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# **Engineering Change in Mexico: The Adoption of Computer Technology at Grupo ICA (1965-1971)**

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## **Engineering Change in Mexico: The Adoption of Computer Technology at ICA (1965-1971)**

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**Abstract**—This article documents the adoption of computer technology by a civil engineering services and construction company in Mexico at the time that it became the first Mexican multinational enterprise. Computerization took place independently of cross border growth. The challenges, failures and successes of computerization attest to the transformation in the use of computer applications from the mechanization of routine procedures to the creative use of these applications. In line with company policy, the latter lead to the establishment of the computer centre as a standalone, profit generating business unit. However, this policy responded to ‘laissez faire’ and fiscal (i.e. minimizing tax payments) rather than strategic considerations. To little surprise computer services never grew to be a significant income stream.

**Index Terms**— Computer centers, History, Data processing, Computer integrated engineering, Computer bureaus, Mexico, Ingenieros Civiles Asociados (ICA), International Business Machines (IBM), Control Data Corporation (CDC), University Computing Corporation (UCC)

### **Introduction**

This brief article records the development of the evolution in the use of computer technology by the civil engineering firm ‘Ingenieros Civiles Asociados S.A. de C.V.’ (ICA). ICA’s rapid and consistent growth has made it Mexico’s first major multinational company. Its first computer, an IBM 1130, was installed within its Aereofoto business in 1966. Driven by ICA’s internal market system, use of the computer soon shifted from engineering to administrative applications, particularly cost accounting and payroll. After winning a major external engineering contract in 1968 the firm ordered a larger CDC 3300 computer as the foundation for an ambitious computer services business. However the computer was unreliable and the fledgling business failed to win many internal or external customers. A push into the fashionable “computer utility” market failed to get off the ground. By 1972 a combination of reduced ambition and the installation of an IBM 360 yielded a stable but conservative subsidiary focused on a handful of applications.

The history of computing has traditionally been dominated by technological histories of key machines or systems and by business histories of major hardware companies. As Michael Mahoney observed, the field

absorbed an implicitly “machine centered” master narrative.<sup>1</sup> In recent years, however, attention has turned toward the use of computers in particular social contexts. This reflects a broader turn toward examination of use and users within both science studies and the history of technology.<sup>2</sup> However early computers were purchased, configured, and applied not by isolated individuals but by large organizations. Attention to use therefore requires us to combine several distinct perspectives. First, we must be willing to follow the suggestion of JoAnne Yates in studying organizations, rather than individuals, as users of computer technology.<sup>3</sup> Yates also makes a persuasive case for the need to consider entire industries, rather than isolated firms, as agents of computer adoptions and has documented the role of trade associations in creating a consensus on the nature and proper application of computers within an industry.<sup>4</sup> But we must not forget that organizations are made up of people, and that institutions exist within the minds of individuals and are reproduced and enacted through in their daily interactions. Hence it is also important to consider the role of different occupational groups and practices in the evolution of computer use.<sup>5</sup>

Shifting our focus to computer technology in use poses other kinds of challenge to the existing literature. A standard computer, such as an IBM 1401, might be used in very different ways in different industries. As James W. Cortada has shown, it is possible to write the history of computer usage as a collection of dozens of loosely connected stories covering different industries.<sup>6</sup> Likewise, by the 1960s the international computer industry was dominated by a handful of firms, mostly American. But every country has its own story of computer use and adoption, and it cannot be assumed that adoption of similar hardware in two nations implies that both countries would use make similar use of computer technology or experience equivalent results.

As a case study of early computer use in a Mexican engineering firm this paper provides a small contribution toward meeting Mahoney’s daunting challenge to explore the “Histories of Computing(s)” in all their richness.<sup>7</sup> The few detailed studies of computer use in particular industries have thus far tended to

<sup>1</sup> M. S. Mahoney, "The Histories of Computing(s)" *Interdisciplinary Science Review*, vol. 30, no. 2 2005, pp. 119-135.

<sup>2</sup> A classic call for attention to users in the history of technology is R. S. Cowan, "The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology" in *The Social Construction of Technological Systems*, W. E. Bijker, T. Pinch and T. P. Hughes, Ed., Cambridge, MA: MIT Press, 1987, pp. 261-280. A recent, a high influential, sampling of work in science studies on users was given in N. Oudshoorn and T. Pinch, "How Users Matter: The Co-Construction of Users and Technology" in, Cambridge, MA: MIT Press, 2003.

<sup>3</sup> J. Yates, "How Business Enterprises Use Technology: Extending the Demand-Side Turn" *Enterprise and Society*, vol. 7, no. 3, September 2006, pp. 422-455

<sup>4</sup> J. Yates, *Structuring the Information Age*. Baltimore: Johns Hopkins Press, 2005.

<sup>5</sup> The early establishment of identities, practices, and division of labor in administrative computing is explored in T. Haigh, "The Chromium-Plated Tabulator: Institutionalizing an Electronic Revolution, 1954-1958" *IEEE Annals of the History of Computing*, vol. 23, no. 4, October-December 2001, pp. 75-104.

<sup>6</sup> J. W. Cortada, *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries*. Oxford: Oxford University Press, 2003; J. W. Cortada, *The Digital Hand, Volume 2: How Computers Changed the Work of American Financial, Telecommunications, Media, and Entertainment Industries*. Oxford: Oxford University Press, 2006; J. W. Cortada, *The Digital Hand, Volume 3: How Computers Changed the Work of American Public Sector Industries*. Oxford: Oxford University Press, 2007

<sup>7</sup> Mahoney, "The Histories of Computing(s)".

focus on financial organizations.<sup>8</sup> Likewise almost nothing has been written about any aspect of the history of computing in Mexico, and indeed Latin America as a whole has received little more attention.<sup>9</sup>

This article details the introduction and diffusion of computer technology within ICA. Details are provided of how purchases were made, benefits to the company, challenges to make the technology work, the transformation in the use of the technology, ways in which computerization altered organizational and events that led to the creation of an independent computer services company. Faced with a dearth of surviving company records, what follows is based on interviews with participants involved in the setting up and running the computer centers for ICA.<sup>10</sup> Where possible these accounts have been cross referenced with publicly available information. The draft was also cross checked by all participants.

### Early Mexican Computing

Mexico's first computers were installed for academic and governmental use. The very first was an IBM 650 installed at the National University ('Universidad Nacional Autónoma de México' or UNAM) in 1958. A second machine for the same university was a Bendix G-15 in 1960. Other state and private universities soon followed while deploying mainframe equipment. For instance, through a donation the National Polytechnic Institute ('Instituto Politecnico Nacional') installed an IBM-709 in 1964.<sup>11</sup> But it was not until 1965 when computer technology was used at UNAM to address administrative applications when an IBM 1440 hosted payroll and mechanize the accounting function.<sup>12</sup>

By the mid 1960s other large machines had been installed within the federal government such as an IBM 704 at the Mexican Social Security Institute ('Instituto Mexicano del Seguro Social') and two CDC 604s at the Finance Ministry ('Secretaría de Hacienda y Crédito Público') to centralize the payroll of all federal government employees. Large banks had also started to adopt mainframe computers for similar purposes: Banco Nacional de México (Banamex) installed a General Electric 415 in 1965; Banco de Comercio installed an IBM 1440 in 1964 immediately followed by an IBM 360 in 1965; Banco Comercial Mexicano

<sup>8</sup> As well as Yate's work, this includes D. de Wit, *The Shaping of Automation : A Historical Analysis of the Interaction between Technology and Organization, 1950-1985*. Hilversum: Verloren, 1994. There has been an increasing interest in Europe for similar studies in banking as suggested by contributions such as Wardley P. 2000. The Commercial Banking Industry and its Part in the Emergence and Consolidation of the Corporate Economy in Britain before 1940. *Journal of Industrial History* 3(2): 71-97; Bátiz-Lazo, B. and Boyns, T. (2004) 'The business and financial history of automation and technological change in 20<sup>th</sup> century banking', *Accounting Business and Financial History Journal*, vol. 14, no. 3, pp. 225-32; Booth AE. 2007. *The Management of Technical Change: Automation in the UK and USA since 1950*. Palgrave: Basingstoke; Bátiz-Lazo B, Wardley P. 2007. Banking on Change: Information Systems and Technologies in UK High Street Banking, 1919-1969. *Financial History Review* 14(2): 177-205; and Bátiz-Lazo B. 2009. Emergence and evolution of ATM networks in the UK, 1967-2000. *Business History* 51(1): 1-27.

