIT leadership first were in negotiations with Alfred Sloan to set up the school, the explicitly compared their mission to the early Carnegie school (see memorandum to Alfred Sloan from Killian, titled “Additional Information on Proposed MIT School of Industrial Management” (November 10, 1950). Located in MIT archives.
afforded a unique advantage, as “...the students’ background in science and mathematics makes possible a more sophisticated treatment in some fields and permits the program to develop advanced work on the application of the newer analytical techniques to management problems” (Gordon & Howell, 1959, p. 251). For GSIA, two events in its pre-history instituted by Carnegie Tech’s president resulted in the fortuitous mix of engineering, science and social science.

The Carnegie Plan. Robert E. Doherty arrived from Yale to become president of Carnegie Tech in 1936. Within a short period of time, Doherty engaged in two massive re-organizational efforts, based on the rapid escalation of knowledge in science and technology, and a more general (personal) concern regarding the students’ eventual role in society. First, labs and departments were merged and reorganized to better link research activities with educational programs. However, Doherty also “gave encouragement to all departments to undertake fundamental research and indicated to department heads that advancement of faculty members would be closely tied to scholarly productivity” (Cleeton, 1965, p. 23). Second, he introduced what was to be known as the “Carnegie Plan” whereby engineering and science students [as reported in his annual report of 1939-1940] had to devote 20% of their education to “humanistic-social” objectives and 80% to “Scientific-Technological” objectives (Cleeton, 1965, p. 31). An enduring element of the Carnegie Plan would take the shape of integrating across disciplines in order to teach the students problem solving.

Funding for Interdisciplinary Research. After World War II, there was still a substantial interest by President Doherty in expanding the role of humanities and social sciences. In

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4 Some reports refer to difficulties of graduate education (including business) based on the “German research model” emphasizing theoretical (suggesting less applied). In fact, Carnegie Tech was founded on the value of the German technical schools, not its universities, noting the existence of American models such as M.I.T. that merge science and technology (Tarbell, 1937). This shaped not only its undergraduate programs (first graduated in 1912) but also its graduate programs (first Masters was conferred in 1914 and the first doctorate in 1920). Graduate programs did not mature at Carnegie Tech until the Doherty administration.

5 This dichotomy would again surface in a more public arena with C. P. Snow’s famous Rede lectures (Snow, 1959) and be prominent in a variety of highly visible subsequent discussions (e.g., Wilson, 1998).
particular, there was an attention to increase graduate education and research in these arenas, but this depended on external funding. But who would fund what? After exploring alternatives, it was determined that economics and psychology were the most promising for research contracts and, therefore, graduate study (Cleeton, 1965, p. 86).

This resulted in the formation of the department of Industrial Administration in 1948 headed by Lee Bach, with graduate study beginning the same year. But this was quickly followed by an offer (by representatives of William Larimer Mellon, the founder of Gulf Oil) to create and endow a Graduate School of Industrial Administration “for developing the kind of interdisciplinary instruction which he felt was not being adequately covered in work offered at other institutions” (Cleeton, 1965, p. 87). Specifically, Mellon saw the need for top executives who “were skilled in management and understood science and technology” (Simon, 2004). When the gift commenced in 1949, the interdisciplinary vision of GSIA was born and Lee Bach was its first dean.6 Bach (1986) recalls the task of starting the program, noting that his “conception called for a teaching program that would stress analysis and flexible problem solving while simultaneously emphasizing the importance of organizational behavior, economic analysis, and modern quantitative methods in understanding how decisions are made and implemented, and could be made and implemented better, in the complex, uncertain world” (p. 39). Furthermore, this was to be firmly rooted in research as Bach declared that “…I want to stress as strongly as I can my own belief that fundamental research is a major part of every leading business school, especially those which offer graduate work…The function of the university is to be ahead of best practice, not to be trailing a few steps behind the operating business world” (Bach, 1958, pp. 363-364).

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6 Doherty’s efforts to expand science and integrate social science had an interesting effect on one undergraduate student in mathematics, John Nash, who had taken a course in economics (international trade) in which he had begun to formulate his famous bargaining solution by thinking about trade agreements between nations (Nash, 1995).
Of course, Carnegie was not the only institution that felt that way, but at least three fortuitous situations facilitated how it responded to the call: it was a new school (thus flexible in its growth with little historical constraints); it was situated in an institution of science and engineering (thus engendering the themes of interdisciplinary research and quantitative methods); and it was being led by Lee Bach. As Bach admits, one of the best things he ever did was to hire Herbert Simon early to help plan the school (Bach, 1986, p. 39).

The Zeitgeist at GSIA

Herbert Simon (Economics Laureate, 1978) came with, and experienced shortly after joining, a significant network of connections and experiences with leaders of the day in a variety of disciplines as a consequence, for example, of his participation in the Cowles Commission and the RAND Corporation (Augier & March, 2002, 2004) and the breadth of his background from Chicago (Simon, 1991). The strategy was to hire young faculty with similar interests who had the technical skills, but also a broader knowledge in social science.

The spirit at Carnegie was such that everybody interacted with everybody else – discussing each others’ ideas and research in a way that encouraged collaborative teams to work together within, as well as across, projects. Despite different disciplines and interests, and despite varying degrees of admiration for the idea of rationality, these teams generally worked together in a mostly accommodating way. For instance, while much of Simon’s research centered on bounded rationality, the work of Franco Modigliani (Economics Laureate 1985) and Merton Miller (Economics Laureate 1990) had a high rational component to it. Naturally, and perhaps more often than not, confrontation did occur and issues were debated as described by Simon in his autobiography (Simon, 1991, pp. 143-148 as “Stormy Weather”). Victor Vroom (1993) reflected on his experience as a faculty member at GSIA noting that “25 years later, I am painfully aware of the fragility of this degree of open-minded collaboration among the

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7 Consider also how both “extremes” could influence theory development, such as transaction cost theory, crafted by a former student of Cyert, March and Simon – Oliver Williamson (Augier & March, 2001; Williamson, 1996).
disciplines. In fact the opposite – veiled hostility and at times open warfare – seems to be the norm at many schools of management.” However, perhaps Harold Leavitt (1996) described it best from his experience at Carnegie “while debate was continuous and intense, it always seemed to aim at discovering the right answer” (p. 290).

It was a business school, but they also thought of themselves as reforming economics. Dick Cyert, who came to Carnegie in 1948, was also instrumental in crafting that environment. For example, Robert Lucas (Economics Laureate 1995) recalls his early days at GSIA (Lucas, 1996) after being hired by Cyert, where “Carnegie-Mellon had a remarkable group of economists interested in dynamics and the formation of expectations.” John Muth and Thomas Sargent were his colleagues at GSIA and Edward Prescott (Economics Laureate 2004) arrived as a student the same year Lucas arrived as a faculty member.

