Michael Mahoney And The Histories of Computing(s)

SIGCIS History of Computing Workshop in Memory of Michael S. Mahoney

Sunday, October 18, 2009, Hilton Hotel, Pittsburgh, Pennsylvania, USA

David Anderson, *University of Portsmouth*

The Corridors of Power: Patrick Blackett and the Political Context of Early British Computing

This paper considers the largely behind-the-scenes role played by the physicist Patrick Maynard Stuart Blackett in nurturing and supporting the development of computing in the UK.

Argument: This paper traces the contribution of Patrick Blackett from his pre-WWII friendship with Max Newman and his working relationship with Freddie Williams, through his wartime membership of the Tizard committee. In peacetime, Blackett's involvement with the National Research Development Corporation (1949-64) marked a period when he was largely ostracised from the central advisory committees and corridors of power in Whitehall. With the support of Prime Minister Wilson, Blackett emerged once more as a man of singular importance in British scientific life. Over a period spanning more than 30 years Blackett decisively but quietly supported a number of projects which came to be seen as vital in the development of computing in the UK. By examining the way in which Blackett used his influence to promote computing we can begin to get a much clearer picture of the larger political context within which the field was shaped.

Evidence: Based on a detailed re-examination of the historical evidence, including Blackett's surviving papers and third party material such as the Newman Digital Archive, I suggest that Blackett was much more influential in the genesis, enabling, staffing, and funding of the Manchester Baby project than has previously been recognized. More widely, Blackett's impact on scientific leadership and policy in the UK between the end of the war and the mid-1970s was very considerable.

Contribution to Existing Literature: A number of well-known accounts have been published covering detailed aspects of the early (post WWII) history of British Computing. Typically these are somewhat narrow in focus and do not address the social and political imperatives which gave rise in Britain to such an abundant flowering of apparently independent computing developments. Works such as Simon Lavington's "Early British Computers" and "A History of Manchester Computers", Maurice Wilkes' "Memoirs of a Computer Pioneer" are fairly typical of the existing literature in the field in concentrating on individual developments or centres rather than taking a wider view of the social and political forces which drive social change. Mary Jo Nye's otherwise excellent biography of Blackett is by no means alone in failing to fully appreciate the extent of Blackett's influence on computing. My paper attempts to go some way towards providing an account of the political context in which early British computing was happening and to re-situate Blackett as an important figure in a field where his name is almost unknown.

Jonathan Aylen, *Manchester Institute of Innovation Research, University of Manchester*

"You've got to roll with it": radical adoption of computers and changes to managerial routines at Llanwern steelworks, South Wales

This paper reports a paired comparison of two pioneering applications of computers in the mid-1960's at Llanwern steelworks in South Wales. The application of a GE 412 to process control of the new hot strip mill was technically successful and imitated worldwide. The use of three Elliott 803 computers for managerial tasks of information handling and order scheduling was problematic. Computers were more readily integrated into routines for physical control of a rolling mill, than into the managerial task of scheduling.

Obvious reasons for differing success were hardware capacity and timely availability of software. However, process control in the rolling mill was readily modified to accommodate computer control with little disruption. Managers and operators understood the operating routines involved. In contrast, scheduling was a "black art" with strong pre-existing routines from an adjacent works.

We expect radical, early stage adoption of computers to alter business routines. As new technologies emerge, organisational capabilities need to evolve too. The comparison shows it is more difficult to develop organisational routines for management computers than for process control. In the case of the "Physical technology" of process control, hardware acts as a mediating factor. Engineered equipment is modular and can be tested off-line and stretched. By comparison, the "social technology" of scheduling relies on tacit knowledge of mill operating practices, is harder to encapsulate in computer programmes and faces conflict between mill operators and mill customers.

Scott M. Campbell, *University of Waterloo*

Agendas and the Promise of Computer Science at the University of Toronto

Michael Mahoney often used the concept of agendas to explore the history of computer science. An agenda, as he described it, was used by practitioners to decide what ought to be done, particularly in establishing and maintaining a measure of autonomy. For example, in 1997 he showed how the agendas of multiple mathematical disciplines, including logic, finite automata, and formal languages combined to create theoretical computer science.

