Early Interactions between the Life Insurance and Computer Industries: The Prudential's Edmund Berkeley and The Society of Actuaries Committee,

1946-1952

by

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Abstract

This paper is a study of how representatives of one commercial user industry, life insurance, interacted with some players in the newly forming computer industry in the years after World War II but before the slae of any computers for commercial purposes. In particular, this interaction shows how pioneers in life insurance, including the Prudential's early computer expert and proselytizer Edmund C. Berkeley and a broader industry effort by a special committee of the Society of Actuaries, viewed computer technology and their potential use of it, as well as the ways in which they influenced its development. Both sets of actors played important roles in educating their own firms and the life insurance industry as a whole about the potential uses of computers for insurance, as well as communicating that industry's needs, especially in the areas of rapid input/output and verification needed for routine transactions processing, to computer vendors. These interactions suggest that the theme of co-evolution of information technology and its use in life insurance, previously established in a study of the tabulator era, continues into the early computer era. Thsi paper reinforces the notion that users can and do shape information technology, just as information technology has a shaping influence on the way users do work.

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Most studies of the advent of computers and the computer industry, such as those by Stern and Flamm, have tended to focus on the technology and its inventors and vendors, along with early government and defense users [1]. Commercial users are typically viewed as minor and peripheral players, considered seriously primarily in studies that focus on the workers whose jobs were affected by computerization [2]. Recently, however, increasing attention is beginning to be paid to users and their innovations, adoptions, and adaptations of information technology. James McKenney and his colleagues, for example, have looked at the important role played by Bank of America and American airlines, both large firms in major user industries, in the evolution of new, specialized applications of information technology in the 1960s [3]. Dirk de Wit and Jan van den Ende have examined the role of past history, managerial ideologies, and organizational cultures in organizations adopting and adapting computer technology in the Netherlands [4]. Others, such as Arthur L. Norberg, Martin Campbell-Kelly, and James W. Cortada, have examined the predecessors of computing equipment, punched card tabulators, and the role of users in the shaping of technology and markets [5]. My own work on the earlier history of insurance industry influence on and use of pre-computer technology, which forms the backdrop for this look at insurance industry interaction with the computer industry in its earliest years, also falls into this category of work [6]. In a recent special edition of the Annals commemorating "50 Years of Computing," several authors include or even focus on commercial applications in their contributions [7]. James Cortada, in particular, focuses on commercial use and calls for more industry-specific studies of early computer use. This paper provides one such study.

This new focus on the role of users in the history of computing, especially commercial (rather than solely government or university) users, is part of several broader movements in history and administrative sciences. The social construction approach, introduced into history of technology and championed by Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch in their 1987 book, *The Social Construction of Technological Systems* [8], shifted focus from inventors to the social systems (including users) around them, and from technical inventions to the broader technological systems of which they were a part. From a different historical perspective, economic historians such as Ross Thomson and Christine MacLeod have focused new attention on users and their role in innovation and diffusion [9]. Scholars of the management of innovation, such as Eric von Hippel and James M. Utterback, have similarly examined the role of users in this process [10]. As part of that shift in attention towards users, this paper examines early interactions between an industry that would become a major user of computers and the newly forming computer industry.

As my work cited above has shown, the life insurance industry had been a major user of the most direct commercial predecessor of computers, punched card tabulators, since before the beginning of the twentieth century. For insurance firms, the processing of data was not ancillary to the production of goods: information was their primary product, and information and document processing formed the production line of the firm. Thus it is not surprising that this industry was also one of first and largest commercial adopters of computer technology beginning in the mid-1950s. Insurance interest in and involvement with computers began, however, even before insurance firms began purchasing and using computers at that time. In his recent article, Cortada identified the period from 1945 to 1952 in computer history as one in which "Commercial uses were nonexistent" (except in defense-related firms) and stated that "Businesses...did not see an economic advantage in commercial applications of digital computers during this period" [11]. User industries learned about technology "mainly through publications, later from vendors," and did not really get involved with this technology until 1952 and after. A close look at one particular user industry shows, however, that key individuals and industry groups in the life insurance industry were ahead of this timetable.

This paper highlights some of the intensive interactions between individuals, firms, and insurance industry associations, on the one hand, and individuals and firms in the incipient computer industry, on the other, in the 1940s and up through 1952, during Cortada's first period and before the first computer was delivered to an insurance firm in 1954. This interaction shows how pioneers in this user industry viewed computer technology and their potential use of it, as well as their attempts to influence its developments in particular directions. Unlike the banking and airline stories told by McKenney, the insurance story does not end with the creation of a new computer product specialized to the needs of that industry or a firm in it, a route that some of the insurance firms had attempted in the tabulator era with unhappy results [12]. Instead, it shows their influence on and ideas about using computer equipment that would be more general purpose in nature, and thus attractive to other commercial users.

After a brief review of earlier interactions between insurance users and vendors in the tabulator era, this paper will focus first on Prudential's early computer expert and proselytizer Edmund C. Berkeley, and his interactions with the embryonic computer industry in the late 1940s. Then it will examine a broader industry effort by a special committee of the Society of Actuaries, led by representatives of Metropolitan Life. Both sets of actors played important roles in educating their own firms and the life insurance industry as a whole about the potential uses of computers for insurance, as well as communicating that industry's needs, especially in the areas of rapid input/output and verification needed for routine transactions processing, to computer vendors.

Insurance and the Tabulator Era

As I have explored in an earlier paper, the life insurance industry, as represented by its firms and its industry organizations, exhibited an early and enduring interest in punch card tabulating, beginning in 1890, the year in which Herman Hollerith's still-primitive tabulating system was first used to tabulate results of the U.S. Census, and continuing through the 1950s. Early tabulating technology included electro-mechanical and mechanical equipment for recording structured data on punched cards, sorting and counting this data by fields, and adding amounts in a designated field. The largest insurance firms, especially, needed a better way to handle their voluminous and long-held records. Thus they were among the very first commercial adopters of the technology, as well as among the most important user-groups shaping the technology as it evolved.

Initially, the insurance firms adopted tabulating technology simply to speed up manual processes of sorting, counting, and adding numerical data, and directly (through in-house innovations) and indirectly (through market decisions of firms and professional associations) encouraged developments that improved those functions. Most routine insurance functions, however, ultimately involved less calculation and more creation of transactional and control documents such as premium bills and internal management reports.