In keeping with this, and with spirit of the Ford Foundation emphasis, the two major projects, Organizations and A Behavioral Theory of the Firm, sought to integrate economics ideas with those coming from the disciplines of sociology and social psychology. These projects were particularly important, filling a need in the establishment of the behavioral sciences. Moreover, research on organizations became an emergent theme, bringing together different disciplines in the study of decision making and behavior in organizations. It furthermore significantly influenced major developments in (organizational) economics, in particular Oliver Williamson’s transaction cost theory. Having been a student at Carnegie in those early days, Williamson (2004) reflected: “The selective joinder of organization theory with economics, as these two bear on the theory of the firm, is what motivated my dissertation … and describes much of what have been up to since” (p. 281).

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8 In a “Report on Activities 1952-1960, Research on Organizations in the Graduate School of Industrial Administration,” (available at the Richard Cyert Presidential Archives at Carnegie Mellon) no less than 81 publications were listed, with a broad array of topics, such as cognitive processes, theory of the firm, simulation of individual and group behavior, complex systems, organizational design, decision making, problem solving, and instruction.
This was all part of the early mission that GSIA had to integrate behavioral social science into the theory of business firms and decision making in organizations. The administrative strategy was detailed in 1953, noting that the GSIA provided an “especially appropriate environment for [organizational] research.” It comes as no surprise that the initial approach of the research program came from the theoretical framework developed in Simon’s earlier work, in particular *Administrative Behavior* (Simon, 1947). Following the decision making framework from the dissertation, then, Simon wanted the central concern of the organizational research program to be “how people in organizations, particularly at supervisory and executive levels, make choices among alternative courses of action, and how organizational changes affect their choices” (Simon, 1947, p. 2-3). This line of thinking also explains why *Organizations* (March & Simon, 1958) was an inventory of organization theory which used insights from organization theory and social psychology, while also praising mathematical and statistical tools.

In particular, the Ford Foundation project on behavioral theories of organizations, the Behavioral Theory of the Firm project, was carried out by Richard Cyert and James March (along with their students, including Julian Feldman, Edward Feigenbaum, William Starbuck and Oliver Williamson). The project originated in the works of Cyert and March to developed improved models of oligopoly pricing by using organization theory (Cyert & March, 1956; March & Cyert, 1955) and was formally designated as a project area, with Cyert and March as the senior personnel, in 1957. Simon had hired Jim March from Yale in 1953, thus acquiring a key influential voice and establishing remarkable collaboration (and friendship) between Jim March and Dick Cyert (see Augier & March, 2002).

The project aimed at investigating how the characteristics of business firms as organizations affect important business decisions. Integrating theories of organizations with

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existing (mostly economic) theories of the firm, they developed an empirical theory rather than a normative one; and focused on classical problems in economics (such as pricing, resource allocation, and capital investment) to deal with the processes for making decisions in organizations. Within this context, several interesting experiments in decision making were conducted (e.g., Cyert, Dill & March, 1958; Cyert, March & Starbuck, 1961). The project led to a series of papers and collaborations with graduate students, and resulted in the book in 1963, *A Behavioral Theory of the Firm* (Cyert & March, 1963). This work extended the earlier ideas, particularly by elaborating concepts of organizational slack, adaptive aspirations, organizational learning, and the role of rules and routines. The book furthermore addressed a major dilemma of organization theory: the choice between a realistic, but unmanageable theoretical model of organization, and a simple, manageable model, but lacking sufficient predictive power.

There was another element of the book that was both significant and substantial from the perspective of weaving together theoretical elements of economics, psychology, and organizational science – the use of unique types of computer simulations in three of the chapters, plus a general discussion of the approach in the appendices. Chapter 7 of the book (*A Specific Price and Output Model*) detailed how a single department of a retail department store (residing in a downtown oligopoly market of three competitors) made comparative predictions of primarily sales estimates and price determinations (i.e., mark-ups, sales, and mark-downs). The

10 Vernon Smith (Economics Laureate 2002), then a professor at Purdue, was conducting a unique set of studies in decisions on markets (Smith, 1962). He recalls the first experimental economics workshops held at GSIA (Smith, 2003): “In 1963 and again in 1964, under the enabling and supporting influence of Dick Cyert, Jim March (and probably Herb Simon in the background), Lester Lave and I conducted Ford Foundation faculty summer research workshops at Carnegie Mellon. With several experimental papers in the pipeline, and a seminar going, experimental economics was becoming much more than a hobby for me.”

11 As Dutton and Starbuck note, “By 1960, simulation programs had been written, or were in the process of being written, in all of the social sciences…” (Dutton & Starbuck, 1971, p. 3). However, there was wide variation in the nature of simulations (e.g., what phenomena they addressed, how they addressed it, the language they used, the level of fidelity, and so forth). For example, with respect to business/economic simulations, Forrester was demonstrating the use of system dynamics in management decision making (Forrester, 1958) and Orcutt, Greenberger, Korbel and Rivlin (1961) illustrated how aggregated micro-analysis could be applied to policy.
A descriptive model was based on a detailed analysis of the decisions, data, and procedures used by individuals in that department, and was especially successful at predicting pricing behaviors. The interesting element was that the form of the computer model instantiated the constructs of the theory that were detected in the analysis of the department, such as the relative independence of the (price and output) decisions, the use of institutionalized heuristics as routines, problem-driven decisions and search, and goal adaptation. Chapter 8 of the book *A General Model of Price and Output Determination* is the duopoly model that is discussed in this paper. Chapter 10 of the book *A Model of Trust Investment Behavior* is written by Geoff Clarkson based on his Ph.D. dissertation at GSIA in 1962 (Clarkson, 1962), but was preceded by papers based on the work (Clarkson & Meltzer, 1960; Clarkson & Simon, 1960). Rather than an organizational simulation, Clarkson studied how a single senior trust officer at a local bank made portfolio design decisions, and then crafted a model of key components of that process, directly influenced by an emerging theory of problem solving and a method of simulation that was active at GSIA (Newell, Shaw & Simon, 1958a, b). Fourth, Appendix A (*Assumption, Prediction, and Explanation in Economics*) written with Emile Grunberg is, as the title suggests, a treatise on laws, prediction, and explanation in economics. For the most part, this is a philosophical note. Emile Grunberg, who was a faculty member at Carnegie Tech between 1948 and 1956, wrote on such issues before and after that Appendix appeared (e.g., Grunberg, 1953, 1957). What is slightly different is that the basic philosophical arguments are appended by consideration of adding knowledge of decision-making behavior and modeling such behavior with computers. Appendix B (*Computer Models in Dynamic Economics*) written with Kal Cohen is essentially a reprint of an article discussing the role of computer simulations in business and economics.