In this paper I will show how the concept of agendas can also be used to understand the founding of the graduate Department of Computer Science at the University of Toronto in 1964, the first in Canada. Although this event can be explained though luck (both good and bad), prevailing traditions at the university, and the growing sense that such a discipline was slowly emerging, the complete story can only be found in the unique local agenda.

Specifically, the seeds for an independent department were sown in 1952, when Toronto installed Ferut, a Ferranti Mark I, and the only computer in Canada until 1955. The university proudly operated Ferut in its Computation Centre almost exclusively on behalf of other Canadian scientists, engineers and mathematicians, but was forced to reconsider the role of a computer on campus as client organizations began to buy or rent their own computers. It took several years to formulate an agenda, during which the aging Ferut was unceremoniously replaced with a disappointingly common IBM 650 in 1958. Aspiring to a better machine, blueprints were drawn up to recapture the university's pride by building a copy of the ILLIAC II supercomputer (under construction at the University of Illinois). To justify the vast cost an equally prestigious computing related research department would have to be created to support the computer. Toronto never built an ILLIAC II, but was able to recover its t
echnological standing with an IBM 7090: less-expensive but still the most powerful computer in the country and the same gateway by which a computer science department could arrive on campus.

As Mahoney pointed out in 1997, a computer was not a device that might normally generate a scientific agenda for a new discipline, but the example at Toronto shows how an agenda might use a computer to generate a new department. The material for this paper is derived from my 2006 doctoral dissertation on the history of modern computing at the University of Toronto.

Dave Goodwin, *Birkbeck College, University of London*

Digital Equipment Corporation: The mistakes that led to its downfall

In 1987 Digital Equipment Corporation (DEC) was the number two computer manufacturer in the world with its founder being named the "'most successful entrepreneur in the history of American business" by Fortune magazine. This paper looks at the later history of Digital Equipment Corporation and asks how an organisation that was so successful in 1988 could sink to become a takeover target for a PC company ten years later. The management styles and company culture have been extensively described in Edgar Schein's book "DEC is dead, long live DEC" but there is much more to the story. The technology that the company developed and the business decisions made in the development and the direction of that technology had a major bearing on the fate of the company. Many mistakes were made over the last fifteen years of the company's existence and this paper offers a suggestion as to what those mistakes were.

In this paper, extensive use is made of interviews with people involved at the time as well as material from the Ken Olsen Archives at Gordon College which contain many of the memos that Ken Olsen sent in his long career at DEC. It considers DEC as a case study set in the context of literature on business change and the impact of downsizing. There is an investigation of the Workstation market, DEC's surrender of leadership and the various architectures that were considered and chosen over the years, in particular the decision to kill various programmes only to resurrect them a few years later. Discussion of the VAX9000 is included and the drain that the product had on the company resources.

OpenVMS, Unix and Windows NT opportunities were also missed due to internal struggles and some management naivety which will be considered in terms of company profits and sales. Also analysis of why the Alpha processor failed when it was years ahead in terms of performance is made. The final mistake involved the internet business which is analysed to understand why DEC failed when it was ahead of most other businesses in this sector. AltaVista was the preferred internet search engine of choice in the late 1990's and many other internet technologies were being introduced by DEC when they lost management focus, not understanding what they had to offer and its potential for the future.

Lars Heide, *Copenhagen Business School*

Punched Cards in German Management of Resources in the Second World War

The paper discusses the essential role of punched card based statistics production in Albert Speer's successful German armament program during the Second World War.

The large statistics production of Speer's Armament and Munitions Ministry was crucial for the successful operation of Speer's armament production program's seemingly diffuse network organization. It was based upon punched cards and extensive standardization. The paper will tell the history of this punched card operation and discuss how this statistics production reveals Albert Speer's detailed knowledge about forced and voluntary labor in the German war production. Also the paper analyzes an attempt to improve statistical details by introducing a large national register of people in Germany that failed. This failure opens for discussing the role of information technology and organization in developing and applying information technology.

The paper is based upon the archives of the German Armament and Munitions Ministry, the German institution monitoring enemy owned property, and IBM's German subsidiary (Dehomag).