Thus from around 1910 on, insurance firms and industry groups used the same direct and indirect mechanisms to encourage Hollerith and his competitors in their development first of numerical printing capability, then of alphabetical sorting and printing capabilities. Metropolitan Life Insurance Company, the largest insurance firm in the world, contracted with an independent inventor, J. Royden Peirce, in an ultimately unsuccessful attempt to develop customized alphabetical printing tabulator equipment for that firm. Peirce's ideas for integrating multiple insurance functions using such technology were ahead of his time, but his mechanical abilities to realize the necessary machines were not. More importantly for most insurance users and technology vendors, insurance firms were among the earliest and most enthusiastic purchasers of the competing Powers printing and then alphabetical tabulators when they came on the market between 1915 and the early 1920s. In fact, in 1919 the largest British life insurance firm (the Prudential Assurance Company, unrelated to the Prudential Insurance Company in the U.S.) intervened directly, buying the British Powers agency and worked with it to develop the first successful alphabetical tabulating and printing machines; this technology was soon modified and introduced by Powers in America. Hollerith's successor firm (which became IBM in 1924) was forced to play catch-up, developing its own printing capabilities by around 1920 and (after becoming IBM in 1924) alphabetical capabilities by 1930.

In 1928 IBM moved from a 45-column to a patented 80-column card, allowing more data per card but introducing the first definitive incompatibility between IBM and Remington Rand (which now owned Powers) machinery. By the end of the 1920s IBM had purchased Peirce's patents and introduced its own alphabetical printing capability. Having caught up with and surpassed Remington Rand, it stayed safely ahead (establishing a sales advantage of about eight to one in the 1930s) through the rest of the tabulator era, at the beginning of the 1950s controlling 90% of all installed punched-card equipment in the U.S. [13]. In line with this general trend, many insurance firms, including such giants as Metropolitan Life and the American Prudential as well as many smaller firms, acquired large installations of IBM tabulating equipment by the 1930s. With their new capabilities, tabulators could be used to accomplish a wider range of insurance functions, and, in a few cases, to integrate these functions. For premium billing, for example, tabulators could be used to compute and print premiums due and policyholder names on the notices; in some cases this was combined with premium accounting functions for an integrated application.

From the 1930s into the 1950s, incremental improvements of tabulating equipment (by this time frequently referred to as electric accounting machines or EAMs, based on internal IBM parlance reflecting a common category of application that spanned many industries [14]) continued, often developed by IBM in close collaboration with customers in the insurance industry and other user industries. These improvements allowed the use of alphabetical printing more rapidly and with a wide array of continuous forms and carbon sets to achieve a range of internal and policy-holder documents. By the early 1950s, a Dallas-area regional survey of premium billing and accounting methods presented to a meeting of the Insurance Accounting and Statistical Association (IASA) showed a considerable increase in use of tabulating equipment for billing and related accounting functions, with over 40% of the firms surveyed using tabulating equipment for the entire premium billing and accounting process, including generating receipts, commission statements, and control checking [15].

By the early 1950s, IBM's calculating punches, both traditional electro-mechanical models and the new 600-series electronic models with vacuum tubes but no stored-program capability (introduced in 1948 [16]) were also being used increasingly for applications involving more calculations, such as renewal commission accounting, dividend calculations and accounting, and actuarial calculations [17]. These devices could be wired to conduct a brief sequence of calculations (limited by the wiring's capacity to hold pre-selected numbers and by the 80-column format of the cards) for a particular application; the calculation ended with the punching of a calculated figure onto a card. This newly punched figure could then be used as input into other, separately run operations such as premium billing and payroll generation. Thus new developments in calculating and input/output for punched-card tabulating equipment were making it possible for life insurance firms interested in reorganizing their business processes to integrate what had previously been several separate steps.

As Bashe et al, historians of IBM's early computers, note, "Insurance companies were among the largest and most sophisticated business users of punched-card machines in the late 1940s and 1950s" [18]. As a major user industry, life insurance certainly was shaped by as well as playing a significant role in shaping, tabulating technology in a co-evolution of information technology and its use. In addition, the on-going interaction between this major user industry and the technology vendors shaped both industries. Insurance business processes in many firms were built around tabulating equipment and cards rather than printed records; cards became a significant and familiar storage and manipulation medium for this information-intensive business. On the vendor side, IBM and its competitors learned to work closely with major user industries such as insurance, developing products in response to the needs they voiced. This earlier era and the close relations established between insurance users, on the one hand, and tabulating technology and vendors, on the other, set the stage for early interactions between insurance users and the new computer industry.

Setting the Stage: Before, During, and Immediately After the War

Insurance interest in computers, like that in tabulators, started early. Even before World War II, during which the developments in this area were radically accelerated by war needs, hints of this interest had appeared. As early as 1936, for example, E. William Phillips, a British actuary and the General Manager for Great Britain of Manufacturers Life, presented a paper, printed in the British *Journal of the Institute of Actuaries*, arguing that actuaries should switch from a base-ten system to octal or binary, in order to allow use of electronics in their calculations [19]. This paper had an important influence on a few key players in the story to follow, including John J. Finelli of Metropolitan Life [20]. As the next section demonstrates, Prudential's Edmund C. Berkeley was also involved in this area of study before World War II. During the war, many mathematically-trained actuaries and other insurance employees were recruited to work on military projects involving statistics and operations research [21]. They were involved in work such as improving accuracy of bombsights; working with Army statistics on casualty rates, personnel structure, retirement benefits; creating a strategy for anti-submarine warfare [22], and code breaking. In all of these areas, their work typically involved working with large-scale IBM data processing installations, though most of the technology was of the tabulator era. A few actuaries (such as Berkeley) worked directly with the new computer technology being developed during the war. In either case this experience, according to a historian of the actuarial profession, gave them "prompt appreciation of the potential in electronic computers" after the war [23].

In the immediate post-war era, the life insurance industry as a whole experienced rapid growth, and the cost of clerical labor grew rapidly, as well. Between 1948 and 1953, according to a Bureau of Labor Statistics (BLS) study, the number of insurance policies in force (which is a better measure of the volume of data processing work than is the monetary value of insurance in force) rose over 24%, and total employment in the life insurance industry grew almost 14%, as compared to just under 12% for total non-farm employment in the U.S. [24]. It also noted that insurance firms (including the one studied in detail in this BLS study, probably Metropolitan Life) had faced recurrent labor shortages in lower levels of clerical jobs since 1940. With already extensive use of pre-computer punched card tabulating equipment, a growing volume of information to handle, growing labor costs of information handling, and the exposure of many actuaries to new data processing uses and in some cases new computer technology, the insurance industry's interest in computing developments was not at all surprising.

Two post-war developments illustrate early interactions between insurance and developing computer technology, demonstrating the life insurance industry's view of, interest in, and influence on these technological developments: in 1946, the Prudential's Edmund Berkeley initiated serious discussions within his firm and with potential vendors on the technical specifications required to make computers useful for insurance applications, and in 1947 the Society of Actuaries established a committee to examine insurance applications of the new technology. Although both of these developments had unique aspects, neither was an isolated anomaly. Berkeley's intense and often technical involvement was paralleled by that of John J. Finelli of Metropolitan Life, one of the founding members of the Society of Actuaries committee, and that committee had counterparts in the Life Office Management Association (LOMA) and the Insurance Accounting and Statistical Association (IASA). Yet these two developments serve to demonstrate the nature of such interactions and some of the influences on insurance and on the early computer industry.