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12 Details of the computer model were not provided. It was programmed by C. G. “Chad” Moore.
13 The entire model, though developed, could not be implemented due to limits on the computer.
14 At this time, there was a fortuitous overlap with Franco Modigliani at Carnegie and, of course, Herbert Simon. This resulted in two papers that addressed the predictability of social events when the agents react to predictions (Grunberg & Modigliani, 1954; Simon, 1954), where the Modigliani credits his work with Grunberg as one of the pillars for the ‘theory of rational expectations” (Modigliani, 1986).
(Cohen & Cyert, 1961). In general, by using computer simulations, a relatively realistic description of actual processes was sought, without losing the predictive power so essential to empirical testing (Cyert, Feigenbaum & March, 1959). But why computers, and why at GSIA?

Computers at GSIA

In the mid to late 1950s and 1960s was the blossoming of computer applications research at GSIA and at Carnegie Tech. Also, it is important to recall that the concept of innovative eternally funded research by key individuals would play a prominent role at GSIA since its inception. For example, in its first year research grants from the Air Force and the Budget Bureau paid for nearly all the research time for its faculty.15 Throughout the 1950s and early 1960s research funding sometimes accounted for about 50% of the school’s operational budget, with some faculty (such as Herb Simon) occasionally being “on leave” for being fully funded for research.16 The research itself was broad and notably interdisciplinary, including engineering, psychology, administration, economics, physics and sociology, with much of the “organizational theory and business decision making” themes recurring, although not always equitable (Simon, 1991).

At RAND.

Herbert Simon’s summer visits to RAND (beginning in 1952) resulted in cross-fertilization and connections to emerging theories, research, and technologies (Augier, 2000). At this time (even before Simon arrived), RAND was engaged in several activities concerning organization theory. For example, RAND hosted a rather unique conference on organization theory in 1951, which included Merrill Flood, Oskar Morgenstern, and Kenneth Arrow

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15 First Annual Report, School of Industrial Administration, Carnegie Institute of Technology, July 1, 1950.
16 Research, of course, also supported junior faculty and graduate students. A memo from Dean Bach listed the Fall of 1954 graduate student assignments to faculty, based on which research project was paying for their assistantship. Twenty students were assigned and 15 were paid by external research grants (e.g., Bill Dill was assigned a Ford Foundation project with Herbert Simon, John Muth was assigned an Office of Naval Research project with Charlie Holt), while others were simply classified as “research” (e.g., Albert Ando was assigned to Franco Modigliani).
(Economics Laureate 1972), and “brought together social psychologists who discussed
interactions among small groups, roboticists who discussed automata, and economists who
discussed mathematical models of choice and information” (Augier, 2000, p. 434). Merrill Flood
had invited also Herbert Simon to the conference; but Simon had declined, nevertheless stating
that he wanted to keep open lines of communication so that the Carnegie work on organization
theory, and the RAND agenda, “would proceed in complementary fashion”.
Another RAND consultant Oskar Morgenstern was in the early 1950s involved in doing a major study on
organization theory, designed to develop a mathematical theory of organization, drawing
considerably on game theory. The two programs were viewed as linked in the 1950s at RAND.
As Olaf Helmer reported, “organization theory can be viewed as a very natural extension of
game theory.”

During his first summer at RAND, Simon crafted a paper that would serve as the “first
major step toward formalizing the psychological theory of bounded rationality” (Simon, 1991, p.
165) and was eventually published a few years later (Simon, 1955). Thus, the seeds of bounded
rationality, satisficing, and a concern for decision process were evident. RAND is also where he
met Al Newell and Cliff Shaw. From 1952 to 1954, Cliff Shaw, Al Newell and others in the
Systems Development Laboratory at RAND were using the RAND machines not for the usual
“number crunching” purposes, but to produce simulated radar maps for air defense research on
small group decision-making processes (Chapman, Kennedy, Newell & Biel, 1959).

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17 Herbert A. Simon, letter to Merrill Flood, April 7, 1951. Herbert A. Simon Archives, Carnegie Mellon
University Library.
18 Oskar Morgenstern: “Prolegomena to a Theory of Organization”, RAND RM – 734. December 10,
1951. The manuscript – 122 pages long – is located in the RAND archives.
RAND archives
20 This paper, its “companion piece” – Rational Choice and the Structure of the Environment (Simon,
1956) – and others that Simon wrote during his early years at Carnegie Tech were reprinted as book
entitled, Models of Man: Social and Rational, whereby he “tried to set forth a consistent body of theory of
the rational and nonrational aspects of human behavior in a social setting” in a distinctively formal
approaches (Simon, 1957, p. vii).
21 Augier (2000) notes that before meeting Simon, Newell “had tried to relate to Simon’s theory in a
couple of RAND working papers in the early 1950s” (p. 433, footnote 42).
Newell had a remarkable insight and what he calls “genuine conversion experience.” Newell (1991) describes the exact time and event that occurred when he was “27.7” years old at RAND, after spending an afternoon at a small seminar given by Oliver Selfridge in mid-November, where Selfridge described how they were building a pattern-recognition system for the Whirlwind computer. From that seminar, Newell knew that “computers can do any kind of complex processing.” Furthermore, like Simon, Newell was interested in chess and the collaboration deepened. In 1955, Newell moved from Santa Monica to Pittsburgh and joined GSIA, but still held formal attachment to RAND, including access to its computational resources. There was something else going on at RAND.

At the time, RAND had one of the largest centers of scientific computing (mostly IBM 604 calculators using punched cards) in the nation, but decided in 1950 that it needed to expand. John Von Neumann, also a consultant to RAND, suggested that RAND do something innovative—build a new machine that was based on the concept of a “stored program” computer based on his experience with designs for the EDVAC (University of Pennsylvania) and the IAS (Princeton University) computers. 22 Completed in 1953, the JOHNNIAC was extremely reliable and powerful, as compared to existing machines. The development of languages for the JOHNNIAC expanded. Equally important, access to the JOHNNIAC expanded as other commercially available machines rapidly entered the market to absorb “normal” computational duties. The impact was interesting and fortuitous for Newell, Shaw and Simon (NSS), as “much of its time was consumed by research on the general questions of artificial intelligence and the initial NSS came to be closely associated with JOHNNIAC” (Gruenberger, 1968, p. 18). This allowed rapid growth in research on artificial intelligence and simulating cognitive processes (e.g., Newell, 22 This refers to the concept of keeping both programs and data in memory, so that the program can incorporate internal addresses and looping. This is opposed to the dominant technologies of the day that required “straight-line” coding via wires or punched cards, which necessitated re-wiring and iterative loading (of cards). Von Neumann, a mathematician, generated the remarkable design for a report to the United States Army Ordinance Department and the University of Pennsylvania (see Godfrey & Hendry, 1993).
Shaw & Simon, 1958a; Newell & Simon, 1961) and their theory of problem solving (Newell, Shaw & Simon, 1958b). Thus, these themes applied to computing were quite strong and entrenched at GSIA, through their connection with RAND, by the mid to late 1950s.