<sup>9</sup> On computing in Mexico, see Cantarell, A. and Gonzalez, M. (2002) *Historia de la computacion en Mexico* (three volumes), Mexico DF: Hobbiton Ediciones SA, Cite the forthcoming paper on the Turing computer for Mexico, 9-Angel. Developments in Chile during the 1970s are explored in E. Medina, "Designing Freedom, Regulating a Nation: Socialist Cybernetics in Allende's Chile" *Journal of Latin American Studies*, vol. 38, no. 3 2006, pp. 571-606; E. Medina, "Big Blue in the Bottomless Pit: The Early Years of IBM Chile" *IEEE Annals of the History of Computing*, vol. 30, no. 4, Oct-Dec 2008, pp. 26-41.

<sup>10</sup> Namely Antonio Dovalí Ramos (General Manager Aereofoto, 1965-1969) José Piña Garza (Manager of the computer centre, 1965-1971), Luis Enrique Maumejean (computer analyst, 1965-1973; Systems Manager, 1974-1984), and Bernardo Bátiz Echavarría (Operations Manager, 1964-1984).

<sup>11</sup> "History of Computing in Mexico," available: [http://cocomc10.pereanet.com/html/coco\\_in\\_mexico.html](http://cocomc10.pereanet.com/html/coco_in_mexico.html).

<sup>12</sup> "50 años de la computación en México," available: <http://www.cs.cinvestav.mx/SemanaComputoCINVESTAV/Computo.html>.

an IBM 360 in 1966; and Banco de Londres y México an undisclosed machine in 1967.<sup>13</sup>

Government spending in infrastructure had effectively become ‘the engine’ for economic growth.<sup>14</sup> Many member of Mexico’s pioneering generation of data processing experts thus received their first exposure to computing while working in the public sector.

In 1961, José Piña Garza, later to head ICA’s computer center, joined the Ministry of Infrastructure’s (then called ‘Secretaría de Obras Públicas’ or SOP) Structures Department (‘Departamento de Estructuras’) while working on the planning and commissioning of bridges for new highways. Born in Mexico City in 1938, at the time he was still an undergraduate in civil engineering at UNAM (from where he graduated in 1962).

The opportunity then emerged to train within SOP facilities by IBM staff on IBM’s assembler for the running of the soon to be installed IBM 1401.<sup>15</sup> There were two of these courses, each attended by between 15 and 20 participants.<sup>16</sup> Since the running of the 1401 was overseen by the General Services Department (‘Departamento de Servicios Generales’) while aiming at administrative processes (i.e. general accounting and payroll) most of the attendees had an accounting or business background. In a lucky break three engineers from the Structures Department, joined the IBM course. These were Piña as the only participant from ‘Dirección General de Proyectos y Laboratorios’ (‘Projects and Laboratories Bureau’), the area responsible for the design of highways, bridges and buildings; and two other young engineers from the Constructions Bureau (‘Dirección General de Construcción’), the area responsible for overseeing construction.<sup>17</sup>

It is interesting to note that higher education had not prepared anyone for the intricacies of electronic computing. Indeed at a time when there were a handful of computers in Mexico (accessed by a small elite), even the engineers teaching the course for IBM found the content totally new and they learned by reading manuals beforehand and then through feedback with other participants as the courses evolved.<sup>18</sup> Moreover, IBM support took the form of ‘service’ and ‘support’ engineers which were often deployed full time to the new site (particularly after a new installation). However they only looked after the hardware and answered very specific queries. The development of data processing applications was very much left to the customer.

<sup>13</sup> G. de Angel Mobarak, "Computerization of commercial banks and the building of an automated payments system in Mexico, 1965-1990," in *Technological Innovation in Retail Finance: International Historical Perspectives*, B. Bátiz-Lazo, J.C. Maixé-Altés and P. Thomes (eds.), London: Routledge, 2010 (Forthcoming); "El Banco Comercial Mexicano, S.A., adquiere un sistema electrónico de proceso de datos IBM 360," *Excelsior*, August 1, 1966; B. Trueblood, *125 años de Banco Serfin*, Dirección de Relaciones Públicas, México D.F.: Banca Serfin, p. 84.

<sup>14</sup> Cárdenas, E. (2003) "El proceso de industrialización acelerada en México (1929-1982)" in *Industrialización y Estado en la América Latina: La leyenda negra de la posguerra*, E. Cárdenas et al.(eds), . México, D.F., El Trimestre Económico - Fondo de Cultura Económica.

<sup>15</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>16</sup> J. Piña Garza, personal communication, November 21, 2009.

<sup>17</sup> J. Piña Garza, Personal communication, December 2, 2009.

<sup>18</sup> J. Piña Garza, personal communication, November 21, 2009.

The assembler-based administrative applications soon filled up and saturated the capacity of the 1401.<sup>19</sup> At the same time there was an expectation within SOP's middle and top ranks (particularly Fernando Espinoza, the head of the Projects and Laboratories Bureau) that computer technology could also be used to develop engineering applications. A couple of trials developing simulations in the 1401 convince them confidence.<sup>20</sup> The first major project was to be developed by staff at the Structures Department and aimed to mechanize photogrammetry capabilities for the design and planning of new highways by storing topographic information on punched cards. This was along the lines of similar processes already in place in Germany, Sweden and Switzerland (which Piña and two others observed first hand during a two month tour of Europe). It was expected that computer applications would minimize the time and increase the accuracy in the geometry to calculate the volume of earth to be moved in highway construction. The ultimate goal however was a substantial increase in the capacity to design and plan for new highways, roads and bridges and thus respond to the central government's policy of enhancing the country's infrastructure.<sup>21</sup>

The decision to go ahead with computerization of photogrammetry was taken towards the end of 1962.<sup>22</sup> Given the lack of capacity at the 1401, this resulted in the General Services Department leasing an IBM 1620 to sit alongside the 1401.<sup>23</sup> The 1620 was selected as it was considered the only one on offer which was both of 'modest' size and highly reliable.<sup>24</sup> Preparations for the 1620 included IBM training some eight to ten engineers (including Piña) in FORTRAN. Of these five were selected as the Programming Unit<sup>25</sup>: three of them were promising recent graduates from UNAM (including Piña). The two others were more senior and experienced in the design of roads and highways.

During early trials after the pilot project was underway, people around the project were skeptical and they consistently voiced their discontent that reports were missing relevant information.<sup>26</sup> At one point and following a printers' breakdown, the head of the area advised that he was cancelling the computerization project. This announcement was immediately followed by an uproar from rank and file who were by then reluctant to return to manual methods.

Programming staff soon discovered that by changing a small number of punched cards a process initially thought of as one of labor substitution and mechanization became one of optimization: the combination of photogrammetric information together with electronic calculus achieved greater efficiency in the vertical

<sup>19</sup> J. Piña Garza, Personal communication, November 24, 2009. It is also noted that the SOP's 1401 FORTRAN compiler was available until 1964.

<sup>20</sup> J. Piña Garza, Personal communication, December 2, 2009.

<sup>21</sup> J. Piña Garza, Personal communication, December 2, 2009.

<sup>22</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>23</sup> J. Piña Garza, Personal communication, December 2, 2009.

<sup>24</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>25</sup> J. Piña Garza, personal communication, November 21, 2009.