Sten Henriksson, *Computer Science Department, Lund University*

A Brief History of the Stack

The stack has a special place in the emergence of computing as a science, as can be argued from a formulation by Michael Mahoney: "Between 1955 and 1970, a new agenda formed around the theory of automata and formal languages, which increasingly came to be viewed as foundational for the field as a whole". In this process, interest arose in "devices with more generative power than finite automata, and more special structure than Turing machines." The push-down automaton based on a stack mechanism is such a device. The history of the stack was first discussed by Donald Knuth . The present paper investigates some further developments and constitutes a reverse history which ends in some medieval tales.

It has been suggested that the history of the stack should not treated by itself but should be embedded in a treatment on the origins of recursion. The stack would then be a technical detail in a far longer discussion of recursion in the history of mathematics. I would like to hear opinions on this and I would also be glad to pick up suggestions for further historical references to the development of the stack.

Hansen Hsu, *Cornell University, S&TS Department*

Connections between the Software Crisis and Object-Oriented Programming

Michael Mahoney and Nathan Ensmenger have both written about the software crisis through the lens of labor history, and both have touched upon object-oriented programming (OOP) as one proposed solution to the crisis. Both have suggested that techniques such as OOP were part of a management strategy to discipline software workers, by making programming more "scientific" through Taylorization or Fordization and less of a "black art." Despite such attempts, however, programming is still widely considered an art or craft, and this view is corroborated by my ethnographic research of programmers at an iPhone startup. Yet OOP has not withered but thrived, and within the context of my case study of iPhone and Macintosh programming, certain OOP technologies have become part of an "Apple" or "Cocoa" technical culture to be espoused in defiance of management over other, more widely accepted technologies. Moreover, a look at practitioners' accounts by Alan Kay, Bjarne Stroustrup, and Brad Cox, suggest a more academic, computer science origin for OOP. While motivated by the software crisis, I suspect that OOP did not arise from management attempts to control programmers, but from programmers' own attempts to find solutions to the crisis by creating technologies to discipline themselves, create better design practices, and better respond to users' needs.

My own background is that of a programmer; I was a software test engineer in Apple's Cocoa framework group before I received my MA in History at Stony Brook and continued my studies in S&TS at Cornell. My long term interests are informed by my experiences at Apple; I am interested in the culture of Cocoa/NeXT programmers, and how that culture plays out in technical disputes with programmers of other environments, such as C++, or Apple's own procedural Carbon environment. Certain principles from Alan Kay's Smalltalk continued through to Cocoa today and form the basis of a continuing technical controversy between dynamic and static binding in OO languages. Understanding the origins of OOP should illustrate one aspect of the technical culture among today's iPhone developers. This paper began as both a term paper for Ron Kline's history of technology class, and as a look at historical background for my iPhone ethnographic project, but also constitutes my preliminary investigations into a possible dissertation topic. I welcome any suggestions, including research questions, methodology, sources, and literature, that could develop this project further.

Anker Helms Jorgensen, *IT University of Copenhagen*

History of User Interfaces to Computers – A Mahoneyan Perspective

Although the first digital computers - and calculators before them - had input/output devices such as dials, switches, and input tables, the concept user interface only gained foothold in computing in the 1960s, with the accompanying theoretical foundation Human-Computer Interaction (HCI) being established in the 1970s. User interfaces are tangible and conceptual artefacts such as input devices and pop-up menus, while the academic field HCI comprises theory, concepts and methodology. Although the two differ, they are closely related and in the literature there is some overlap. My focus here is on user interfaces.

The last decades have seen a growing interest in historical aspects of HCI and user interfaces alike. It is time to ask: What is the historical relevance of these fields? The computer has in half a century mi–grated from large computer rooms to everyday objects. It is increasingly invisible, embedded, and pervasive and the user interface has come to the fore at the expense of the computer itself. Accom–panying this migration, a number of perspectives on user interface issues have emerged in the literature such as usability, aesthetics, emotion, media, and culture. With so wide-ranging rami–fications, the user interface must be said to be a relevant candidate for historical inquiries.