**In the Basement.**

In 1956 another fortuitous event occurred. Lee Bach, still Dean of GSIA, conspired to acquire the first computer at Carnegie Tech (IBM 650) and locate it in the basement of GSIA in August of 1956, perhaps the first business school to house a computer (Bach, 1986). The machine was supported with funds via the founding Mellon grant and subsequent Ford Foundation support. Bach (1986) recalls the consequences:

A closely parallel faculty and Ph.D. student and research group, more completely centered in GSIA but similar in research spirit, was developing early work on formal mathematical models in business decision making in those days: Bill Cooper plus Abe Charnes from mathematics, Charlie Holt from economics and engineering, and Franco Modigliani from economics. Herb Simon provided a bridge between the groups, and a group of extraordinarily good doctoral candidates produced intellectual sparks comparable to those of the computer-artificial-intelligence groups. They were no less enthusiastic for the new lodger in the basement and were its heaviest users. … The extraordinary intellectual drive and group spirit built around the new computers made the new venture’s path breaking success (p. 40)

Carnegie Tech was not a major player in the development of computing hardware, so it did not absorb much of the risk regarding technical discontinuities and cost that several early adopters encountered (Aspray, 2000). Rather, they accepted “commercial” machines (sometimes at a substantial discount, or supported by research funds), and did software development. To appreciate the significance of this, we must briefly examine the state of computer languages at that time. As Sammet (1972) has noted, the period from 1952 to 1956 was “a time of preliminary groping and to understand the concepts and limitations of programming languages” (p. 604), while 1958 to 1959 were possibly the “two most prolific years” in the history of programming languages (p. 604). Three contributions of note in those periods emerge out of GSIA’s basement. The first was the concept of incorporating symbols, list-structures and levels of abstraction into programming. The second revolved around two major projects at GSIA that exploited the
machine’s analytical capabilities. The third was the development of the Carnegie Tech management game and a new compiler. With these (and several lesser) projects, fundamental research in computer science and its application to cognitive science and organizational science was active in the basement of GSIA.

Symbols and Lists. The concept of using computers to operate on “symbols” and “symbol structures” or sometimes called “list structures” (as opposed to solely numeric objects and structures, such as integers, real numbers, vectors and matrices) was underway in research laboratories around the world, but in a variety of directions and for a variety of purposes (Bobrow & Raphael, 1964). In 1956, Alan Perlis moved to Carnegie Tech (where he had received his undergraduate degree in 1943) to become director of the computing laboratory at GSIA. For Perlis, the use of list structures was both interesting as a technical problem and functional in the design of languages and compilers (e.g., Perlis & Smith, 1958; Evans & Perlis, 1959). For Newell, Shaw and Simon, list structures could be a way to represent dynamic and complex symbol structures that emerge and change during the process of problem solving (recall the Newell’s “conversion experience” at RAND). In order to model complex problem solving, Newell, Shaw and Simon invented a new language – IPL.

IPL (Information Processing Language) was actually a series of evolving versions that originally were developed at RAND for the JOHNNIAC and considered the first language for list processing and included recursion (Sammet, 1972, p. 603). While at RAND, Newell, Shaw and Simon crafted IPL-I that served as the initial design, but was never implemented. This evolved into IPL-II and IPL-III, which were used to program the Logic Theorist (Newell, Shaw & Simon, 1957; Newell & Simon, 1956), generally considered to be the first artificial

23 Alan Perlis was to become the first head of Carnegie’s new graduate computer science program in 1965 with substantial help from an Advanced Research Projects Agency (ARPA) grant. An innovative and influential researcher in programming languages, he served as the first president of the Association of Computing Machinery (ACM) and was the first recipient of the Turing award. He was also famous for his epigrams, such as: “One man’s constant is another man’s variable,” “If a listener nods his head when you're explaining your program, wake him up,” and “Every program has (at least) two purposes: The one for which it was written and another for which it wasn’t.”
intelligence program. Two more versions were developed in parallel. IPL-IV was done at RAND (again for the JOHNNIAC) and (finally) resulted in the chess program Newell, Shaw and Simon originally wanted to complete (Newell, Shaw & Simon, 1958a) as well as a GSIA doctoral dissertation that applied heuristic methods to solve an ill-structured problem of assembly line balancing (Tonge, 1961). IPL-V (Newell & Tonge, 1960) was developed at Carnegie Tech to run on their IBM machine and quickly supported GSIA dissertations on verbal learning (Edward Feigenbaum, GSIA 1960) and binary choice (Julian Feldman, GSIA 1959).24

The influence of both the nature of the IPL language and its use by the team of Newell, Shaw and Simon was substantial. With respect to the list-processing languages emerging at the time, FLPL (Gelernter et al., 1960), SLIP (Weizenbaum, 1963), and LISP (McCarthy, 1978) were directly or indirectly influenced by IPL.25

GSIA was well-versed at the workings of a computer at the “symbolic” level and was inventing languages that pushed the machine to address (so to speak) new types of applications. There was another design concept that, when coupled with symbols, yielded a powerful insight into research – levels of abstraction. What this means is that one conceptual language can be written “on top of” or “in terms of” another language. Looking back at the earlier paper written on the Logic Theory Machine (Newell & Simon, 1956) we find this insight as they “call the system the logic theorist (LT), and the language in which it is specified the logic language (LL)” (p. 61). This arose from their more general method of studying complex systems – “to synthesize some [complex systems] and study their structure and behavior empirically” (p. 61). To accomplish this, they suggested that two major technical problems must be solved. First, there is