<sup>26</sup> J. Piña Garza, Interview, September 19, 2009.

and horizontal alignment of the highway. This resulted in savings in the order of 10 to 15 percent of the overall expected cost of the construction. A substantial amount indeed, which more than compensated the cost of the additional effort to input data in punched card form.

According to one estimate, there were 250 computer centers in Mexico in 1967.<sup>27</sup> This grew to 1,200 by 1976, most of which were deployed in the cities of Monterrey and Mexico, sites of rapid urbanization.<sup>28</sup> The same source claimed that the total annual cost of electronic data processing increased from 1.5 to 6.7 percent of Gross Domestic Product (at 1970 prices) between 1967 and 1976. Hence the adoption of a small machine by Aereofoto took place in the context of a broader move for the computerization of scientific, engineering and administrative processes in Mexico and particularly in Mexico City.

### **Aereofoto and ICA**

Since the mid-1930s 'Compañía Mexicana Aereofoto S.A.' had been Mexico's sole provider of topographic maps based on information extracted from aerial photographs (a process known as photogrammetry). It also provided photo interpretation and photometry services, but relied primarily on selling maps based on existing photographic stock rather than securing new (higher added value) photogrammetry contracts.<sup>29</sup> The untimely death of Luis Struck, the founder, the company's technical director and Struck's two sons in two separate airplane accidents, decapitated the company. This led the founder's widow and sole owner to sell the company to ICA, one of its main clients.<sup>30</sup> Victor San Miguel, then general manager of SOLUM (ICA's soil mechanics business) suggested the purchase of Aereofoto. The acquisition took place in 1965. The aim was to beef up Aereofoto's customer portfolio and use it to facilitate contacts with government officials, learn of their plans and future priorities and thus get a heads up to eventual civil engineering contracts.<sup>31</sup>

At this time ICA was led by Bernardo Quintana Arrijoa, a colorful and charismatic leader who was the company's president until his death in August 1984.<sup>32</sup> In July 1947, Quintana had been one of a group of 18 engineers, then aged between 23 and 28 years old, who established the firm in Mexico City. Like other engineering firms created by the growing cadres of Mexican civil engineers, ICA needed to establish

<sup>27</sup> J. Piña Garza, *La ingeniería de sistemas del Grupo ICA*, ICATEC S.A. Consultores: México, D.F., p. 1.

<sup>28</sup> According to official figures from the, Instituto Nacional de Geografía Estadística e Informática (INEGI), the first Mexican census took place in 1895 and recorded 12.3 inhabitants. This grew to 15.2 million in 1910, the same year that marked the start of social unrest. The end of the worse armed fighting resulted in 14.3 inhabitants being recorded in 1921. Population then started to grow very fast. By 1950 it reached 25.8 million while 34.9 million were recorded in the census of 1960. In other words, population doubled in the thirty years to 1950. But it was in the process of doubling again in the twenty years to 1970 (when the census recorded 48.2 million) and again in the next twenty five years (reaching 91.2 million inhabitants in 1995). At the same time, the number of people living in urban areas (with 2,000 or more inhabitants) grew from 12.9 per cent in 1912, to 31.2 per cent in 1921, 42.6 per cent in 1950, 58.7 in 1970 and 73.5 per cent in 1995. In the vernacular this period of urbanisation and high economic growth between 1950 and 1970 was called 'el milagro mexicano' (the Mexican miracle).

<sup>29</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>30</sup> ICA used aerial mapping until the mid-1980s but satellite sources only after 1990. E. Buzio, "Resguarda ICA acervo aerofotográfico," *Grupo Reforma*, August 10, 2005, available: [http://anuario.ajusco.upn.mx/site?accion=articulo&id\\_art=78154&tema=](http://anuario.ajusco.upn.mx/site?accion=articulo&id_art=78154&tema=)

<sup>31</sup> A. Dovalí Ramos, Interview, September 25, 2009.

<sup>32</sup> ICA, "Nuestra historia," available: [http://www.ica.com.mx/home\\_ica.htm?idioma=sp](http://www.ica.com.mx/home_ica.htm?idioma=sp); Dirección de Relaciones Públicas del Grupo ICA, *El Grupo ICA a 1967*, México D.F.: Grupo ICA, 1967, p. 1.

credibility, capabilities, and government connections sufficient to bid competitively for large urban projects and other infrastructure contracts. Since the late 19<sup>th</sup> century these had been awarded to foreign companies who then subcontracted to smaller Mexican outfits. But from the late 1940s into the 1970s a wave of economic nationalism inspired governments throughout Latin America to encourage the development of local firms and reduce reliance on imports and foreign companies. Upon its establishment, ICA created two main administrative divisions: Structures (aimed at the construction of buildings) and Heavy Engineering Projects. ICA's first two large contracts were awarded in 1948 for the construction of a council housing state ('Conjunto Urbano Presidente Miguel Alemán') in Mexico City and a hydraulic irrigation system ('Sistema de riego del Río Cupatitzio') in the state of Michoacán. Other projects soon followed.

As early as 1953, ICA's business was growing at such intensity that increased activity of sections within administrative partitions led to these being spun off as independent, standalone companies that sold their services externally to the market and internally to other companies within the group (at arm's-length prices). By 1967 there were 30 such companies, employing almost 20,000 persons and forming what was then called 'Grupo ICA'.<sup>33</sup> The growth of its reputation and success in delivering to the Mexican government combined to secure a leading role in the construction of the Alto Anchicayá dam in the Colombian Andes. By the time the construction of this dam ended in 1974, ICA had already attracted several other contracts within Central and South America. These had effectively positioned the firm as the first indigenous Mexican multinational company.<sup>34</sup>

In 1965, when it purchased Aerofoto, growth through acquisition was a new strategy for ICA. However, such growth did not respond to the pursuit of a 'corporatist' strategy.<sup>35</sup> Rather than building a multi-division company, ICA aimed to maximize capital formation by maximizing the reinvestment of after-tax profits and reducing tax payments by obscuring a contract's net profit inside a web of seemingly independent companies.<sup>36</sup> This resulted in the group being run by a number of 'divisional viceroys' (who had ultimate say within the companies under their control), hindered the development of standardized processes, procedures and practices, and gave no incentives to share common facilities (such as accounting, central purchasing of stationary or computing equipment).<sup>37</sup> Blurred organizational boundaries also meant

<sup>33</sup> Ten of these were grouped into building and construction ('Empresas Constructoras'), four related to technical services ('Servicios Técnicos'), three into auxiliary services to construction ('Servicios Auxiliares a la Construcción'), one in real estate management ('Inmobiliarias') and eleven in heavy construction engineering ('Industria de Mécanica Pesada'). Dirección de Relaciones Públicas del Grupo ICA, *El Grupo ICA a 1967*, México D.F.: Grupo ICA, 1967, pp. 1, 5.

<sup>34</sup> Indeed, by 2009 ICA had been involved in civil engineering projects in 21 countries in America, Europe and Asia [10]. Normally ICA, as a private company that did not disclose its financial information, but the Mexican business magazine *Expansion* classified it as the eighth largest reporting company in the nation in 1980, with revenues of 26.19 billion pesos (US\$1.15 billion) [idem]. By 1991, there were 180 independent companies (30 of them inactive) within the group [22 – Piña]. These were consolidated into 12 as part of the preparations for its initial public offering in Mexico City's stock market ('Bolsa Mexicana de Valores') in 1992.

<sup>35</sup> A. Dovalí Ramos, Interview, September 25, 2009.

<sup>36</sup> A. Dovalí Ramos, Interview, September 25, 2009 and J. Piña Garza, Personal communication, December 02, 2009.

<sup>37</sup> J. Piña Garza, Interview, September 19, 2009; L.E. Maumejean, Interview, September 15, 2009.



that as part of their responsibilities (and pay) junior and senior managers could offer their services to three or four companies within a division at any one time.<sup>38</sup> But for simplicity in what follows we assume strict organizational boundaries.