In getting to grips with the emerging historical interest, it is obvious to ask if history of computing and technology can be helpful. Here the writings of Michael Mahoney on software history spring to mind with the most significant contributions being "The History of Computing in the History of Technology" (1988), "Issues in the History of Computing" (1996), and "The Histories of Computing(s)" (2005). By using these works as frame of reference I will outline the state-of-art in history of HCI and user interfaces.

As to the types of literature at large, I can almost quote the 1988 article directly. The first type emphasizes - and is to some extent written by - the people involved; it also comprises corporate stories (not IBM though, but Xerox Palo Alto Research Center); and there is a good deal of facts and "firsts". The second type is writings by journalists "with an eye for the telling anecdote" – on pioneers and organizations alike. The third type is professionally written historical work – of which only little exists, written by historians and HCI scholars, where Grudin (2005, 2008) stands out with his analyses of HCI as a moving target and the evolving discretionary use of computers.

Mahoney discusses the "tripartite nature of computing": the tactile and manifest hardware, the software with a teasing static and dynamic aspect, and the activity of programming involving individuals in an organisational context and professional practices. When dealing with user interfaces, it is in place to add a fourth component, namely that of the user dealing with the software through the interface in an organisational or social context. Just as the dynamic nature of software and programming adds to the complexity of the historian's task, the fourth component does likewise to historical inquiries into user interfaces.

Mahoney also stresses the significance of addressing use and users as well as design and designers, topics that so far have been given limited attention in the user interface and HCI literature.

Finally, Mahoney suggests a number of candidate models from history of technology that can be brought to bear on computing history: mass production, assembly line, Middletown, revolution, invention, innovation, and determinism. Given the state of art in the historical writings in user interfaces, it will be quite a while before an understanding of these concepts – let alone an agreement on a set of histories – will be established.

Carolyn Kane, *New York University*

Synthetic Color: Electronic Signal Processing & The Reconfiguration of Perception at the End of the Twentieth Century

This research project argues that electronic color technologies revolutionize age-old debates about the subjective and objective nature of color. The project places late-twentieth-century electronic color within Western theories of color and color perception since the pre-Socratics. This background creates the theoretical framework in which more recent cases of electronic color can be situated.

To date, there have been two main schools of color theory: I call them the subjective and the objective. The subjective tradition claims that color perception only occurs in the mind's eye. This tradition finds advocates in work of the experimental scientists such as Hermann von Helmholtz, James Clerk Maxwell, Johann Ritter, Jan Evangelista Purkyně, and philosophers and artists such as Plato, Goethe, the Impressionists, and the Op artists. The objective tradition follows from Aristotle, Descartes, Newton, and the color philosophies C.L. Hardin and Frank Jackson. This school finds its widespread applications in color science, contemporary physics, and technical color ordering systems such as the C.I.E. Lab color chart (1931), the NTSC color standards for broadcast television, and the newly approved xvYCC digital color space (2005).

My research methodology is critical of either of these extremes. Thus I synthesize both the objective and the subjective extremes into two intertwining discourses on media archaeology and phenomenology, respectively. The former traces the material and technical history of color recording, encoding, and reproduction in computing, while the latter reflects on the subjective experience of these colors and color technologies, in the world. I argue that perception cannot be separated from the technological and environmental situations that they occur in.

Each of my case studies support and advance this argument. These studies include an analysis of early experimental color systems made by collaborative teams of artists and programmers at Bell Labs in the 1970s, a history of infrared technology and the informatic perception it engenders, an archaeology of digital compositing in computing, and close readings of the artists and engineers who have critically engaged this topic. My results address issues in media studies, computer history, and perception studies.

Andrew Mamo

Computing Societies: Communications Technologies and Social Science in the Cambridge Project

This paper addresses the changing relationship between computer development and the behavioral social sciences during the Vietnam War years through the story of the Cambridge Project in the 1960s and 70s.