24 Fred Tonge also converted the Logic Theorist from IPL-II/III to IPL-V.
25 Some have also suggested COMIT by Victo Yngve, but that language had a different origin. It began as a project specifically for mechanical translation and linguistic research. Yngve received a Ph.D. in physics from the University of Chicago, and then took a position at MIT in 1953. At the time, Noam Chomsky was at Harvard (joining MIT in 1955) and just published an article on syntactical analysis (Chomsky, 1953). The COMIT language is rather abstract and, in part, based on Chomsky’s notation (Yngve, 1963). However, the limits of syntactical analysis were eventually reached, and the influence of Chomsky’s work (transformation grammar) has been questioned (Hutchins, 2001). SNOBOL (developed at Bell Labs) was influenced by COMIT.
the *specification* problem in which the components and processes of the target system are sufficiently specified to capture the characteristics of interest. Second, there is the *realization* problem in which the specification can be implemented in an actual physical system to enable synthesis. As they explain in a subsequent RAND report (Newell & Simon, 1959):

> To explain a phenomenon means to show how it inevitably results from the actions and interactions of precisely specified mechanisms that are in some sense “simpler” than the phenomenon itself….For complex phenomena there may be, and usually are, several levels of explanation; we do not explain the phenomena at once in terms of the simplest mechanisms, but reduce them to these simplest mechanisms through several stages of explanation. (p. 6)

The concept of “levels” and “symbols” were innovative and insightful in thinking about these systems, but about other artificial systems as well. Later Newell, along with Gordon Bell (then a faculty member at Carnegie Tech) would write one of the first and most influential books on comparative computer architecture, and this was based on a unique formalism for describing levels of abstractions in computing systems (Bell & Newell, 1971). Newell would recurring invoke those concepts as fundamental substrate for this (and Simon’s) work in cognitive science and artificial intelligence (e.g., Newell, 1990, 1982, 1980; Newell & Simon, 1976, 1972).

However, from the onset, both Newell and Simon also applied the concept of symbols and levels in the discussion of programming non-numeric models and, for example, how those could be used to simulate thought.26 Using IPL afforded a clean way to realize and manipulate symbol structures, but using this “pseudo-code” (as they called it) to define specific task models (such as chess or logic) did not afford *generality* that would capture their emerging theory of problem solving. This need resulted in the development of another program – The General Problem-Solver.

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26 The link between computational modeling and thought endures in a variety of forms, levels of specificity, and goals. For example, one of the most ambitious projects is the recently announced “Blue Brain Project” between IBM and the Ecole Polytechnique Fédérale de Lausanne in which IBM’s Blue Gene computer architecture will be extended to model mammalian brains to high levels of biological accuracy (Markram, 2005). A general overview and historical perspective can be found in the collection of articles in AI Magazine’s Twenty-fifth anniversary issue (AI Magazine, 2005).
The General Problem-Solver (GPS) was an interesting landmark in that it was a general problem solving computational architecture that was written in IPL. Initially, there was GPS-1 in IPL-IV for the JOHNNIAC (Newell, Shaw & Simon, 1958c), but eventually took final form as GPS-2-5/6 coded in IPL-V for the CDC G32 and the IBM 7090 (Ernst & Newell, 1969). Worked progressed on GPS to solve a variety of problems, such as the Tower of Hanoi, theorem proving, the Water-Jugs problem, sentence processing, and the Bridges of Königsberg (Ernst & Newell, 1969). Graduate students at GSIA were generally involved in programming as research assistants contributing to projects (e.g., Cyert, Feigenbaum & March, 1959), but often included this method in their dissertation area and some, such as Ed Feigenbaum, spent time at RAND (e.g., Feigenbaum, 1964; Fegenbaum & Simon, 1962). As a group, they covered a variety of interdisciplinary topics. For example, consider the GSIA dissertations of some of those who emerged in the timeframe leading up to the ABTOF book: Julian Feldman (“An Analysis of Predictive Behavior in a Two-Choice Situation”) and Kal Cohen (“Computer Models of the Shoe, Leather, Hide Sequence”) in 1959, Edward Feigenbaum (“An Information Processing Model of Verbal Learning”) and Fred Tonge (“A Heuristic Program for Assembly Line Balancing”) in 1960, Geoff Clarkson (“Portfolio Selection: A Simulation of Trust Investment”) in 1961, and Charles Bonini (“Simulation of Information and Decision Systems in the Firm”) in 1962.

The key point about GPS is that it was designed to solve not a particular problem (e.g., chess), but a “broad class” of problems by detaching the underlying fundamental problem solving architecture (i.e., GPS architecture of goals, subgoals and associated default methods of

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27 While on a voyage in 1959 to Southhampton, Feigenbaum sent an interesting airmail note (dated July 14th) to Herb Simon regarding implementing IPL on a particular computer: “A vague idea I have suggests that memory be not organized into lists of indefinite length, but into ‘pages’ of fixed size, with an information –shuffling system similar to that of a loose leaf notebook.” This, in fact, was envisioning two important concepts in computer science regarding memory management, paged and virtual memory (Fotheringham, 1961; Kilburn et al., 1962).

28 Feigenbaum, Feldman, Tonge, Cohen, Clarkson and Bonini each were among the GSIA winners of a Ford Foundation dissertation award.
search) from the domain-specific knowledge that would be required to solve a particular problem that would be defined in terms of the GPS architecture. Thus, in 1957-1958, elements of their problems solving theory (that would remain thematic throughout their career) appeared as elements in GPS: task environment, objects, goals and goal structure, operators, and search. The problem solving theory was now in the GPS code.

Relatedly, Simon and Newell were co-directors of a Ford Foundation/Social Science Research Council training institute held in the Summer of 1958 on the simulation of cognitive processes. Cliff Shaw and Fred Tonge (at that time at RAND after completing his Ph.D.) assisted in the workshop, which lasted three weeks with 20 participants including Carl Hovland and Robert Abelson of Yale, George Miller and Roger Shepard of Harvard, James Coleman from Chicago, Ward Edwards from Michigan, Jack Block from Berkeley, and Marvin Minsky from MIT (Simon & Newell, 1958). In this report it was concluded that:

Simulation techniques represent a significant new tool for psychological and other social science research. The next important objective is to make this tool available, as a normal part of graduate training opportunities, at the major graduate training centers in the social science. (p. 39)

Although many of the arguments and examples were drawn from models of individual deliberations, it was recognized early at GSIA that computational modeling would, in fact, “have an even more central role” in social psychology than in individual psychology (Newell & Simon, 1963, p. 419), and also serve as a mechanism for theory building in economics (Clarkson & Simon, 1960).  