Shortly after its acquisition by ICA, Aerophoto secured a hefty contract to draw topographic maps of large irrigation areas based on photogrammetry.<sup>39</sup> San Miguel oversaw the running of Aereofoto while a permanent general manager was appointed. He and an Aereofoto technician, Alberto Villasana, approached Piña regarding the possibility of deploying in Aereofoto a system similar to that at SOP.<sup>40</sup> Villasana was then made responsible of updating the photogrammetry equipment and staff training while Piña, acting as external consultant, with the task of overseeing the selection of the computer and programming team.<sup>41</sup>

Soon Antonio Dovalí Ramos, an up and coming young talent within ICA, was appointed general manager of Aereofoto. Like San Miguel, he was of the view that manual processes for originating maps through the combination of aerial photographs and topographic information were extremely time consuming, tedious and prone to error.<sup>42</sup> For instance, correlating information required the four people involved in calculations at Aereofoto to work with 16 digit decimals in operations involving logarithms and trigonometric functions. Since the demand for large projects at Aereofoto was influenced by requests for up to date maps and cartography, workloads were uneven and followed random patterns of intensity. This was a concern as it limited possibilities to add new, younger people to the staff at Aereofoto, whose workforce was aging rapidly.

### **The Arrival of the IBM 1130**

Towards the end of 1964 it was becoming increasingly evident to those involved in Mexican computing that second generation (transistor-based) machines such as the 1401 and 1620 would soon be replaced by third generation (micro-transistor-based) machines.<sup>43</sup> It was suggested that ‘the new machines could be a hundred times faster.’<sup>44</sup> There had also been a proliferation of manufacturers in the international scene. But the only European competitor in Mexico was GE-Bull (servicing the National University and Banamex) while Burroughs and Honeywell were the only other US manufacturers with local servicing facilities.<sup>45</sup>

The advent of third generation machines lead a number of people in organizations already using computers to consider upgrading their equipment. At the SOP, for instance, plans were drawn by comparing the newly

<sup>38</sup> B. Bádiz-Echavarría, Personal communication, November 29, 2009.

<sup>39</sup> B. Bádiz Echavarría, Interview, September 15, 2009.

<sup>40</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>41</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>42</sup> A. Dovalí Ramos, Interview, September 25, 2009.

<sup>43</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>44</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>45</sup> B. Bádiz Echavarría, Interview, September 15, 2009; J. Piña Garza, Interview, September 19, 2009.

launched IBM 360 with offers from other manufacturers.<sup>46</sup> At ICA, however, the selection strongly favored IBM: its prevalence within the Mexican government (i.e. ICA's main client) made its use 'de facto' requirement. IBM was also seen as the most (if not the only) credible provider with infrastructure to service computer equipment in Mexico.<sup>47</sup> Moreover, ICA had leased IBM tabulators to help control the location and servicing of earth-moving equipment.<sup>48</sup>

Although the IBM 360 was already in the market, Piña, who had been given free rein to choose staff and equipment, decided for another newly launched IBM machine, the 1130, believing it more suited to engineering projects. Introduced in 1965, the 1130 'was IBM's least-expensive computer to date, and was aimed at price-sensitive, computing-intensive technical markets like education and engineering'.<sup>49</sup> The 1130 addressed many of the shortcomings of the 1620, used by Piña at SOP, an earlier low cost technical and educational machine. For instance, the 1130's removable disk was seen as more versatile and opening up greater possibilities than the 1620 fixed storage device. At 64k the 1130's memory was substantially bigger than the 1620's 60,000 digit capacity storage. The 1130 was thus seen by Dovalí, Villasana and Piña as better value for money than the 1620.<sup>50</sup>

Securing the funding for the computer was an uphill struggle. ICA's hierarchy in general and Quintana in particular, were not convinced of the benefits of computer technology. Actually, Quintana remained unsure whether the acquisition of Aereofoto had made sense at all.<sup>51</sup>

In the six to eight months that followed his appointment as general manager, Dovalí had several meetings with Quintana in order to secure the computer. Quintana run ICA under a tight expenditure policy regime which "would rather repair the same [earth moving] equipment several times than purchase a new one."<sup>52</sup> Dovalí thus argued primarily on the basis of efficiency, as Aereofoto had to continually recalculate estimates. The expenditure related to the computer was not seen as a capital investment but as an irrecoverable (i.e. sunk) cost, whose monetary value was modest.<sup>53</sup> Ultimately, Quintana saw the move to install a computer at Aerophoto as an experiment, which had more to do with fostering the innovativeness and ingenuity of its young engineers than any sign of modernity or keeping up with technological change.<sup>54</sup>

ICA's order for the 1130 was made a couple of weeks after it was announced in March of 1965 in the US.

<sup>46</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>47</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>48</sup> J. Piña Garza, Personal communication, December 2, 2009.

<sup>49</sup> "IBM 1130 Computing System," available: <http://ibm1130.org>.

<sup>50</sup> A. Dovalí Ramos, Interview, September 25, 2009 and J. Piña Garza, Personal communication, November 24, 2009.

<sup>51</sup> A. Dovalí Ramos, Interview, September 25, 2009.

<sup>52</sup> A. Dovalí Ramos, Interview, September 25, 2009.

<sup>53</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>54</sup> L.E. Maumejean, Interview, September 15, 2009.

This secured the second order for the machine anywhere and the first to be deployed outside the USA.<sup>55</sup> However, there were delays due to problems at IBM and it arrived to Aereofoto until 1966.

Even though the 1130 still required an air-conditioned room, a dust free environment, and input via punched cards, it remained small and cheap when compared with the large mainframes being deployed at banks and government offices at the time. It was also a relatively low expenditure when compared with investments in equipment and working capital made in other parts of a growing construction and heavy engineering company.<sup>56</sup> Moreover, the monthly rent was roughly equivalent to the monthly payroll of three senior engineers and therefore, its cost could easily be recouped by any of the usual studies and projects in which Aereofoto was involved at the time.<sup>57</sup>



*The first IBM 1130 at Aereofoto, circa 1966. Courtesy of Fundación ICA.*

As is evident in the picture above, there were severe limitations in room that housed the first machine. Temperature was controlled through an air-conditioning unit mounted on a window while cables were initially exposed (later covered with makeshift cardboard covers).<sup>58</sup> After the computer had been installed, Piña was hired on a full-time contract by Aereofoto and named Chief of the Electronic Computer Department (‘Jefe del Departamento de Cómputo Electrónico’). He employed ten newly graduated engineers to be trained on the job as computer programmers and analysts (all male), most of which were graduates from the National University’s Faculty of Engineering and with enough experience with computing to be able to write FORTRAN.<sup>59</sup> The team also included four female punched card operators as

<sup>55</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>56</sup> J. Piña Garza, Interview, September 19, 2009.; B. Bátiz Echavarría, Interview, September 15, 2009.

<sup>57</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>58</sup> J. Piña Garza, Personal communication, November 29, 2009.

<sup>59</sup> One of this was Luis Enrique Maumejean, graduate in civil engineering from Universidad Iberoamericana where he had worked with an IBM 1620 (L.E. Maumejean, Interview, September 15, 2009). It is not clear when this private university installed its computer equipment but undergraduate courses in electrical

well as the services of Bernardo Bátiz Echavarría, who had recently returned from doctoral courses in Operations Research at the Wharton School (thanks to ICA's scholarship program).<sup>60</sup> Although these defined job roles promised a clear division of labor, in practice it was fairly informal working environment. Computer programmers and machine operators in particular shared the workload and many became a 'jack of all trades' as 'everybody tended to do a bit of everything'.<sup>61</sup> There was a great deal of camaraderie amongst specialist around the computer centre. This was in sharp contrast to the strictly hierarchical and even dictatorial organizational structure typical of Mexico in the 1960s.