Argument: Project MAC (Multiple-Access Computing or Man And Computer) at MIT is best known for the development of time-shared operating systems, such as CTSS and MULTICS. A spinoff of MAC, the Cambridge Project, involved a collaboration between computer researchers and social scientists at both MIT and Harvard in the late 1960s and 1970s. It sought to make computing accessible to less technically-savvy social scientists, in the belief that digital computers, properly tailored to their needs, could spark a revolution in social science methodology and in the application of these theories for social reform. This type of applied social science fit a broadly liberal vision, as did the specific topics studied by researchers affiliated with the Project. The optimism with which the Cambridge Project began soon faded amidst Vietnam-era campus politics. Located at the intersection of social thought and high technology, the Cambridge Project's demise marked the end of a particular vision of communications technologies as vehicles for mid-century liberalism.

Evidence: I draw upon archival materials from MIT (the papers of the Cambridge Project, Project MAC, Robert Fano, and J. C. R. Licklider) and upon published debates concerning methodologies in political science and the nascent discipline of management science.

Contribution: This paper makes explicit connections between studies of computing discourses (such as Edwards' Closed World and Agar's Government Machine), studies of Cold War era social science (including Amadae's Rationalizing Capitalist Democracy and Gilman's Mandarins of the Future, and Light's From Warfare to Welfare), and of the collapse of the "liberal consensus" during the Vietnam War (Tomes' Apocalypse Then). The paper builds upon existing studies of computing at MIT by putting the technical developments in dialogue with the sciences of social management. The technical work of the Cambridge Project was explicitly designed for a particular political vision, and these ideas of social management had in turn been articulated in the expectation of the availability of computing power. This paper contextualizes the role of computing for American social science by situating it within transformations in America's role in the world in the 1960s and 70s.

Christopher McDonald, *Princeton University*

A New Nervous System of Society: The Technology and Politics of Mass Computer-Communications Systems

Inspired by the technology of computer time-sharing, a group of American academic computer experts in the 1960s and 1970s envisioned "a new nervous system of society." National computer utility networks would connect every individual to a world of information. These experts, and their social scientist allies, argued that national policy and planning were necessary to ensure this outcome. Without it, technological and social trends instead pointed toward a system in which access to information and computer power would be stratified and fragmented.

But their opinions, although widely discussed, were not widely adopted or acted on. Although social planning was at a peak of popularity in the U.S. in the late 1960s and early 1970s, no institutional focus existed for a national computer-communications policy. Moreover, the cost of a truly mass-media computer system at the time was extremely high, and the cultural image of computers in the wider public was one of bureaucratic machines for calculation and automation - not something most individuals wanted or needed to interact with.

Over the course of the 1980s, the cost of computers and communications declined dramatically, and the PC turned computers into a familiar appliance for many Americans. Political interest in the problem of national computer-communications policy surged in the early 1980s in response to the apparent successes of MITI in Japan and France's state-sponsored Minitel system.

But by the time the "national information infrastructure" became a major item on the American political agenda in the early 1990s, planning was politically unpopular. France and Japan had become warnings of the hazards of state interference. Most political leaders, in either party, believed that the optimal way to produce the best, most accessible technology for the American people was to unleash the forces of the free market. The 1996 Telecommunications Act reflected this philosophy. Ironically, what would become the dominant computer-communications framework, the Internet, came from neither a coherent national plan, nor free market forces.

Pierre Mounier-Kuhn, *Centre National de la Recherche Scientifique (CNRS)*

The Emergence of Computing as an Academic Discipline in France

I have written a few hundred pages on the emergence of computing as an academic discipline in France, which are now materializing in a book . What I am presenting here aims at summarizing this story, leaving aside the local or individual details and focusing on how historiographical models of « emerging scientific fields » apply to this case, in the view to stimulate international comparisons.

Basically, it appears that Thomas Kuhn's model of a « scientific revolution » does not fit , although his concept of « normal science » describes well what militant computer scientists of the 1960s wanted to establish. A « branching out » model is adequate to analyze a first period (1950s-mid-1960s), when applied mathematics, particularly numerical analysis, developed and struggled to assert their legitimacy in academic spheres dominated by the pure mathematics values of the Bourbaki group. It was under cover of these titles, and within these sub-disciplines, that computing education and research were hatched.