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As an aside, about the same time, Jay Forrester was developing Industrial/Systems Dynamics and DYNAMO (the associated programming language) at MIT’s School of Industrial Management (Forrester, 1961, 1959, 1958). This was of a systematic way of integrating dynamic components and levels of systems involving time dependencies, delays, and feedback, and not equivalent to the work being done at GSIA. However, there are many parallels and sympathies between these groups: Newell and Simon were building a language for categories of reasoning processes; Forrester was building a language for describing categories of systems processes. There is not a lot of evidence of these groups communicating with each other (though they probably did at some level) or collaborating (which they did only indirectly through some students). Forrester himself was a most remarkable character to have in a business school at that time (see Forrester, 1992). Other parallels between the two schools are noted by Leavitt (1996).
Analytical Machinery. Meanwhile, another use of computers at GSIA came out of a center led by Bill Cooper and funded by the Air Force. This center was to focus on “the development of mathematical, statistical and econometric methods for use in managing industrial operations” including (eventually) the applications of computer technology (Cooper, 2002). Two streams and teams of work were soon underway. One team involved Cooper and Abe Charnes (a faculty member in the mathematics department) working on several types of applied problems that resulted in the development of innovative and influential operations research techniques (e.g., Charnes, 1952; Charnes & Cooper, 1954; Charnes, Cooper & Ferguson, 1955; Charnes, Cooper & Mellon, 1952). Another team consisting of Charles Holt, Franco Modigliani, John Muth, and Herb Simon. This team focused on one problem context – a local manufacturing facility. The goal of this work was basically to develop methods that could be applied to improve plant performance and, similarly, the results of this effort were influential (e.g., Holt, Modigliani & Simon, 1955; Holt, Modigliani, Muth & Simon, 1961). Both streams involved developing analytically-based, with computer-implemented methods, to solve practical organizational problems, but also had substantial theoretical implications. Cooper (2002) reflects on these projects:

It is of interest here to note that both Modigliani and Simon subsequently received the Nobel Prize in Economics, in part for their work. The “exponential smoothing” models and methods developed for this work by Holt now occupy prominent places in business forecasting practices. Muth, a PhD candidate at GSIA, formulated the ideas known as “rational expectations” in the course of this work, which Bob Lucas (then a member of the faculty at GSIA) subsequently extended and elaborated in research for which he also received the Nobel Prize in Economics. (p. 39)

Game and IT. In 1957, Dick Cyert (then Dean of the undergraduate Department of Industrial Management) assembled an impressive group to serve as the development committee for what would become the Carnegie Tech Management Game (singularly called “Game” and is
still part of the core MBA today). This group consisted of William Dill, Merton Miller, Alfred Kuehn, Fred Tonge, and Peter Winters. Other faculty members who contributed (to greater or lesser extents) were equally impressive, including: Kal Cohen, William Cooper, John Muth, Neil Churchill, Robert Trueblood, Gerald Thompson, Harold Leavitt, Jim March, and Herb Simon. Accordingly, the game was unique not only in its design and complexity (as a computer model), but also in its integration into the curriculum with a board of directors to which each team/firm must report and a vehicle for research (see Cohen et al., 1960). The game was initially played in its first version from the summer of 1959 to the spring of 1961, being programmed on the IBM 650, with Kal Cohen was the first administrator of the game (Cohen et al., 1960, 1964). The value of actually building such a simulation (versus simply applying one) added substantially unique experiences and skills to GSIA students and faculty.

Kal Cohen received his Ph.D. from GSIA under the direction of Dick Cyert, Merton Miller and Franco Modigliani. For his dissertation, Cohen included models programmed on the IBM 650 computer (Cohen, 1960), thus gaining critical and relevant experience for events that would follow. Alan Perlis was now the director of the computation center and heavily involved into developing new languages, which had an indirect impact on what languages (and support) where available. One language, called IT (Interpretive Translator, also called the Carnegie Tech Compiler), was originally designed at Purdue by Perlis for the ElectroData Datatron 205. When Perlis moved to Carnegie Tech (where had received his undergraduate degree in 1943), he completed a port of IT to the IBM 650. IT is significant in that it was actually considered one of

30 Management games evolved out of military “war games” and were seen as plausible experiences for managers at this time (e.g., Andlinger, 1958). However, the use of the term “game” at the time did not usually mean a computer-based game; rather, it usually meant a role-playing and/or board-game type of play. Histories and descriptions of these computer games in this era can be found in Cohen and Rhenman (1961) and Kibbee, Craft and Nunn (1961). One of the earliest and most influential computer-based business games was the Top Management Simulation developed by the American Management Association with input from RAND, IBM, and the Naval War College (Bellman et al., 1957). Results of research demonstrating the usefulness of these simulations began to appear from institutions such as GSIA (Dill & Doppelt, 1963; Dill, et al., 1961), UCLA (Jackson, 1959) and the Harvard Business School (McKenney, 1962).
the first “useful” compilers. Consequently, Cohen (and others) programmed his models in IT as it handled alphanumeric input easier which facilitated the implementation of math-based algorithms into code (Perlis, Smith & Van Zoeren, 1957).

The development of IT is important as it illustrates the general collaborative nature of researchers of this era. Improvements on IT proceeded and by the fall of 1957 it was made available to other universities who could make their own modifications and implementations, or to design variants and extensions (e.g., Knuth, 1959). One variant of note came from a group at the University of Michigan (Arden & Graham, 1959), who developed the Generalized Algebraic Translator (GAT). GAT was quite successful and, consequently, Carnegie Tech adopted that version and extended it as GATE – GAT Extended. In 1961, the IBM 650 was replaced by a Bendix G-20 and GATE was ported to that machine (Perlis, 1986).

Cohen, by then graduated and a faculty member at GSIA, was eventually Head of the Department of Economics by 1965. In the mean time, the game administration responsibilities shifted to Merton Miller (1960-1961) and then to Peter Winters (1961-1962). Peter Winters received his Ph.D. from GSIA (Dick Cyert was his thesis chair). The first version of the Management Game was then revised in 1961, and was rewritten from IT to GATE. As the Behavioral Theory of the Firm project proceeded, Professor Cohen added substantially to the role of computer models in economics, business research and education. When the C-M model was eventually written, it was written in GATE and Professor Cohen helped Peer Soelberg (who received his Ph.D. from GSIA in 1967) develop the code on the Bendix G-20. From a coding perspective by today’s standards, it was not an especially pleasant experience; however, for the times, the innovation of GATE mechanisms allowed programs to function beyond the physical

31 IT was influenced by the work of Laning and Zierler’s (1954) work at MIT on a compiler for their Whirlwind computer.
32 The port of GATE progressed, in part, due to the inadequate software that was shipped with the (albeit superior hardware) Bendix G-20.
33 At the same time Kal Cohen and Dick Cyert were working on a textbook to use in their course on The Economics of the Firm at Carnegie Tech. Interestingly, this was somewhat confusingly titled “Theory of the Firm” and appeared two years after Cyert and March (Cohen & Cyert, 1965).
constraints of the Bendix memory as well as incorporating routines written in another local product, TASS (Tech Assembly System). As one can imagine, GATE was rather terse and the Bendix computer itself was quite limited. More to the point, the code itself was not that intuitive (compared to current languages) and was more than likely understood by few readers.