*José Piña Garza and Bernardo Bátiz Echavarría, both were instrumental in the running of the IBM 1130 and the purchase of the CDC 3300. September 2009.*

### **Establishment of an Internal Service Center**

Upon his arrival, Dovalí also noted to the team that, as other parts of ICA such as SOLUM, the newly created computer centre team at Aereofoto had the mandate to sell its services to other companies within the group by providing computerized support for engineering projects related to the construction of roads, highways, dams, and irrigation canals.<sup>62</sup> Some of these could benefit from pre-installed packages in the 1130 such as those for project management and structure cost estimates.<sup>63</sup>

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engineering had 19 lecturers and 50 students in 1957. J.J. Ledesma, *Trayectoria Historico-Ideologica de la Universidad Iberoamericana*, vols. 1 & 2, México, D.F.: Universidad Iberoamericana, 1985, p. 434.

<sup>60</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>61</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>62</sup> B. Bátiz Echavarría, Interview, September 15, 2009.

<sup>63</sup> J. Piña Garza, Interview, September 19, 2009. See further Campbell-Kelly, *Software*, p.89.



*Building that housed Aereofoto in the 1960s (Obrero Mundial # 338, Col. Narvarte). The IBM1130 was located in the second floor. September 2009*

Computerization of engineering applications was a success and met everyone's expectations.<sup>64</sup> But an uneven flow of work threatened to leave the computer idle for long periods of time. Dovalí therefore pushed for the development of administrative applications. At the instance of Fernando Favela (vice president of the Heavy Engineering division, 'vicepresidente de la División de Ingeniería Pesada') the first of these was a program for the accounting control of construction equipment.<sup>65</sup> This involved keeping a tally of hourly use of earth moving equipment by different companies at different locations. These machines were owned by ICA and not the subsidiaries, and so were managed from headquarters and provided to subsidiaries at market prices. This application benefited from a pre-existing procedure based on punched-cards and electro-mechanic tabulators.<sup>66</sup> However, the computer program also estimated depreciation charges and kept a record of service and maintenance per machine. People were quite happy with the results, paving the way for other administrative applications of computer technology.<sup>67</sup>

<sup>64</sup> A. Dovalí Ramos, Interview, September 25, 2009; J. Piña Garza, Interview, September 19, 2009.

<sup>65</sup> J. Piña Garza, Interview, September 19, 2009.; B. Bátiz Echavarría, Interview, September 15, 2009; J. Piña Garza, Personal communication, December 2, 2009.

<sup>66</sup> J. Piña Garza, Personal communication, December 2, 2009.

<sup>67</sup> L.E. Maumejean, Interview, September 15, 2009.



*Mechanization of engineering projects at ICA. Photogrammetry capabilities for highway design included a punched card machine (towards the back). Aereofoto circa 1967. Courtesy of Fundación ICA.*

In parallel with the accounting control system, the team built a payroll system for Aereofoto. It aimed to automate manual processes by updating staff turnover files and daily attendance to generate paychecks as well as debits and credits to the general ledger. The payroll was run weekly and paid in cash. This application was attractive not only because of the need to automate but because it would consume computer time at regular intervals.<sup>68</sup> Developing the payroll application proved to be quite a challenge for the programming team.<sup>69</sup> The main hurdle was that at the time the 1130 would only run FORTRAN, intended for scientific applications, rather than the administrative programming language COBOL. FORTRAN for the 1130 used floating point arithmetic and would often round up. Hence adding and multiplying subroutines were developed in order that individual checks and the ultimate accounting tally for pesos and cents was accurate.<sup>70</sup> Why was such a generic application developed from scratch? IBM did offer some sort of payroll application for the 1130. But IBM's software was based on US laws, requirement and

<sup>68</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>69</sup> To meet cash payments the main printout was a tally of how many bills and coins of each denomination had to be inserted in pay envelope. Dealing with actual cash was outsourced to a securities transport and armored truck company. Besides weekly and annual taxes, the system also had to calculate weekly and annual contributions by individuals to the national health service ('Seguro Social') as well as aggregate bimonthly reports to it. At the end of the calendar year, companies also had to make pro-rata payments of a fixed portion of after tax profits to all employees ('reparto de utilidades'). Some of the companies being serviced also required 'ad hoc' reports by project or function so they could inform their cost and management accounting systems. It was thus quite a complex and comprehensive application. *Source:* J. Piña Garza, Personal communication, December 2, 2009.

organizational practices. Many Mexican companies (within and outside ICA) had idiosyncratic practices and requirements that made localizing US software more expensive than programming from first principles.<sup>71</sup> And, even in the US, the market for generalized application software had not yet developed.<sup>72</sup>

In a parallel development, Quintana convinced General Alfonso Corona del Rosal, the newly appointed Mexico City regent (Jefe del Departamento del Distrito Federal, 1966-1970)<sup>73</sup>, to build a metropolitan subway system (Metro) in support of the Olympic games (1968) and Football World Cup (1970). Moreover, that ICA would deliver in record time.<sup>74</sup> To support Quintana's effort, Aereofoto's programming team developed an operations research simulation programs (most in FORTRAN but some using the General Purpose System Simulator or GPSS) to estimate optimal passenger loads and train lengths of the proposed Metro. The contract was granted. But this then poised the challenge of managing a weekly payroll of up to 12,000 manual laborers.<sup>75</sup> Moreover, a large number of manual and construction workers were hired within short periods of time (sometimes even back to back shifts) by different companies within ICA.<sup>76</sup> A tax reform introduced in 1967<sup>77</sup> required that companies report consolidated annual income and tax withheld per worker to the Finance Ministry. No administrative system within ICA was ready for such challenge and the case was made for a second and much larger computer, better suited to administrative applications.

### Scaling up Computer Capabilities

Aereofoto's computer team started the search for a new machine after ICA secured the contract to build the Metro in 1967 as this included a payroll contract for Aereofoto (granted in 1968). At the same time and in order to respond to the increased workload, a second IBM 1130 was leased. This machine had double the memory as the previous, two more removable disk units, an additional magnetic tape reader/writer (used mainly for back-ups), cables covered under 'proper' flooring and temperature controlled through 'more appropriate' air-conditioning.<sup>78</sup>

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<sup>70</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>71</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>72</sup> T. Haigh, "Software in the 1960s as Concept, Service, and Product" *IEEE Annals of the History of Computing*, vol. 24, no. 1, January-March 2002, pp. 5-13.

<sup>73</sup> Until reforms introduced in 1987 and 1993, Mexico City was run by a personal appointment by the President (in the vernacular, 'regente' or regent). This appointment followed Article 22 of the 1917 Constitution which embodied the notion that the city as the country's capital and a federal zone (Distrito Federal) was the responsibility of a regent while managed in conjunction with a parliamentary select committee ('comité de la Camara de Diputados'). The first popular vote to elect direct representatives took place in 1987 (these replaced the parliamentary select committee) while the regent was replaced by a directly elected mayor in 1997.

<sup>74</sup> B. Bádiz Echavarría, Interview, September 15, 2009.

<sup>75</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>76</sup> L.E. Maumejean, Interview, September 15, 2009; B. Bádiz Echavarría, Interview, September 15, 2009.

<sup>77</sup> The 'Ley del Impuesto sobre la Renta' introduced a 'Impuesto sobre Productos del Trabajo' or ISPT.

<sup>78</sup> J. Piña Garza, Personal communication, November 29, 2009.