Early Insurance Involvement with Computers: The Prudential's Berkeley

Edmund C. Berkeley joined the Prudential in the Actuarial Department in 1938 [25]. As early as 1939 Berkeley, later described by Prudential colleagues as "a nut," "a genius," and "the most meticulous man I ever knew," was studying the potential uses of computing machinery (generally electromechanical at this point) and methods in insurance. In 1939, he visited Bell Laboratories to see George Stibitz's calculator, which he judged not to be applicable to insurance work [26]. In a series of memoranda and reports in 1941-42, Berkeley explored possible applications of symbolic logic (in particular Boolean algebra) to the Prudential's work [27]. In what appears to be one of his earliest documents on this work, he stated that the "the end product of the application of symbolic logic in a territory should be an algebra," then listed several such territories [28]. The first of these is now recognizable as a predecessor of computer programming for insurance applications:

Algebra of electric accounting punch card operations: which will deal with the operations under which punch cards are manipulated by International Business Machines. These operations include coding, punching, sorting, tabulating, reproducing, collating, etc. If a successful algebra is constructed, the most efficient and economical chain of machine operations to perform a given job will be able to be determined mathematically, and similar problems will be solved mathematically. This algebra (which will probably not be called an algebra at all) will probably be applied as a supplementary shorthand by experienced machine men in Departments equipped with IBM machines.

During the same period, Berkeley also engaged in discussions with Bell Labs about its electrical relay computing machine and General Electric about the "electric network calculating machine" it was experimenting with [29]. His reports from these contacts indicate that these potential vendors were learning about market needs from him at the same time that he was learning more about the technology. For example, in his report of the visit to General Electric's labs in Schenectady, NY, he records:

[T]hese men first wanted to know how we thought their machines might solve problems for us. I explained that my present purpose was to search out the correspondence between mechanical operations, abstract operations, and the operations taking place in an insurance company, with a view to a variety of applications of machines and abstract systems to insurance company problems....Mr. Kuehni inquired if we would be willing to pay from $100,000 to $250,000 for the development and production of a new machine. I said that, depending on clerical and other savings computed on reasonable assumptions, we would be willing, and that we were now paying an amount of that order in each year for [renting IBM] punch card machines and equipment. [30]

Further discussion centered on specific examples Berkeley provided of insurance tasks, such as classifying underwriting risks. In the ensuing discussion of coding and sorting rules, Berkeley pointed out the need, for such applications, of a machine that handled discontinuous, Boolean algebra, rather than an analog machine such as GE's electric network calculating machine. So even in this early period, Berkeley was clarifying his own thinking about potential uses of computing machinery and decision criteria for assessing such devices. Moreover, he was providing market information about a large potential user firm and industry to vendors.

Berkeley spent the period from 1942-46 serving in the Naval Reserves, stationed for part of that time at Harvard, where he observed the use of the Mark I computer developed jointly by Harvard's Howard Aiken and IBM, and worked with Aiken on constructing the Mark II automatic sequence controlled calculator [31]. When he returned to Prudential in 1946, Berkeley became a Methods Analyst, focusing on how to improve the methods and systems by which work was accomplished at Prudential, rather than returning to the more narrowly focused Actuarial Department. Berkeley's investigations into new computing technology were now central to his activities. For example, he reported that from August 1 to December 31, 1946, he initiated a total of 60 visits with individuals or groups to discuss applications of the new computing technologies to insurance [32].

As a result of these activities, he wrote a series of reports including one entitled "Sequence Controlled Calculators for the Prudential - Specifications - First Draft, November, 1946" [33]. By this time he had clearly determined that his company should order one of these computing devices. This report represents his first of many attempts to formulate and communicate his firm's needs to the nascent computer industry. Many of his tentative specifications would turn out to be simple to meet and exceed with the new electronic technology, as will be seen below, while others would not be met for decades (e.g., his demand for unattended overnight operation of the machine). Still others would influence computer vendors (particularly the makers of the Univac) in their development of a general-purpose commercial computing machine. This draft illustrates that Berkeley had complete faith that new "large scale calculating machines" or "sequence controlled calculators" would soon be introduced into business and "become indispensable." Significantly, he closed the report with the following interesting "specification":

There should be close cooperation at all stages between the manufacturer and the Company [Prudential], in regard to the design and development of the machine and other features, so as to make the fullest use in the Company of all applications of devices developed for the machine, etc.

In this passage he revealed the importance he placed on the interaction between user and technology developer. He was not simply waiting for a commercial product to reach the market--he was determined that he and the Prudential would play a role in shaping the development of a product for its use.

In addition, on December 6, 1946, Berkeley ran what he claimed to be the first insurance problem ever to be run on a sequence controlled calculator, a problem which involved a complex set of table look-ups and computations to compute the costs for a change of policy, using the Bell Laboratories general purpose relay calculator [34]. He went on to explain that "The purpose of this trial was to prove beyond the shadow of a doubt that a sequence controlled calculator can easily perform an insurance company calculation with many successive steps," a goal he achieved. Thus as early as this, Berkeley was examining the types of insurance processes that could be aided by a computer and experimenting with the logical sequences of steps needed to accomplish such processes.

Berkeley's Educational Mission

During the first half of 1947, Berkeley's activities revolved around two missions: educating the Prudential's management as well as the insurance industry at large about the technology, and communicating with potential vendors about the Prudential's needs. On the educational front, he continued to write reports and memos educating his superiors about the nature of the rapidly evolving technology and its potential applications to insurance, as well as possible methods of paying for its development [35].

His list of potential insurance applications for a sequence controlled calculator ranged from actuarial problems involving complex calculations but limited outputs to routine operations with little calculation but considerable input and output, such as the premium billing process handled by tabulating equipment at many firms. In early 1947, he also considered various modes of financing development, from cooperating with other insurance companies or government agencies to doing it alone, spelling out advantages and disadvantages of each [36]. He reached a preliminary conclusion that the government had already funded much development, and that expecting a single manufacturer to finance the rest of the development would result in slow, uncertain, and costly development. Thus an association of large potential purchasers of such equipment would be most advantageous.

He also extended his educational mission outside of the Prudential into the broader insurance community via presentations to several insurance associations. In a paper presented to the Society of Actuaries in May, entitled "Electronic Machinery for Handling Information, and Its Uses in Insurance" [37], he described the new technology by analogy to calculators and punched card tabulators, connected in series, with a pre-set sequence of operations, and requiring no human movement of information from one to the next. He asserted that the current $100,000-$125,000 cost of such computing machines, as quoted to him by vendors, was much less than that for a comparable tabulating set-up and its operators, and described the range of possible insurance applications, as he had done for his own management. He ended by mentioning the two key motives that insurance companies would continue to cite for adopting computers: reductions in clerical labor and the ability to undertake calculations not feasible in the past. Three other members of the association (Mssrs. Barber, Wells, and Rieder) commented on the paper, showing a range of visions of what this new technology could do for the actuarial profession and the insurance industry [38]. Barber and Rieder underscored Berkeley's emphasis on the ability not just to process information more rapidly, but also to rethink what information is processed and how. Rieder noted favorably Berkeley's observation that the actuarial formulas developed in the nineteenth century were selected in great part for ease of manual computation and extended it: "If this thought is carried far enough, we arrive at the surprising conclusion that the whole structure of life insurance as we know it to-day can, in large measure, be traced to computation limitations." He went on to speculate about how certain common insurance practices might change once this new electronic computational machinery was available to the industry. Berkeley's work (along with that of the Actuarial Society's committee, also mentioned by Barber) clearly stimulated the thinking of other actuaries about potential uses of computers.