From the mid-1960s on, as academic computer practitioners addressed more and more problems of non-numerical nature (programming, systems, data- and file processing, machine translation, etc.), they had to integrate theories and intellectual tools which were not labeled « applied mathematics » : logic and various branches of algebra, formal linguistics, information theory… Simultaneously, specialists of these fields were attracted by computers, either by the computers' potential to test their ideas or by computers as problems. A « convergence » model aptly describes this second stage, for which several of Michael Mahoney' papers provide a detailed analysis framework . His concept of « agenda » is also an efficient tool to understand the policy of applied mathematics and numerical analysis in the earlier period.

Major milestones of this story were the mid-1960s, when the word informatique appeared in the titles of several university laboratories and the first debate was organized at the CNRS to decide whether a specific committee should be created for it (the answer was « no ») ; and the mid-1970s, when official recognition of this new discipline materialized with the creation of autonomous evaluation committees in the university and research system, while French and other European activists created an association for theoretical computer science.

I would be glad to discuss all aspects of this research, and eventually to broaden its historiographical background.

David Nofre, *Informatics Institute, University of Amsterdam*

The Dutch politics of computing and the limits of international cooperation, 1945-1965

In the early decades of the Cold War, Western-European computing centers sought to promote international cooperation. Two products of this cooperation were the creation of an Unesco's International Computing Centre in 1952 and the cooperation between US organizations and European centers in the late 1950s that led to the definition of the programming language Algol. In both projects, the Mathematisch Centrum in Amsterdam played a crucial role. The Dutch center saw in both projects the opportunity to fulfill its ambitions to turn Amsterdam into the European center of computing. The policy of the Dutch center shows the limits of promoting international cooperation in a period of strong involvement of nation-states in the development of computing infrastructures.

Argument: This paper will show how much international projects in computing were defined by national agendas during the Cold War. The making of Algol and the establishment of the Unesco's center were two projects clearly different in their content, elaboration and actual outcome. Yet they share some striking similarities from a historical point of view. First, both projects had their origins in attempts of Western-European countries in the late 1940s and early 1950s to join efforts to overcome their own limitations. Second, in both cases the result was divisive, controversial and unsatisfactory for the European centers. And third, in both cases the European centers questioned the role of the United States.

Evidence: I draw from unpublished material from the archive of the Mathematisch Centrum, the archive of the Netherlands national scientific organization (NWO), and the archive of the Belgium national scientific foundation (FNRS). The archives of Unesco and NATO provide complementary material. This material is examined together with the archives of US organizations involved in the Algol project, that is, IBM's users organization SHARE and the Association for Computing Machinery, and the Unesco's organization IFIP (hold at the Charles Babbage Institute and at the National Museum of American History). In addition, I draw on the personal papers of the main Dutch and American actors (J. Van der Corput, A. Van Wijngaarden, D. Van Dantzig, A. J. Perlis, R. Bemer, and H. H. Goldstine). Finally, I use the published correspondence of Mario Picone, head of the Istituto per le Applicazione del Calcolo -seat of the Unesco's center.

Contribution: Historians have long recognized the importance of the state in the development of modern computing. More specifically, Paul Edwards (Closed World) and Kenneth Flamm (Targeting the computer) have showed the role of military funding in the development of computing in the United States. For the British scene, Jon Agar (The government machine) has argued for recognizing the role of government bureaucrats in British computing developments. Similarly, Dutch historians have recognized the role of computing as part of the quest for the rationalization of society that characterized the postwar years (G. Alberts Jaren van berekening; A. v. d. Bogaard, et al. De eeuw van de computer). Building on these studies and David Edgerton's idea of 'nationalization' of British science and John Krige's study on science and US foreign policy (American hegemony), I will explore the links in the Netherlands between the politics of computing, the national scientific policy and the national agenda.

Larry Owens, *University of Massachusetts Amherst*

Walking Around Computerville: The PC and the Encyclopedia of Computer Science, 1976-1983

This is the story of a book, a moment, and a community – all of them of central importance in the history of computing. The book is the Encyclopedia of Computer Science, which made its first appearance in 1976; the community is those readers whose interests and livelihoods involved them with computing; the moment is that remarkable decade that witnessed the birth of the personal computer. More specifically, with the help of special software, this essay will explore the Encyclopedia as a virtual place, one in which the reader can "walk around," exploring the landscape and places of computing as they changed in that decade. These walkabouts among the neighborhoods of Computerville make possible observations both about the history of the personal computer and raise intriguing general questions about the nature of books and the ways in which books and readers co-construct one another and contribute, especially with working reference books, to the disciplinary worldviews of professional groups like computer scientists.