*Second IBM 1130 at Aereofoto circa 1968. This time an effort was made to house it under more suitable conditions. Courtesy of Fundación ICA.*

Aereofoto's leaders anticipated further outsourcing of payrolls, general accounting applications and project management from other firms within ICA. In January 1970 a new company was established within ICA called 'Procesos y Sistemas de Informacion, S.A.' (PSI). The idea was for computer operations in ICA to grow into a general purpose company that 'offered all services currently available around electronic computing'.<sup>79</sup> All those directly and indirectly involved at computing around Aereofoto were relocated to staff the new company, with Dovalí as general manager ('Gerente General'), Piña as second in command ('Subgerente General') and Bátiz Echavarria as chief operations manager ('Jefe de operaciones'), overseeing the day to day running of computer related projects, computer selection and details of the new computer centre.<sup>80</sup>

Leonard Rappaport was retained as selection consultant and eventually hired as full-time member of the PSI team.<sup>81</sup> Several manufacturers with local representatives were considered and these included IBM, RCA, Victor, and Honeywell.<sup>82</sup> Eventually the team decided for a Control Data Corporation (CDC) 'lower 3000 series' as CDC made the best offer when it proposed installing a 3300 at the price of smaller 3100.<sup>83</sup> Both of these had been initially released in 1965 in the USA. CDC had also promised to build up

<sup>79</sup> *Establecimiento de un servicio public de computo electrónico*, Compañía Mexicana Aereofoto, S.A., circa 1970, p. B.

<sup>80</sup> B. Bátiz Echavarria, Personal communication, November 29, 2009.

<sup>81</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>82</sup> B. Bátiz Echavarria, Interview, September 15, 2009.

<sup>83</sup> B. Bátiz Echavarria, Interview, September 15, 2009.



capabilities to deliver a highly reliable and swift engineering support for Mexican companies.<sup>84</sup> IBM's 'unbundling'<sup>85</sup> decision in December 1968 played against it as renting its equipment was perceived as much more expensive than competitors by the selection team at PSI.<sup>86</sup>

Quintana was again reluctant to release additional funds for the new machine. During their negotiations Dovalí suggested placing the computer in a glass plated room on the ground floor of the newly opened central office building (in the corner of Minería No. 145 and Viaducto Miguel Alemán, Col. Escandón, Mexico City). This building embodied modernist architectural concepts of the time such as open plan and floor to ceiling glass entrance.<sup>87</sup> Dovalí told Quintana: 'you are going to be able to show off all the little lights, because these machines have loads of them'.<sup>88</sup> This as a way to using the machine as a 'sign of modernity' given that it would be placed right in the front entrance and across the hall from the elevator bank (leading to Quintana's office). Quintana finally warmed to the idea of a new computer as a 'marketing device' and agreed to the replacement.

The new machine started working on February 1970.<sup>89</sup> This computer together with the 130 staff that built around it was then claimed to be one of the top ten computer capabilities in Mexico.<sup>90</sup> To cater for the new computer the ground floor at Minería 145 had been set up in terms of power, temperature, humidity and dust control. Cables that brought power and connected peripherals were hidden from view behind false flooring and ceilings. CDC not only supervised but also financed the cost of fitting the room for the computer. This cost was to be repaid to CDC as part of the monthly rental fee.<sup>91</sup>

<sup>84</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>85</sup> Campbell-Kelly, *From airline reservation*, p. 109.

<sup>86</sup> J. Piña Garza, Personal communication, November 24, 2009.

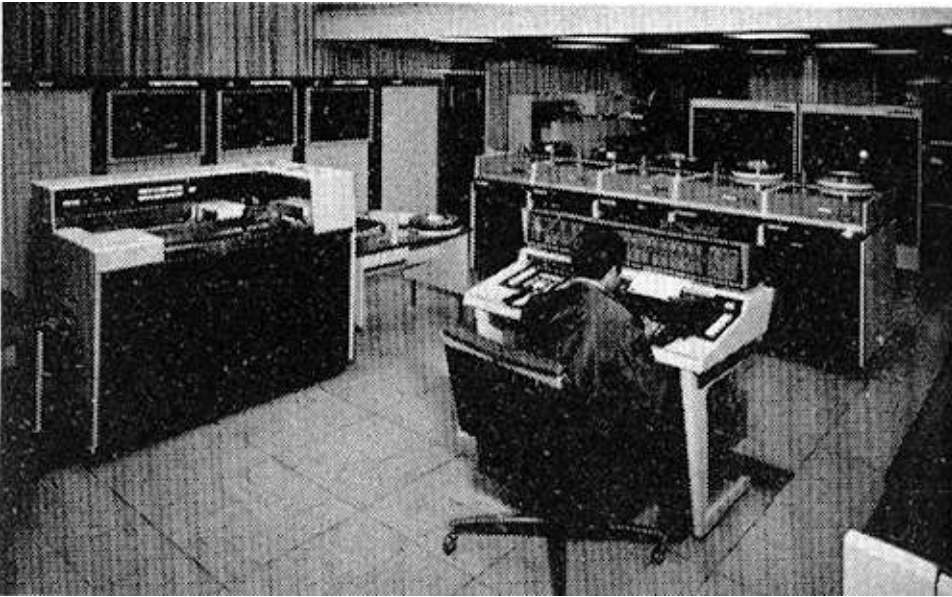
<sup>87</sup> This building was designed by the bureau of Juan Villagran García (1901-1982), who was one of the top Mexican architects at the time. Villagran had also been teacher and former employer of Quintana, during the latter's very early career and before establishing ICA. Quintana thus had great appreciation and respect for Villagran. The original design had not planned for a computer centre. It was during the relocation of staff to the new building when Dovalí approached Quintana with the idea of locating the computer in the ground floor. Source: B. Bátiz Echavarría, personal correspondence, November 10, 2009.

<sup>88</sup> A. Dovalí Ramos, Interview, September 25, 2009.

<sup>89</sup> F.P. Guerrero, *Propuseta a Grupo ICA (1-1078)*, México, D.F., Arthur D. Little de México S.A., May 5, 1970, p. 1.

<sup>90</sup> 'PSI: apoyo técnico', *Boletín del Grupo* (circa 1970), México, D.F.: Departamento de Relaciones Públicas, p. 1.

<sup>91</sup> J. Piña Garza, Interview, September 19, 2009.



*The CDC 330 at ICA's headquarters in Minería 145 (circa 1970). Punched card reader and magnetic tape units to the left, removable disk units towards the back. Curtains to front and back of the building were drawn to help with temperature control. Towards the top there is a glimpse of the mezzanine floor housing programmers. Courtesy of Fundación ICA.*

Staff was initially housed in the mezzanine floor overlooking the glass plated computer area (but eventually re-located to the basement just below the computer). As mentioned, new staff had been hired and, as had been the case in the US and elsewhere, PSI quickly found out that the combination of speedy growth, staff turnover and poor documentation resulted in administrative mayhem.<sup>92</sup> Moreover, new graduates within the 35 or so programming and computer operating staff were keen to learn new computer languages (such as IBM's APL) and interpret a business situation through that lens regardless of whether that was any resemblance to the real world.<sup>93</sup>

As opposed to the situation of the initial team at Aereofoto, where everyone knew about every aspect of running the computer, the increase in staff numbers allowed for specialization within the computer team (with some focusing on the operating system, others on computer operation, managing data input, the payroll system, engineering applications, etc.). In other words, administrative functions were created while a proper organizational system was built around the new computer and the services it offered.<sup>94</sup> Isolating computer staff and equipment behind physical as well as organization walls was a bit of a shock for some, particularly to those who had more intimate contact with computer equipment at university.<sup>95</sup>

<sup>92</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>93</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>94</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>95</sup> L.E. Maumejean, Interview, September 15, 2009.