In addition to his presentation at the Actuarial Society, Berkeley extended his educational efforts to two other insurance associations. In 1947, Berkeley also presented a paper to the Insurance Accounting and Statistical Association on using computers to aid in insurance underwriting [39]. In the same year, he also presented a more general paper about "Electronic Sequence Controlled Calculating Machinery, and Applications in Insurance" to the Life Office Management Association (LOMA)[40]. Although this title is quite similar to that of his Actuarial Society paper, here he focused more on the nuts and bolts of computers and how they would reduce the costs of office management for life insurance firms. After a brief description of the principles and components of such equipment, he listed several new types of devices, not yet in existence, that insurance offices would need to go with the computer itself: translator devices between magnetic tape and other media (printing devices, card or paper tape), a verifier to check information on one magnetic tape against that on another, and a selector device to allow rapid selection of information on a magnetic tape. Again, he was creating a larger group of insurance managers educated in what would be needed to use computers in commercial settings such as insurance. He listed a wide variety of potential applications, but focused in on how such machinery could be used in one specific application, maintaining a medical index. He also noted the activities of a recently formed LOMA committee, called the Electronic Sequence Controlled Calculator Committee, which he had been instrumental in founding [41]. At this early point the Committee's activities already included four meetings and two visits to existing experimental computers at Harvard and the Moore School. During this period, then, he proselytized in the insurance industry at large, as well as within Prudential, sharing his growing understanding of the nature and potential of computers with his colleagues in at least three insurance associations.

Berkeley's Communication with Vendors

In addition to these educational missions, Berkeley also began talking seriously to potential vendors about developing a sequence controlled calculator or computer for the Prudential, soliciting and receiving a series of proposals responding to his initial draft specifications and conversations. Engineering Research Associates, Inc. (ERA), for example, proposed that the Prudential, possibly in conjunction with Metropolitan Life (with whom ERA was also talking), sponsor the development of such a sequence controlled calculator or a more special purpose insurance calculator. Proposals also came from Raytheon, Electronic Control Company (ECC), later renamed Eckert-Mauchly Computer Company (EMCC), and others [42]. Berkeley had talked with John W. Mauchly of ECC at the Symposium on Large Scale Digital Calculating Machinery that he attended at the Harvard Computational Laboratory on January 7-10, 1947 [43], and initiated extensive follow-up correspondence with him. In addition to the detailed formal proposal, there was on-going informal correspondence between Berkeley and John Mauchly to discuss details of the proposal [44]. Of the potential vendors, Berkeley favored ECC, because of both the specificity of its proposal for developing the Univac and the extent of its relationship with him, apparently cultivated by both sides. By May 16, Prudential had received a second proposal from ECC, taking into account this informal correspondence.

Berkeley clearly demonstrated his desire to shape ECC's Univac, still in development at this point, to assure that it met Prudential's needs. He recognized that in choosing this option, he was electing to go with a general purpose computing machine, rather than a special purpose one developed for life insurance. In fact, in subsequent correspondence negotiating the exact terms and wording of the contract, Berkeley noted to Eckert and Mauchly that Harvard's Aiken had approved of Prudential's decision, but also had suggested that special purpose machinery designed for insurance might be even more useful. Berkeley went on to reassure them, however, that "we are convinced that we should have general purpose machinery" [45]. Nevertheless, the desire to shape this general purpose machine remained. As Arthur Norberg has noted in relation to ECC's second proposal "the role of the customer in helping to set objectives is fairly explicit" [46].

The initial, February proposal illustrates the issues where, at ECC's invitation, the Prudential was applying pressure on developments. In one section of the first version of the proposal, ECC used a two-column format to display Berkeley's specifications against ECC's ability to fulfill them. On most internal *computational* issues, ECC's specifications already surpassed those proposed by Berkeley. Only in his desire for rapid random access to stored tables did Berkeley's computational desires exceed what ECC felt it could easily deliver. There, the problems of searching sequentially accessed tape posed problems. Berkeley's desires in the area of *input and output*, however, caused definite difficulties for ECC. For example, Berkeley wanted an auxiliary machine for translating data and instructions into some special medium readable by humans as well as by machines (he suggests punched paper tape) to allow checking of input. At this point, Eckert and Mauchly envisioned direct entry of policy information onto magnetic tape via keytape recorders, and they saw this tape as the sole storage medium. They noted that magnetic tape was not readable by humans, but it could be sent through a printer and printed out for checking. Moreover, the passage went on to suggest:

Proof-reading by visual methods and other methods which involve human scanning of the entire data for detection of errors are not in general to be recommended. More efficient methods of detecting and correcting errors can be devised for use with this equipment.

Berkeley was not convinced. Both verification of input and visible output remained important for him. Finally, machine *accuracy* or *reliability* was also an item for which Berkeley lists desired specifications (no more than one machine error/failure per month), a specification Eckert and Mauchly claimed to be able to achieve.

The input issue arose again in the section on insurance applications. In this section, Eckert and Mauchly also considered how their machine could handle three types of problems the Prudential (and other insurance firms) faced: premium billing, mortality studies, and group insurance. Of these, they noted that the premium billing application was the largest, the most interesting, and the most likely to generate cost savings. Implementing such an application would, of course, require a large up-front conversion. While they saw direct entry onto magnetic tape as the probable method of a one-time conversion, they also noted that the Prudential, which had not yet converted its premium billing to tabulating equipment, "could start now to convert the information onto punched cards with IBM or Remington Rand punch machines. The information on these punched cards could then be converted onto the tape by readers at a later date." This may have been the beginning of ECC's realization, which would grow rapidly in the next two years as the young firm interacted with more insurance companies, that direct entry and the abandonment of all cards was not an attractive option to many insurance (and other commercial) firms already using extensive tabulating installations. As a subsequent section demonstrates, Berkeley was more accepting of magnetic tape than many others in the insurance industry, but even he wanted the data to take a visible form, as well. As the Society of Actuaries study described below suggested and subsequent history confirmed, most firms were loath to give up the visible punched holes on cards for the invisible electric charges of magnetic tape. Most insurance firms would not abandon cards as a mainstay of their data operations for almost two decades, and some kept them until quite recently for limited uses [47]. ECC and its successors, EMCC and the Univac Department of Remington Rand, would have to develop a line of card-to-tape and tape-to-card devices to support input-output operations.