In conclusion, from the early 1950s a confluence of different and fortuitous events at Carnegie Tech resulted in innovative work being done in computers in and around GSIA. Alan Perlis drove the development of fundamental and innovative software. Newell and Simon (along with Shaw at RAND) with their graduate students and colleagues drove the theory of problem solving and the use of computers in articulating theories of human behavior. Cyert, March, Cooper, and a host of other faculty and students did applied and theoretical projects on firm behavior. When the ABTOF book appeared in 1963, the listing of the duopoly model in Chapter 8 (the most elaborate and complete model) was a listing of the source code (roughly 540 card images) and one of the runs on the Bendix, totaling 54 pages (about 18% of the main text). The ABTOF theory was now in the code.

Reviews and Reflections

As a theory, ABTOF is a coherent, rich source of interrelated concepts explaining many aspects of firm behavior. C-M represents instantiations of that theory in terms of a specific model realized in code. What was the effect of the appearance of the book in organizational science? From a theory standpoint, ABTOF has a well-established citation record in leading

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34 The significance of TASS and its successors is that the assembly (i.e., low-level) routines written in them would be both efficient (in terms of resources) and sharable from a library, where no detailed knowledge of its inner structure would be required. For example, when statistical routines were written by the graduate students (which was often the case), other graduate students and faculty could benefit immediately.

35 Consider that the basic central processing cabinet had a main memory of 4,000 words (i.e., 4k, 32 bits each) up to 32k words, weighed about 2,000 pounds, had about 8,900 (non-integrated) transistors, and cost $290,000. Today’s AMD Opteron has a main memory support of 1 Terabyte (one trillion bytes), can address 256 Terabytes, has about 233 million transistors (integrated), uses 64-bit words, can fit in your hand, and costs about $1500.

36 Although working on substantially different projects with substantially different goals, Allen Newell, Alan Perlis and Herb Simon came together in 1967 to craft a letter to Science (Newell, Perlis & Simon, 1967) that argued for the legitimacy of computer science as a discipline. This had substantial impact on the spread of computer science in universities as well as the interest in the discipline itself as a career.
journals (Engwall & Danell, 2002). However, the influence of the method – computer simulation in the organizational sciences – is less certain.

The substance of discussions in book reviews can be bellwethers, so what did the reviews of A Behavioral Theory of the Firm say with respect to the computer model? We examined twelve reviews of the first edition of the book. As most reviews, they varied substantially in their breadth and depth of coverage, and each bears the perspective of the reviewer (e.g., sociologist, accountant, and economist). Within these reviews we simply focused on assessing the comments made regarding the computer models and the method of simulation. The results summarized in Table 1.37

For the most part, the reviews ranged from only passing remarks and acknowledgements (both positive and negative) on the computer models to glimpses of substantive issues regarding the use of simulation in general. Two reviews stand out as substantively different. First, Richard Day’s review brought in an interesting argument on the similarity between behavior rules and mathematical programming: both focus on processes (empirical and functionality), both involved forms of constrained maximization (technical or behavioral), there is a “fundamental duality” between decision rules and explicit optimizing (consider the costs of information search and decision time), and both can engage information feedback mechanism.

The second review of note was that by Carl Thomas Devine. It was an in-depth, substantial review of the book and theory covering 24 pages in the Accounting Review. Although a few pages were devoted to covering the computational models (descriptively at a high level), several were devoted to positing an answer to a question not too dissimilar to the one addressed

by this paper, but one of the theory itself: Why ABTOF at Carnegie Tech? He suggests that it could have emerged at several other universities: Wisconsin, Columbia, Johns Hopkins, and MIT, yet “the curious fact remains that the center of this development has been at Carnegie where the tradition includes little economics, psychology, or social science and none of the more abstract mathematical and philosophical attitudes necessary to develop new social theory of this importance” (Devine, 1964, p. 199).

This prompted a personal letter of response not from Dick Cyert or Jim March, but from Herbert Simon, “correcting” the intellectual and collaborative antecedents. The most telling part of the Simon letter is in response to a comment directed toward the “Why ABTOF at Carnegie Tech?” question:

Hence, when you characterize Carnegie as a place “where tradition includes little economics, psychology, or social since and none of the more abstract mathematical and philosophical attitudes necessary to develop new social theory of this importance,” you miss the point of the whole matter. For precisely what happened when the new graduate school was created, about 1949, was to transplant these things from the Chicago environment with the deliberate and considered intent of following the lines we have, in fact followed. I would suspect myself of substituting hindsight for foresight if the documents did not remain in the files to show that we really knew, in general, what we were trying to do. (Simon, 1965, p. 3)

In a similar muse over 20 years later, Lee Bach (1986) asks “Why a computer at GSIA?”:

An interesting period and group brought the first computer to Carnegie. Partly we had luck – luck in getting Herb Simon at the beginning and the other key people in the early days with their extraordinary mix of flexibility and understanding of the problems they work with. Some things turned out well that were barely rescued from trouble. We had a terrible time hanging on to the best people we got when they became highly visible over the decade following the acquisition of the computer in our basemen. But I can’t, and don’t want to, believe that it was luck alone. The time was right for a revolution in management research and education, and for the computer to play a central role. (p. 41)

Conclusion

In this paper we examined only some of the rich history and context of the academic environment at GSIA with respect to the emergence of computer modeling. At the time, it was a
remarkable period for intellectual seeding and growth of many areas – artificial intelligence, computational economics, experimental/behavioral economics, organizational modeling, and cognitive simulations. Furthermore, all were conducted within an overarching concept of both problem solving and design which would be a unifying theme at GSIA and Carnegie Tech to this day. The concept of design was well-known at Carnegie Tech and at GSIA, as Herbert Simon had published two critical articles (Simon, 1962; Simon & Ando, 1961) related to organizational complexity and design theory, which would lay the foundations for his famous Compton lectures at MIT and published as “The Sciences of the Artificial” in 1968. In a 1965 memorandum entitled “GSIA Future Educational and Research Policy,” Richard Cyert (1965) argued the following:

The time seems appropriate for GSIA and E&S [Engineering and Science] jointly to pursue the area which we have referred to broadly as design. The time seems ripe for a marriage [sic] between the engineering and management aspects of design. We need to develop a methodology that can simultaneously comprehend the problems in both areas [and proceeds to note the] importance of integrating questions of technology with those of management, especially information systems [their term] and strategic planning.