Interestingly, at the time of signing the computer leasing contract Quintana questioned but did not overruled the team's decision to deploy a CDC. When learning of the reasons why the team failed to continue using IBM, Quintana opined:

‘You know better, but for us in the construction business its “Caterpillar, Caterpillar and Caterpillar”. Each time we have selected a brand other than Caterpillar because it seems cheaper, we always regret it because we do not receive the same maintenance service, there are no spares, poor technical engineering assistance, etc. So eventually it turns out to be more expensive. Are you then sure of the decision [to select CDC and not IBM]?’<sup>96</sup>

With hindsight, Quintana's query turned out to be somewhat prophetic as the CDC was plagued with problems. Everyone regretted the deployment of the CDC.<sup>97</sup> Initially the CDC seem to have been the right choice as it would require only a couple of hours to run the same process that took a day at the 1130.<sup>98</sup> But failures were very frequent. Often were the results of poor management -- installing the wrong update, operating system or software package. So ‘overflow’ problems were quite common.<sup>99</sup> Hardware issues due to the newly introduced integrated circuit technology were rare but much more serious. For instance, the soldering of circuits onto circuit boards was prone to loosen up.<sup>100</sup> Another problem was that the 3300 required 400 Hz electrical power. Standard equipment included a converter from the standard 60 Hz grid power frequency in the USA, but because the feed in Mexico was 50 Hz this required the installation of a second frequency converter.<sup>101</sup> Problems in converting from 50 to 60 to 400 Hz was one of the most frequent (and frustrating) sources of operational failure.<sup>102</sup>

To make matters worse CDC's Mexican engineering support and servicing teams were not to really set up to deliver on past promises. More often than not, engineers and spare parts often had to be flown in from the US and this increased the time to provide a solution.<sup>103</sup> This was in sharp contrast to the service IBM had provided to Aerefoto, as IBM's service engineers proved to be quite knowledgeable, available immediately at any time of day (or night) and prompt to secure spare parts.<sup>104</sup> Fortunately the abundant down time was compensated by a high throughput, meaning that when it actually functioned properly the CDC could quickly tackle the accumulated backlog of jobs.

By mid-1970 the credibility of the PSI team was at a freefall as quite often the machine failed to be ready to

<sup>96</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>97</sup> A. Dovalí Ramos, Interview, September 25, 2009; J. Piña Garza, Interview, September 19, 2009.; L.E. Maumejean, Interview, September 15, 2009.

<sup>98</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>99</sup> L.E. Maumejean, Interview, September 15, 2009.

<sup>100</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>101</sup> J. Piña Garza, Interview, September 19, 2009.; B. Bátis Echavarría, Interview, September 15, 2009.

<sup>102</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>103</sup> J. Piña Garza, Interview, September 19, 2009.

run weekly payroll (manual workers at Metro organized more than one revolt in response). To make matters worse, frustrated with the slow and error prone process of key punching, Dovalí had insisted that the 3300 should have an Optical Character Recognition (OCR) device.<sup>105</sup> The hope was that the OCR would speed up and reduce error in data capture tasks by being more accurate and faster than punched card data entry. But even in ideal case where volume was sufficient to use them continuously, the OCR devices of the late 1960s and 1970s could only capture half of the data on ICA's forms as a large part of the information was hand written. This short coming was made more acute by the fact that the OCR's rent was very expensive.<sup>106</sup>

### **Offering Computer Bureau Facilities through Joint Ventures**

In 1970 Carlos Flamand was appointed general manager of PSI while Dovalí moved with some of the technical team that been part of Aereofoto on to set up a consulting and special projects company called ICATEC.<sup>107</sup> Piña remained at PSI with the same post, responsibilities and remuneration.<sup>108</sup>

Teams at ICATEC and PSI then began planning to maximize the use of the CDC as well as finding new income streams.<sup>109</sup> The number of 'client' companies had remained stable when migrating from the 1130 to the 3300, rather than increasing as planned.<sup>110</sup>

To address this, an external group of consultants based at Arthur D. Little de México S.A. submitted a proposal in May 1970.<sup>111</sup> In exchange for US\$36,400 they claim to able to identifying and prioritizing areas for software development by PSI.<sup>112</sup> By then the PSI team had started to develop a large number of engineering and administrative applications around the 3300. However, these developments (and particularly non-engineering applications) were taking place without consultation with general managers at other firms within the group.<sup>113</sup> General managers of other ICA subsidiaries were not interested in outsourcing administrative procedures to the computer centre. Adding transparency to their operations would mean losing opportunities to 'dress up' financial performance. Neither was here consensus within ICA's top management regarding the need to 'modernize' financial operations and automate procedures

<sup>104</sup> J. Piña Garza, Personal communication, November 24, 2009

<sup>105</sup> A. Dovalí Ramos, Interview, September 25, 2009; J. Piña Garza, Interview, September 19, 2009.

<sup>106</sup> A. Dovalí Ramos, Interview, September 25, 2009; J. Piña Garza, Interview, September 19, 2009.

<sup>107</sup> B. Bádiz Echavarría, Interview, September 15, 2009.

<sup>108</sup> J. Piña Garza, Personal communication, November 24, 2009.

<sup>109</sup> At this point the Metro payroll project was coming to an end after approximately three years in operations. Specifically the first part of the firstline opened in September 1969. The second section together with stations for the second and third lines opened to the general public in April, August and November 1970, respectively. Although interesting and important to help secure the second computer, this was only one application which did not generate sufficient business for all of the available computer capacity at the 3300 nor enough income to cover the monthly rent. J. Piña Garza, Interview, September 19, 2009.

<sup>110</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>111</sup> The proposal considered a US\$30,900 fee and plus US\$5,500 in expenses. The consulting team was made out of Arnoldo C. Hax, Joseph J. Leshick, Fernando Pérez Guerrero and José Sánchez Padilla. F.P. Guerrero, *Propuseta a Grupo ICA (1-1078)*, México, D.F., Arthur D. Little de México S.A., May 5, 1970, pp. 8, Appendix.

<sup>112</sup> F.P. Guerrero, *Propuseta a Grupo ICA (1-1078)*, México, D.F., Arthur D. Little de México S.A., May 5, 1970, pp. 3-4.

<sup>113</sup> J. Piña Garza, Interview, September 19th 2009.; L.E. Maumejean, Interview, September 15, 2009.

across the group. Not surprisingly the outsourcing of payrolls and accounting from other firms into the computer centre never materialized. This failure to develop internal markets for the new applications killed ICA's hopes of becoming a leading local provider of computer and software-related consulting services.

The search for new income streams also included considering a joint 'computer utility' venture with local and US-based computer services organizations. The idea rooted to Dovalí, Bátiz-Echavarría and Maumejan (as technician) successfully deploying a machine maintenance application while contracting and operating a 'service bureau' terminal from University Computer Corporation (UCC) in the border town of Brownsville, Texas (while supporting an engineering contract in the Mexican side of the border).<sup>114</sup> Confident on this success idea was born of offering a shared service to give other Mexican firms (and particularly those with headquarters in Mexico City) access to computer capacity and expertise. US-based computer services organization were expected to provide secure access to know how for software development, help with localizing software packages as well as offering time sharing and teleprocessing services inside and outside ICA.<sup>115,116</sup> The 'computer utility' concept was relatively new and not very widespread in Mexico (as a similar service had been offered locally since circa 1966 by IBM based on a 1401<sup>117</sup>) and PSI was seen as 'taking a leading role in its development.'<sup>118</sup>

A first project considered establishing a PSI' subsidiary called 'Servicio Público de Computación' (UIA). A factor in this joint venture was that potential US partners had strong preferences for different computer vendors: Scientific Research Co. favored Xerox's Sigma machines; Optimum Systems Inc. suggested IBM equipment; while UCC, pointed to a combination of Univac and DEC's PDP machines.<sup>119</sup> UCC was the partner of choice for PSI.<sup>120</sup> As a complement to the UCC proposal, Government Studies and Systems, Inc. or GSS (a Philadelphia-based subsidiary of Mathematica, Inc.), was sought as an opportunity to gain access to their 'large library of useful software'.<sup>121</sup> However, negotiations with the Americans stalled chiefly because the Mexican government retained the monopoly in data transmission.<sup>122</sup>

ICA's top brass welcomed the initiative to a computer bureau and the consultant's report but failed to make

<sup>114</sup> B. Bátiz-Echavarría, Personal communication, November 29, 2009.