A few days after receiving ECC's second proposal, Berkeley wrote his superiors recommending that the Prudential inform ECC of its intent to sign a development contract with that firm [48]. He based his support of the proposal on several factors. He argued that "[s]uccess [was] [v]ery [l]ikely," "[s]aving [v]ery [g]reat," and "[p]urchase [p]rice [l]ow" (in fact, he claimed that "This whole purchase cost [ignoring a one-time conversion cost] is less than 1/2 year's annual rent paid to International Business

Machines for the punch card equipment used in the Company"). Berkeley also argued that Eckert and Mauchly could achieve reliability of internal computer operations "of the order of not more than two or three brief mechanical failures a week," a conservative estimate less than his specifications and ECC's claims, but adequate to convince his superiors. Also cited in ECC's favor was the fact that the young firm had other governmental and commercial customers also contributing to development, including the Bureau of the Census, Northrop Aircraft Co. and, as soon as a pending contract was signed, A.C. Nielsen Co., thus assuring that the cost of development would be shared with a group of commercial firms.

In addition, Berkeley argued that ECC had not only the scientific knowledge to create such a machine, but also the best "understanding of our problem as a business problem instead of a scientific problem" of the firms working to develop such machines at that time: "For example, they alone of our prospective suppliers wished to come and survey in a day or two our typical problems at no cost to us, saying it would be very valuable to them to know if their machine could not handle our problems." Probably as a partial consequence of their lack of such knowledge of business applications, other potential suppliers of computers such as Raytheon, ERA, and the Moore School, Berkeley noted, "have hardly begun to investigate thoroughly input and output devices, large automatic files, etc. for business applications." While IBM would be better known for its industry-oriented development and marketing efforts in subsequent years, at this point Berkeley also felt that ECC was more proactive in its approach to this representative of what would be a major market segment for the computer industry. In his recommendation, he argued that such a contract would provide salutary "[c]ompetition for IBM."

Indeed, if Berkeley clearly favored ECC, he had even more clearly rejected IBM as a potential supplier of these new types of machines. In a confidential memo and notes for a meeting that Berkeley wrote a few days before receiving the second ECC proposal, he had laid out a series of objections to IBM [49]. He argued that because of IBM's stake in current tabulating equipment, "it would be excessively costly to IBM to quickly introduce more modern machinery using electronics and magnetic tape instead of relays and punch cards." Indeed, "IBM has a record of long delay (or suppression) in the introduction of new devices." He criticized IBM reliability and engineering design as well, specifically pointing to problems Aiken had experienced with the IBM-built Mark I, causing the complete redesign of the relays for Mark II. Finally, he noted IBM's policy of secrecy about new developments until devices were ready for the market, a factor that may well have loomed large for someone like Berkeley, who wanted to be involved in developments in this area. All in all, he judged that "there is no prospect of modern electronic machinery from IBM before the next four or five years elapse and probably much longer." While his indictment is damning, his desire to make a radical break with IBM and the tabulating technology of the past was extreme for the insurance industry, as subsequent widespread insurance adoptions of IBM 650 punched card computers made clear. A list of questions and issues he wrote out for himself in preparing for his meeting with a vice president and other superiors indicated that even then, his superiors were considering additional, opposing factors, including "possible decline in the value of our investment in IBM" (Prudential was a major source of funds for IBM at that time) and "possible pull by IBM at the time we approach the Board of Directors for authorization."

The Contract and Beyond

Berkeley evidently carried his point concerning ECC, for within two weeks, Prudential assured Eckert and Mauchly that it intended to enter into a contract, and started a series of negotiations that resulted in a development contract for what would become the Univac, dated 4 August 1947 [50]. The contract as signed had a series of developmental milestones but an option rather than a commitment to buy a machine after the development phase. It also included arrangements by which EMCC (as it soon was renamed) would pay back Prudential's share of development costs once the Univac was being sold to other customers. Interestingly, the contract included card-to-tape and tape-to-card devices, indicating the Prudential's decision not to go solely with direct entry to magnetic tape and forcing EMCC to develop such devices. An earlier report from EMCC to the Prudential had noted,

It is agreed that it is desirable for Prudential to be able to convert data stored on punched cards into data stored on magnetic tape, should the UNIVAC System be installed. It would be inefficient to have any reasonably large amount of data transferred by means of a human operator and keyboard. The logical solution therefore is to design and construct a device which will read the holes punched on the cards, translate this into electrical impulses, and then record these pulses on magnetic tape. [51]

In spite of the signing of this contract, and in a move probably required to satisfy his more conservative superiors, Berkeley also pursued discussions with IBM about new equipment (primarily tabulating equipment, but with enough intentional vagueness on IBM's side to allow it to include electronic equipment, as well) to handle its premium billing application, discussions which eventually led to the conversion of the Prudential's premium billing and accounting to IBM tabulating equipment around 1950 [52].

Over the months following the signing of the initial contract, EMCC constantly missed milestones and renegotiated them with the Prudential [53]. In spite of these delays, and with Berkeley's urging, in late 1948 Prudential signed a contract to purchase a Univac, which was to be delivered in June of 1950. Meanwhile, in the summer of 1948, however, Berkeley had left the Prudential to enter the newly emerging computer industry, leaving others to carry on his work, though none as knowledgeable as he.

Delays continued from the purchase contract in 1948 through 1950, when Remington Rand purchased EMCC [54]. Soon Remington Rand, recognizing that the Prudential's $150,000 contracted price was much too low, tried to renegotiate. In 1951, Remington Rand ultimately succeeded in canceling its contract with Prudential (and with another early backer, A.C. Nielson), by offering to return the $30,000 already paid on the initial developmental contract upon cancellation, and at the same time by threatening to set up EMCC as a separate firm again and to allow it to go into receivership if Prudential refused to cancel [55]. After Prudential agreed to cancel the old contract, Remington Rand attempt to sell it a new Univac contract, this time for $1,250,000, and the two firms worked together to conduct a test of a Univac application to handle premium billing and dividend and commission calculations. According to a later account, however, after Prudential observed the apparently successful demonstration in December 1951, "It was decided that the UNIVAC would not be economical for our use."

Implications of Berkeley's Role

While Prudential did not ultimately install a Univac (it switched allegiance back to IBM), and turned out not, in fact, to be one of the first handful of insurance firms to computerize, Berkeley's activities clearly played an important role in early exploration of applications for computers, the publicizing of such uses within his own firm and in the broader insurance industry, and the conveyance of much information on insurance applications to the embryonic computer industry. His early proselytizing to members of various insurance organizations helped shape perceptions of what computers were and why and how they should be used in insurance firms. He argued that with appropriate modifications to input and output peripherals, computers could be used, not just for complicated calculations, but for the routine information and document processing transactions then handled by tabulators and other office equipment. His early movement away from actuarial and towards large operational applications was the first instance of what would become a common movement, reflecting his and the insurance industry's desire to reduce growth in clerical labor. Although new, previously impossible actuarial calculations were intriguing, that was not where the largest initial gains lay for the firms. He, like many executives of other insurance firms to follow him, initially thought more about speeding up existing processes than reconfiguring them totally. He also demonstrated some of the factors insurance firms would find important in their decisions to obtain particular computers as well as to use them for certain types of applications. Berkeley was more willing to move directly to magnetic tape than many other insurance executives would prove to be, but he, too, saw the need for some *visible* medium to supplement the invisible magnetic records.