Buhm Soon Park, *Korea Advanced Institute of Science and Technology*

Chemistry by Computer: Machines and Ideas for Computational Chemistry

In 1992 the Science magazine reported the recent research trend in chemistry that might require a "serious overhaul" of the traditional image of chemical laboratory—the place of sharp-smelling chemicals on the shelf, beakers and other glassware at the bench, and a battery of analytical instruments. By contrast, it was observed, the practitioners of a new brand of chemistry were studying the structure and behavior of molecules in much less odoriferous environments "cluttered with software documentation, humming with computers, and glowing colorful monitors." Computational chemistry, or what was more provocatively called "odorless chemistry," came of age. New compounds and reactions could be predicted in silico without ever mixing solutions. This number-crunching practice found its usefulness especially in rocket fuel development, drug design, and polymer science. It is no wonder that the 1998 Nobel Prize in chemistry was awarded to two scientists, Walter Kohn and John A. Pople, for their development of computational methods of describing molecular properties.

The use of calculating machines for the study of molecular structure and behavior began shortly after the advent of quantum mechanics in the late 1920s, but it took many years for number crunching to be seen as a legitimate practice in chemistry. In this paper I will show the ways in which computational chemists took advantage of state-of-the-art computing technologies from hand-powered calculators to mainframe computers to workstations. Although computers were not specifically built for computational chemists, they were able to pool the available resources together for their benefit. They even led "chemists' first try at big science" in the 1970s by seeking to establish a national center for computational chemistry. How, then, can we understand the parallel-development of computer technology and computational chemistry? How crucial was technology to the progress of computational chemistry? I will argue that its practitioners could ride on the wave of technological development, no matter how big or small that wave was.

Stephen Patnode, *Temple University*

The Impact of Computers on Corporate Paternalism in the Post-war United States

This paper assesses the impact of computer technologies on labor relations and worker identity in the United States during the 1960s and 1970s. The paper draws upon rich archival sources and oral histories to examine the case of the Grumman Aircraft Engineering Corporation, a large defense manufacturer based in Long Island, New York. These records demonstrate that the company's introduction of computers facilitated new forms of management that disrupted labor relations and worker identities. This project represents an original contribution to the history of computers and engages with the work of gender, labor, and oral historians.

This paper builds upon the insights of Michael S. Mahoney, particularly his observation that historians must examine computer hardware and software in the context of the social and cultural networks where they were utilized. In order to do this, the paper also engages with the work of historians of science and technology such as Nina E. Lerman who have called for greater sensitivity to the issue of gender. Gender played an important role at Grumman. Prior to the 1960s, the company's management effectively played upon gender dynamics to foster employee loyalty and discourage union organization. By defining the workplace as a site of masculine identity formation, the company encouraged workers to believe that joining a union would actually reduce their autonomy within the workplace. This model represented a very successful form of corporate paternalism. The company supported the mostly male workers' sense of identity in a variety of ways. In return, these workers rewarded Grumman by rejecting unionization efforts.

However, over the course of the 1960s and 1970s, the company used computer based technologies (both hardware and software) to assert greater control over workers and alter its paternalistic relationship with employees. Computers allowed management to scrutinize workers' activities and limit their interactions within the workplace. Michael S. Mahoney suggests that the computer is what we make of it "through the tasks we set for it and the programs we write for it." In the case of Grumman, we find a specific instance where workers held up their end of the welfare capitalism promise, but management ultimately did not deliver on their end of the bargain. Borrowing Mahoney's concept of "communities of computing" in the most straightforward sense, in this case Grumman's management was a discrete community that decided to break from its traditional, tacit role in the larger, paternalistic corporate community. Workers thus experienced the introduction of computers as disruptive to their sense of both community and identity.