We noted the infusion of formality and computer modeling in the social sciences at GSIA. Both, of course, were not unknown at the time in the social sciences, such as Coleman’s classic work in sociology (Coleman, 1964) and the growing of computer models noted in the paper. Rather, it was the unique confluence of skilled characters and interdisciplinary events of the time – some resulting from design and others from opportunity.

Our own cursory examination of the ABTOF citations reveals that only a small fraction (less than 1%) actually resulted in derivative simulations. Dick Cyert did express his concerns over this issue. Why did it not “catch on” in organizational studies? In 1964 they were essentially defining routines, meta-routines, organizational learning, organizational memory, organizational attention, communication structures, and doing computational experiments. We can be speculative at best and certainly agree there may be many explanations and space precludes an in-depth exposition. Consider the obvious: at the time computers were new, difficult to use, extremely expensive, and few faculties could teach the subject. However, times
have indeed changed. Computers are many times more powerful, easier to use, and a fraction of the cost; furthermore, every university has resources for teaching programming. Yet, it is not about programming. It is about adding a method to the toolbox of organizational science (Cyert & March, 1960).

Interestingly, the problem was not unique to organizational science, but at a broader level impacted computer science itself. Alan Perlis (1986) reflects in similar tone on the growth of computer usage and development.

Looking back one can see that computation at Carnegie evolved the way it should have everywhere but often didn’t. There was a confluence of minds, tools and problems – an absence of administrative blindness and an appreciation of potential and consequence that spread beyond the computation center. An environment came to exist in which all future computer developments, no matter their area or purpose, could gestate and bear without irrelevant justification. (p. 46)

We end with a smaller observation. As we researched the archives and conducted the interviews, an additional theme of the times emerged. For those engaged at Carnegie Tech and GSIA at the time, it was indeed an exciting place with big ideas. In fact, Simon noted that GSIA delayed seeking accreditation “to avoid constraining our ability to innovate” (Simon, 2004, p. 6). Thinking back on those times, individuals recalled fondly the dynamism and intellectual environment. William Dill (Ph.D. 1956), former Dean of the Stern School of Business at New York University, President of Babson College, and recipient of the first Ph.D. from GSIA, recalled “it was exciting…everyone was doing something that was a little off-beat with respect to tradition…it was very interdisciplinary…I still don’t know what I got my Ph.D. in.” Alan Perlis noted that “No other moment in my professional life has approached the dramatic intensity of our first IT compilation” (1986, p. 43). Gordon Bell is senior researcher in Microsoft's Media Presence Research Group, was the former Vice President of Digital Equipment’s research and development, and also led the cross-agency group as head of NSF's Computing Directorate that

38 Interview conducted August 1, 2006.
generated the plan for the National Research and Educational Network in 1986 – the Internet. He recalls his time as a faculty in Computer Science as “one of the most exciting periods of my life.” (Interview conducted July 21, 2005). Other former faculty and students often had similar responses to their experience at GSIA. It was indeed, as Dick Cyert and Jim March note in their Acknowledgements to the book, a “uniquely exciting research climate” (p. vi).

References


Table 1. Analysis of Book Reviews of Cyert and March (1963)

<table>
<thead>
<tr>
<th>Reviewer</th>
<th>Computer Models/method discussed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. J Baumol</td>
<td>Yes, in depth. Generally positive, characterizing the approach as a method that seems more suited for testing, rather than erecting, a behavioral theory. Specific comments on M7 and M10.</td>
</tr>
<tr>
<td>Kenneth E. Boulding</td>
<td>Somewhat. Only specifically mentions (and is supportive of) M10, but considers the oligopoly code (M8) as “53 pages of non-English computer jive talk.”</td>
</tr>
<tr>
<td>Rufus P. Browning</td>
<td>Yes. General discussion of simulation as method addressed. Concerned about the number of variables, their theoretical standing, and interactions. Concerned about the extent to which simulations can be understood and manipulated by other researchers. From political science perspective.</td>
</tr>
<tr>
<td>Marshall R. Colberg</td>
<td>Somewhat. Only generally addresses M7 and M8, and discusses concerns of over specificity and large number of parameters.</td>
</tr>
<tr>
<td>Richard H. Day</td>
<td>Yes. Generally mentions M7, M8 and M10 and the method. Much of the discussion centers on the relationship between behavioral rules, current approaches to the development of mathematical programming, the concept of algorithms.</td>
</tr>
<tr>
<td>Carl Thomas Devine</td>
<td>Somewhat. Despite being the most extensive review of the book, only summarizes approaches taken for M7, M8 and M10.</td>
</tr>
<tr>
<td>Herbert A. Simon</td>
<td>Specific response to intellectual antecedents of GSIA proposed by Devine (see text).</td>
</tr>
</tbody>
</table>

*M7 refers to the retail markup model in Chapter 7; M8 refers to the general oligopoly model in Chapter 8; M10 refers to the Clarkson portfolio model of Chapter 10.*
Table 1. (cont.) Analysis of Book Reviews of Cyert and March (1963)

<table>
<thead>
<tr>
<th>Reviewer</th>
<th>Computer Models/method discussed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. Livesey</td>
<td>Somewhat. Generally notes the use of computer programs to express and test models in the book.</td>
</tr>
<tr>
<td>P. A. Losty</td>
<td>Yes. Few comments on the organizational theory. Sees M7 and M10 as less interesting that M8, which is viewed as “interesting but inconclusive.”</td>
</tr>
<tr>
<td>John A. Sawyer</td>
<td>Somewhat. Brief mention of the use of “flow charts and a computer language” that economists must master if they are to take advantage of this method.</td>
</tr>
<tr>
<td>Martin Shubik</td>
<td>Somewhat. Mentions the use of computer simulation as a model for M8.</td>
</tr>
<tr>
<td>Thomas L. Whisler</td>
<td>Somewhat. Notes that it is useful for behavior scientists to read for the in-depth exposition of decision-process analysis and the computer simulations of those processes.</td>
</tr>
<tr>
<td>Sidney G. Winter</td>
<td>Yes, in depth. Generally positive, noting that the department store (M7) and the Clarkson (M10) are impressive, while the oligopoly model (M8), although interesting, does not seem to implement many features of the theory and may suffer problems of needing to estimate large numbers of parameters.</td>
</tr>
</tbody>
</table>

*M7 refers to the retail markup model in Chapter 7; M8 refers to the general oligopoly model in Chapter 8; M10 refers to the Clarkson portfolio model of Chapter 10.*