Moreover, Berkeley and the Prudential had some influence on the development of the Univac itself. A few years later, officials from Remington Rand were to give the insurance industry, and Prudential by implication if not by name, a great deal of credit in shaping the Univac. As George Boyd, General Manager for Insurance Markets at Remington Rand in 1950 [56], said a few years later, "Almost from its inception in 1947, UNIVAC has been associated closely with insurance. Specifications from one large life company [Prudential], one other commercial company [A.C. Nielsen], and the Bureau of the Census, determined the completion of its design in 1949" [57] Another Univac official discussed more specifically what that computer's design owed to studies conducted for these three organizations:

The results of these studies showed that while the arithmetic units which were common in the many different computer developments at that time were quite adequate to do the commercial processes needed, the primary requirement was to get data into the computer's internal memory and arithmetic system rapidly, and get the computed results out rapidly; that the computer mustn't be tied up to the slowest speeds of keyboard input devices, or output printing devices; that these must be separate units and, furthermore, for commercial work, that the equipment must be completely self checking. [58]

Indeed, we have seen that Berkeley and the Prudential put EMCC on notice, via the contract to purchase a Univac, of its need to develop and make available card-to-tape and tape-to-card converters for those firms that wanted to hedge their bets and maintain their card files. Moreover, as the quotes above suggest, he helped shift the emphasis from internal computation, useful in scientific and defense applications that had previously been the most important uses and potential uses, to input and output devices and verifiers, forcing EMCC to confront these essentials for insurance and many other commercial uses. Thus Berkeley was an important agent of insurance influence on the emerging computer technology far before commercial influences are generally assumed to be present.

Finally, he seems to have influenced the competitive dynamics of the computing industry. By persuading the Prudential to back Eckert and Mauchly, he helped keep their efforts alive until they were taken over by Remington Rand in 1950. At the same time, he unintentionally motivated IBM to greater efforts. In spite of the sop to IBM in the contract for converting premium billing and accounting to IBM tabulating equipment, the Prudential's backing of Eckert and Mauchly came as a shock to IBM. Thomas J. Watson, Jr., later noted that "The first UNIVAC wasn't due to be ready for years, but with nothing more than a paper description Eckert and Mauchly won financial backing from two of our ten biggest customers--the Census Bureau and Prudential Insurance--and at least one other insurer besides. When Dad found out about that, his skepticism [about Eckert and Mauchly's business venture] turned into fury." When Thomas J. Watson, Sr., questioned one of his senior engineers about what he would do about the defection of the important insurance industry and received what he considered an unsatisfactory answer, Watson replied, "We can't think and intend when insurance companies are backing this outfit to build machines! [...] This business wasn't built that way!" [59] From that time on, according to Thomas J. Watson, Jr., his father focused seriously on the threat from computers and how IBM would answer it.

The Society of Actuaries Study of Computing

At the same 1947 meeting of the Actuarial Society (in 1948 renamed the Society of Actuaries) at which Berkeley delivered his address on computers and their potential applications in insurance, a committee of that association was formed to undertake a study of the potential of the new electronic calculating equipment on the horizon. Initially constituted the *Committee on Society Participation in Development of Calculators* and in 1948 renamed the *Committee on New Recording Means and Computing*

Devices, it was composed of two representatives of Metropolitan Life Insurance Company (Malvin E. Davis, Vice-President and Actuary, who served as committee chair; and John J. Finelli, Assistant Actuary), one from Connecticut Mutual Life Insurance Company (William P. Barber, Jr.), and one from Equitable Life Assurance Society (Walter Klem, Vice-President and Associate Actuary) [60]. Finelli was Metropolitan Life's parallel to Berkeley in computer involvement and expertise, though unlike Berkeley he stayed in the insurance business for his entire career.

Here, however, the activities of a life insurance association, not those of an individual, are our focus. As noted above, both LOMA and IASA had similar committees; nevertheless, as a representative of the most prestigious and the most professionalized segment of the insurance industry [61], as well as that most involved in issues of calculation, the Actuarial Society committee was initially a very visible representative of the insurance industry to vendors. Moreover, its study is well-documented in a series of reports issued from 1952 to 1957 [62]. Its early activities (through 1952) will be my focus here.

This committee's activities from its founding in 1947 to 1952 are described in its initial, multi-part report of its activities and conclusions originally presented orally in 1952 to the Society of Actuaries and to a Special Meeting arranged by the society but including some outside vendors or potential vendors such as IBM and Remington Rand's Univac Division (p. v). This report, which was subsequently produced in book form for distribution, reveals much of the interaction that took place between the life insurance industry (as represented by the Society of Actuaries) and the computing industry well before the first computers would actually be delivered to firms in 1954. Some of this activity involved communicating industry needs to vendor firms. As Metropolitan Life's Malvin Davis, chairman of the committee, explained in his part of the report, "We are not going to build this equipment. There are many manufacturers very much better qualified to do that. What we can do is to know our job well enough to be able to tell about it in terms that the manufacturers can use" (p. 25). Indeed, the Committee worked closely with at least two firms which would be major vendors to the insurance industry in a later period; although the two firms remain unnamed, internal and external evidence identifies them clearly as IBM and Remington Rand's Univac Division. The report also provides considerable information on the flow of information about computing into the insurance industry, and the early development and spread within the insurance industry of ideas about how insurance might use this new machinery. In this effort, Committee members essentially picked up where Berkeley left off when he left the insurance industry (though their early activities actually overlapped with his late ones), educating both vendors and the insurance community on the possible uses of this new technology in insurance.

The Committee's Founding and Investigation

In describing why the committee was established, Davis, the chairman of the committee, explained why the actuaries undertook this investigation of the new computing devices that had emerged from the war:

Now one part of the insurance business where more than elementary arithmetic is applied is in the actuarial part of the business, so naturally actuaries began to wonder whether such computers could be of assistance to them. How was an actuary to find out? When he tried to do so, he quickly learned that life insurance people and electronic engineers were two groups who did not speak each other's language. He found electronic engineers quite willing and anxious to have their ability and experience applied to the changes necessary to take computers out of purely laboratory work and into the business world, but they were lacking an adequate picture of the kind of facilities the business world needs. On the other hand, actuaries and others in the life insurance field were also lacking a sufficient understanding of the type of equipment which it would be reasonable to expect for insurance use. It became apparent that some medium was necessary to bridge the gap between the two. (p. 4)

Thus Davis and his committee, like Berkeley beginning even earlier, felt that two-way communication between the vendors and life insurance companies was necessary. Davis went on to explain that actuaries chose to attempt the necessary bridging jointly through the Association to save each firm from having to do it independently:

Accordingly, four years ago the Society of Actuaries appointed a committee to examine into the new recording means and computing devices which were becoming available and to report when it felt that such devices had been developed sufficiently for business use so that life insurance companies could consider their possible employment. (p. 4)

During the next four years, this Committee undertook extensive investigation both of developments in equipment and of possible applications of that equipment to life insurance work. At the time of the 1952 report, Davis noted, these machines were no longer

...purely computing machines capable only of a large amount of arithmetic. In recent years, some very important improvements have converted them into machines capable of a wide variety of operations. Nowadays we must think of them as *information processing machines* with computing representing just a part of their total capabilities. (p. 5)

The Committee's activities would be a factor in this shift.