Rebecca Slayton, *Stanford University*

An Evolving Discipline: The Political Economy of Software Engineering

How does a field of expertise come to be recognized as a discipline without formalizing barriers to entry or agreeing upon a body of formalized knowledge? This is the concern that drives Chapter 7 of a book-in-progress, Arguments that Count: Physics, Computing, and Missile Defense, 1949-1989. The book aims to show how the rise of software engineering shaped public debate and scientific advising about missile defense. This work is partly inspired by Mahoney's observation that software engineering tends to elide categories such as "science" or "engineering." Chapter 7 focuses on primarily on the growth of shared practices attached to "software engineering" during the 1970s – including special interest groups, conferences, discussion about commonly recognized (if not always accepted) rules, and an archive of documented experiences – rather than on a "discipline" in any traditional sense.

There are two primary challenges for this chapter. First, the chapter aims to connect the content of software engineering as a discipline to its broader political and economic milieu. Throughout the 1970s, Congressional scrutiny into defense department projects increased dramatically, even as budgets tightened. I argue that these pressures both helped software engineers find a funding niche, and shaped two distinctive research agendas for software engineering. One was closely tied to management and keeping the total cost of software relatively low. A second research agenda was tied to concerns about the security and reliability of software in the face of newly networked computers.

As this caricature may suggest, the second challenge is to do some justice to the complexity of the divisions pervading the "software engineering," while nonetheless explaining why there is some cohesion. I have developed a reasonably large relational database for the purposes of analyzing coauthor relationships in the field. While it's simple enough to map networks, it is more challenging to map similar research interests. The primary methods of the book are much more qualitative, based on archival and other document-related research, and I am currently struggling with the challenges of integrating a more technical style of analysis. I believe that this might prompt some interesting methodological discussions of interest to historians of computing. I would also welcome comments of any sort, since Chapter 7 is drafted primarily in qualitative form and is currently in the process of revision. The book manuscript is approximately eighty percent complete in draft form (eight out of ten chapters are drafted).

Cristina Turdean, *Hagley Program - Department of History, University of Delaware*

Reimagining a Gambling Technology: The Digitization of the Slot Machine (1970-2000)

This paper is a chapter of my dissertation titled "Betting on Computers: Digital Technologies and the Rise of the Casino Industry in the U.S.(1950-2000)." A social history of computer applications in one of the fastest growing (and largely overlooked by historians) American industries, this project illustrates how computing machines and practices shape and are shaped by historical context. My dissertation argues that the late 20th century boom in casino gaming was closely connected to the massive and incremental introduction of digital technologies in virtually all aspects of casino activity, in a process that considerably altered the traditional ways of gambling, surveillance, entertainment, and management in gaming establishments nationwide. Nonetheless, this narrative stresses the technology-contingent roles played by policymakers, corporations, and gamblers in the public quest for the regulation and institutionalization of gaming.

In this paper, I discuss the development of the slot machine by looking at the gradual replacement of its mechanical parts with digital components, the ways in which the culture of the casino floor and the specifics of the mechanical machine shaped the evolution of its digital successor, and the opportunities it created for casino managers, gaming technology manufacturers, and gambling regulators. The narrative of deployment of digital technologies in casinos yields insight into the process of reimagining a technology by its designers and operators with the purpose of surmounting the problems associated with its use. I argue that the transformation of the mechanical slot machine into a digital device emerged as the technological fix devised by engineers and casino managers in reaction to the early machine's unreliability, vulnerability to cheating, and cumbersome auditing. In addition, the digitization of slot machines and their consequent integration within computerized information, communication, and control systems provided managers with the effective means to streamline the activity on the casino floor and broaden the casino customer base. This story also stresses the direct connections between the deployment of digital technologies in casinos and the rise of a corporate style of casino management, geared on high profits and performance. In the process, as the digital slot machine also came to serve the lawmakers' interest in ensuring a fair game for both casinos and players, gambling rose to public prominence as one of the favorite pastimes in the United States.

At this workshop, I am interested in comments on the possibility to (1) enhance the main argument of the paper and (2) improve the balance between the social approach and the use of detailed technical data.