Davis's overview of the committee's activities included some simplified explanations of how some of the new technologies worked, including, for example, magnetic tape and mercury delay tubes, before turning to its central topic, insurance applications. The report itself did not name specific vendors and tried to avoid favoring one type over another (particularly important since both IBM and Remington Rand were in the audience for its presentation). However, after mentioning that there were 25 to 30 electronic computing machines in existence (a number which undoubtedly included some machines we would now consider electronic calculators rather than computers), mostly of the punched card type, the explanations of the technology focused primarily on the new elements, especially magnetic tape as a potential medium. In the Society study, as in Berkeley's studies, they focused on input-output issues, as well as on the problems of sorting with a sequential medium such as tape, programming, and verification of accuracy at various stages. The input problem clearly seemed best addressed through card-to-tape converters, available by 1952, rather than through direct entry. The output issue, at least for magnetic tape computers, was more problematic, but they felt it was on its way to a solution:

Today to convert answers which are in punched card form there exists the regular line of tabulators which are very rapid printing mechanisms. A corresponding high speed printing machine to read answers from magnetic tape does not exist. Magnetic tape information must be converted to readable copy by a slow one-character-at-a-time typewriter which is actuated by a magnetic tape reading mechanism and, because of the relatively high printing cost involved through use of such a machine, it does not appear to be very useful on a large volume of such work. Higher speed printers operating from tape, however, are in a very advanced state of development, so much so in fact that for our purposes we can practically regard them as an accomplished fact. (p. 12)

Sorting was another problem that concerned them, especially since at this point they still thought in terms of the separable sorting, counting, and calculating steps of tabulator operations. In fact, they note that computers using magnetic tape "are most efficient when the amount of sorting involved is kept down to a minimum" (p. 12). Davis also noted the importance of programming and the need to develop more efficient methods than were then available, including developing libraries of standard procedures to draw upon (p. 14). Finally, he mentioned that at least one of these machines (he was probably referring to the Univac) had a complex system for checking results at each stage, a system which involved the use of a special pulse attached to each character for the purposes of verification.

Insurance Applications

After this brief consideration of the technology itself, Davis also summarized the Committee's considerations of possible insurance uses of the new computers to explain why the rest of the report focused on a particular application set (pp. 15-16). Not surprisingly, back in 1947 and 48 this committee of actuaries started by considering computation-intensive actuarial investigations such as mortality studies and financial analyses. While these applications were attractive to them and could certainly be handled by the technology, investigation convinced the committee (as it had Berkeley) that the such work was generally not large enough in volume to keep a computer busy enough to pay for itself. They then turned to operational applications.

The concept of maintaining a large electronic file of policy information that could be stored compactly, updated electronically, and used to look up information on any policy was compelling to them. Since large firms had literally millions of policies, electronic rather than paper or card storage of policy records could save enormous amounts of space, as well as time. But the Committee encountered two main problems. First, the technology at this stage simply did not support efficient random access to policy information. Searching would have to be sequential and thus too slow for many uses. Furthermore, there were significant issues concerning the legal standing of such records, especially in magnetic tape form, to the various state insurance departments and the courts as the primary records on policies:

For one thing, how do we know, for example, how long it would take for policy records which are recorded on magnetic tape to be acceptable to the various Insurance Departments? It has only been within the last few years that some State Insurance Departments have accepted a printed form of annual statement. Microfilm copies are still not acceptable in some courts. How acceptable a completely invisible magnetic tape record would be to the business community at large certainly is a very important question and one that is not likely to be resolved in a short time. We concluded, therefore, that regardless of how excellently magnetic tape might substitute for existing kinds of policy records we would probably need a visual record of the account with the policyholder which would be generally accepted by the courts and regulatory bodies--at least until wide use of tape has become commonplace. (p. 16)

Thus the Committee rejected this application, as well.

Ultimately, like Berkeley, the Committee concluded that the real gains to be made with electronic computers were in the areas of routine transactional processes, especially premium billing and accounting. This task involved computing dividends and loan payments on policies, sending out notices of premiums due and statements of values, and conducting the related accounting and control functions. Thus it focused its attention on figuring out how best to use computers, of both punched card and magnetic tape varieties, in such work.

The Committee established several principles or "guide posts" for such computer applications:

1. An electronic computer should be applied to the whole job, not to some separately departmentalized piece of it. [...]

2. Small jobs should be combined with others. [...]

3. Source records should be consolidated. [...]

4. Make all calculation at one time. [...]

5. Use a self-checking machine. [...] (pp. 22-23)

The first four principles (and particularly the first principle) were important in their implications for firm structure. Clerical tasks in high volume insurance operations were quite subdivided, and tabulating equipment, though itself often situated in a centralized tabulating department, had in some ways exacerbated that subdivision. As noted in the earlier section on the tabulating era, in the 1947 to 1952 period during which the Committee was doing its work some firms were installing better integrated premium billing systems based on tabulating equipment. In most insurance firms, however, different departments handled each aspect of servicing a policy (e.g., policy loan payments, though part of the premium billing process, were generally handled by a separate department than that figuring the premiums). The Committee recommended handling such jobs as a whole, as well as consolidating source records and different small jobs. The final principle focused on the need for accuracy in conducting millions of operations, a concern to Berkeley and other business users, as well.

The centerpiece of the Committee's work was what it termed the Consolidated Functions Plan, which was intended to be a general plan applicable to both card- and tape-based computers, and which was worked out and tested based on the procedures of one firm (clearly Metropolitan Life). In his section of the report, John J. Finelli described this plan as it would work on one small-sized, card-based computer (which he identified in a later article [63] as the IBM Card Programmed Calculator) and one tape-based computer (the Univac). Although this plan consolidated several previously separated insurance tasks, as described above, it separated sorting and output from the actual computing, delegating them to different machines and, in the case of magnetic tape computers, to different media. In both cases, input was in the form of two eighty-column cards (one with the address visibly typed on it, as well), though these were converted to magnetic tape via a card-to-tape converter for the latter computer. In addition to retaining punched cards, the plan also included one typed "history card" with a history of premium payments and other facts. These three cards consolidated what had previously been 10 different cards or files of various sorts (other check-off and accounting cards were created as by-products of the process, but these cards were intended to be destroyed as soon as they had served their control purposes).

The description makes clear that much of the gain in performance came from this consolidation of files and processes before the actual "computing," consolidation that could be achieved with tabulating equipment [64]. The Committee saw the need for reconfiguring processes or, as Davis put it in one paper, "a basic reengineering of present procedures" [65] to take advantage of the equipment. Perhaps the most conservative aspect of the plan was the retention of the humanly readable, typed history cards. Finelli justified the Committee's stance, saying "We just do not believe that the time has yet come to completely dispense with readable card records of this kind, and we do not have to in order to realize substantial economy with electronic computers" (p. 41). Moreover, he justified retaining the punched cards even with the magnetic tape computer by objecting to putting processes completely at the mercy of such new and not always dependable machines: "To avoid to the degree possible a complete dependence on the operating effectiveness of such complicated equipment, complete compatibility with punched card systems seems to be an almost essential requirement" (p. 46).

The output procedures for both types of computers were designed to be independent of the computer itself. For the card-based computer, an innovative photo-electric scanning system was to be used for printing name and address information from the address card, saving the addition of two or three more cards with that information encoded on punched cards. The rest of the information (amount of premium, any dividends or loan payments, etc.) would be printed by the high-speed printers used in conjunction with non-electronic tabulating machines. For the tape-based computer, Finelli noted that current printing capabilities were still quite slow but that high-speed printers are well along the development process and would soon be available. This development was probably spurred by the demands of Berkeley and the Prudential, the Society of Actuaries

Committee, and others in life insurance and other industries for the better output capabilities needed by information-intensive businesses, in contrast to the minimal output capabilities demanded by defense and scientific work.

Implications of the Society of Actuaries Report

This insurance industry report highlights several issues in the continuing interaction between it and the information processing industry. While Berkeley's actions on behalf of Prudential might be attributed to idiosyncratic factors, the Society of Actuaries Committee clearly represented multiple large players in the industry, who were determined both to stay informed and to make potential vendors aware of their interest and needs. IBM and the Univac division of Remington Rand were exhibiting equipment and sitting in the audience at the Special Meeting of the Society of Actuaries where the 1952 report was presented. Univac clearly needed to attract some such large business users and seems to have cooperated fully with the committee to give them information on the tape-processing machine. IBM had an enormous installed base of tabulating equipment in the insurance industry and was clearly monitoring the Committee's work and cooperating, even though its commercially available computer technology was not as advanced as that of Univac at this stage. Both vendors and others were learning more about the industry's needs, especially for verification, rapid sorting, and high-speed input and output. At a conference on the development and use of the Univac held many decades later, Paul Chinitz, who worked for Univac during this period, assessed the importance of this and later Society of Actuaries committee study as follows:

The insurance industry had a forum, early, for the use of large computers. They had the actuarial society committee studying that for many years so that the concept and the results of that evaluation spread out on all the insurance companies. So I think that the concept of the computer as an important [tool] by the insurance industry was generated from within on that. I rather suspect that for a large number of other industrial companies, the concept of going to a computer, or at least investigating the thing, came by an osmosis from the publicity that was generated not only by the election, but also by major insurance companies acquiring systems and [using them successfully]. [66]

Thus he saw leaders in this industry as taking a proactive role in exploring computers and their possible uses in insurance, and in spreading the word throughout that industry and ultimately beyond to other commercial companies.

The Society's initial 1952 report also revealed the life insurance industry's progression from seeing computers as actuarial devices to seeing them as operating workhorses such as tabulating equipment had been. Further, we see that much of the gain from the new process the Committee designed came from the reconfiguration of their own processes, rather than from the computer technology itself. The Committee's work suggested that these machines were at a stage of being useful and cost-effective for large firms, and might be shared by smaller and medium sized firms. More conservative than Berkeley, the Committee saw computers as an important but incremental improvement in current processes. It was cautious in its estimates of the potential savings from reducing clerical labor. It anticipated a savings, but only a gradual reduction in the clerical workforce, usually by attrition. In fact, no actual reduction in headcount would emerge in the next decade, but a slowing of rapid growth would be achieved [67]. Finally, the Committee was cautious about any abandonment of punched cards and even of cards on which facts were typed or posted by accounting machines. It foresaw the need for punched card duplicates of all information stored on tape for a long time to come. This conservatism would appear more frequently in the early years of insurance computing than Berkeley's relative willingness to embrace magnetic tape, though even Berkeley wanted a visible medium for data back-up.

Conclusion: Early Interactions between Insurance and Computer Vendors

In this paper I have detailed the early interactions of Berkeley (acting for the Prudential) with computer vendors and insurance societies, and of the Society of Actuaries (acting for the insurance industry) Committee on New Recording Means and Computing Devices with computer vendors and with broader insurance membership in the Society. All of these extensive and rich interactions occurred during the period from 1948 through 1952, the period designated by Cortada as one of little involvement with computers on the part of commercial firms, before actual insurance company purchase and use of computers began in 1953/54. These findings thus indicate the importance of Cortada's call for more industry-specific studies of early computer use.

Moreover, these interactions suggest that the theme of co-evolution of information technology and its use in life insurance, previously established in study of the tabulator era, continues into the early computer era. While life insurance's influence on the technology of computing may not be as significant as that of government and defense, life insurance, along with other commercial firms and industries, clearly did have an influence on input-output technology and the ongoing importance of punched cards. While these technological aspects may seem relatively minor in comparison to other aspects, they would be critical to computer success in broader commercial markets. In this shaping role, insurance firms represented markets that would be essential to vendors as they moved forward. Reciprocally, the interactions with vendors influenced the view life insurance firms held of how they might use computers. These early interactions shifted attention from highly mathematical uses to operational uses, a shift that reflected existing tabulator use and would be reflected in later computer use. They also suggested a model for reengineering and integrating insurance processes (a trend which had also begun in the late tabulator era) to make best use of computers, although in the early decades of computer use this model was to be honored more in the breech than in the observance.

This paper, then, has contributed a close look at early interactions between computer vendors and potential (soon to be actual) users of the technology. It helps computer historians refine the time line of commercial knowledge of and interaction with computers and their vendors. Moreover, it supports the growing body of literature mentioned at the beginning of this paper that argues that even in such a "high tech" development as that of computers, users can play a significant role in defining future technical and commercial development. Finally, it shows more specifically than before the evolution of user attitudes about the technology that would shape, but not determine (as future papers will show) their later adoption and use of this technology.

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[63] [J.J. Finelli, "A Report on the Electronic Activities of a Large Life Insurance Company," *Transactions of the 15th International Congress of Actuaries* (1957), pp. 13-14.]

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[66] Paul Chinitz, in *The Univac Conference*, Charles Babbage Institute Oral History #200, Organized by the Charles Babbage Institute, the Smithsonian Institution, and Unisys Corporation, Conducted 17- 18 May 1990, Smithsonian Institution, Washington, D.C.

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