<sup>115</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>116</sup> In 1972 Grupo ICA had 41 subsidiaries and took part in many joint ventures, plus holding minority shares in other enterprises ("Empresas ICA Sociedad Controladora, S.A. de C.V.," available: <http://www.fundinguniverse.com/company-histories/Empresas-ICA-Sociedad-Controladora-SA-de-CV-Company-History.html>. For details of a successful non-technology joint venture with a US partner in the 1980s and 1990s see G. Gordon and T. Williams, "How do you spell success in Mexico? CALICA," *Business Horizons*, Jan-Feb, 2001, pp. 11-18.

<sup>117</sup> J. Piña Garza, Personal communication, November 24, 2009. This source also notes that IBM's 'service bureau' evolved well into the mid-1970s when it offered 'enviable support and service based on an IBM 370'.

<sup>118</sup> Letter from R.L. Sisson, vice-president of Government Studies and Systems Inc. to B. Bátiz-Echavarría, Procesos y Sistemas de Información S.A., July 14, 1970, p. 3.

<sup>119</sup> On University Computer Corporation (UCC) see further [Campbell-Kelly, pp. 79-85].

<sup>120</sup> Internal memo from B. Bátiz-Echavarría to V. San Miguel, Procesos y Sistemas de Información S.A., July 27, 1970.

<sup>121</sup> Letter from R.L. Sisson, vice-president of Government Studies and Systems Inc. to B. Bátiz-Echavarría, Procesos y Sistemas de Información S.A., July 14, 1970, p. 1.

<sup>122</sup> *Establecimiento de un servicio public de computo electrónico*, Compañía Mexicana Aereofoto, S.A., circa 1970; J. Piña Garza, Interview, September 19, 2009.

a decision. Lack of progress led Piña in 1971 to explore the possibility of developing a joint computer centre with Carlos Sama, chief systems engineer at Banco del Atlántico, a mid-sized financial institution.<sup>123</sup> The idea was to create three areas, focused on developing banking service applications (made out primarily from bank staff), engineering applications (made out primarily of PSI staff), and general purpose computing (staff by members of both organizations). But could the CDC 3300 could absorb applications already running on Banco del Atlántico's UNIVAC 9200 as well as serving the 'real time, online' data transmission needs of the bank?<sup>124</sup> Given that operational problems were clearly evident with both the 3300 and the 9200, Piña and Sama recommended terminating contracts with both CDC and UNIVAC and migrating to either a Burroughs or preferably an IBM.<sup>125</sup>

To study the options GSS was again brought in as an external consultant to PSI. Its report, delivered in September 1970, concluded that 'at an unspecified future date, [the Mexican computer utility business] will become a very significant market.'<sup>126</sup> Although GSS recommended renegotiating the terms of the proposed joint venture with UCC, its report urged ICA to enter the market and acquiring 'the necessary managerial expertise' either with UCC or alone.<sup>127</sup> Interestingly, the report noted that the market could be serviced through 'straight-forward batch-process systems' apparently endorsing a more traditional service bureau approach over the online timesharing model associated with computer utilities.<sup>128</sup>

However it was other sections of the report that were to have the biggest influence on the development of data processing within ICA. The report argued for PSI to spearhead the diffusion of best practices and automation within ICA but urged that ongoing 'consulting tasks' be stopped, redefined and deferred until after a suitable development plan was put in place. It called for a revision of staff and managerial tasks as well as a search for new technical personnel and 'managerial talent'.<sup>129</sup> The report was read by ICA's top brass, rather selectively, as recommending abandoning all external activities, dropping all plans for bureau services and focusing PSI in servicing ICA's subsidiaries.<sup>130</sup>

<sup>123</sup> C. Sama and J. Piña, *Consideraciones para la integración del centro de cómputo PSI-BANATLAN*, México, D.F., Ingeniería de Sistemas BANATLAN-Procesos y Sistemas de Información S.A., circa 1971.

<sup>124</sup> C. Sama and J. Piña, *Consideraciones para la integración del centro de cómputo PSI-BANATLAN*, México, D.F., Ingeniería de Sistemas BANATLAN-Procesos y Sistemas de Información S.A., circa 1971, pp., 23-4.

<sup>125</sup> J. Piña Garza, Interview, September 19, 2009.

<sup>126</sup> R.L. Sisson, *An Assessment of the Possible Market for a Computer Utility in Mexico*, Philadelphia, PA: Government Studies & Systems, Inc., September 11, 1970, p. 1.

<sup>127</sup> R.L. Sisson, *An Assessment of the Possible Market for a Computer Utility in Mexico*, Philadelphia, PA: Government Studies & Systems, Inc., September 11, 1970, p. 1.

<sup>128</sup> R.L. Sisson, *An Assessment of the Possible Market for a Computer Utility in Mexico*, Philadelphia, PA: Government Studies & Systems, Inc., September 11, 1970, p. 1.

<sup>129</sup> R.L. Sisson, *An Assessment of the Possible Market for a Computer Utility in Mexico*, Philadelphia, PA: Government Studies & Systems, Inc., September 11, 1970, pp. 2-3.

<sup>130</sup> J. Piña Garza, Interview, September 19, 2009.

## Conclusion

Following Piña's dismissal from PSI (but not of ICA as he joined ICATEC) in 1971, the PSI team decided to replace the temperamental CDC 3300 with an IBM 370. Once the decision had been made, the CDC was immediately replaced with an IBM 360/40 in 1972 while the 370 installed until 1974.<sup>131</sup> At the same time, there was a review of internal and consulting activities. Only the most profitable applications were retained, among them some engineering applications and payroll of construction workers (as a means of control rather than cost savings from automation). This rationalization together with a reduction of staff size finally left a profitable (although much smaller) operation.

ICA had finally reached a stable, if conservative, model for the application of computer technology. Its first computer, the IBM 1130, had initially been installed for engineering applications but was soon switched to automating administrative tasks in search of stable income stream from other ICA units. Strategies and applications were pursued with gusto but without much discipline and without a firm grounding in an understanding of the internal or external markets of the reality of internal political rivalry within ICA. The pursuit of computer bureau and teleprocessing facilities was visionary but again failed to be firmly grounded: long on strategy and short in implementation. As a result and in spite of a large library of administrative computer applications, it was very hard for PSI to secure appropriate business volume. The computer centre survived as a scaled down operation. The grand plans of those around the computer centre in Aereofoto and PSI were not profitable.

This lack of internal demand was not simply a matter of bad marketing on the part of the computer staff. Adoption of standardized accounting and administrative programs implied, and facilitated, the standardization of financial controls and procedures across the company. But business managers had considerable autonomy and the ICA hierarchy did little to enforce the rapid introduction of standardized norms and procedures across subsidiaries. This was rooted in the origins of subsidiaries as 'tax efficiency' vehicles rather than from a corporatist vision of what could be offered in the service sector. Business historian Alfred Chandler famously explained the emergence of diversified multidivisional companies as an intelligent adaptation of business structure to new strategies, but in the case of Mexico it appears to have taken place more as a response to the distinctive political economy developed under decades of rule by the 'Partido Revolucionario Institucional' (Institutional Revolutionary Party).<sup>132</sup>

With hindsight, however, it was not a question of whether but when financial standardization would take place. This eventually took place in response to external pressure (in 1992) when ICA was floated on the

<sup>131</sup> J. Piña Garza, Personal communication, November 29, 2009.

stock exchange. Reporting requirements and investor expectations drove the consolidation of account control, rationalization of subsidiaries, and elimination of the incentives to general managers had to tweak reporting of internal accounting figures.<sup>133</sup>

More generally, however, this story confirms the need to consider the histories of computer use within the broader contexts of nations and industries. The development of computer usage in construction firms did not necessarily proceed along same path documented previously for banks and insurance companies. ICA's unconventional shift of the 1130 from the engineering applications for which it was designed and purchased to administrative work for which it was ill adapted was prompted by the firm's internal market, which in turn was shaped by the Mexican regulatory environment and the dominant place of public infrastructure projects in the Mexican economy. In this case ICA's structure as a web of interlocking companies encouraged its computer staff to seek out external customers, but also starved them of the resources and support needed to effectively enter the nascent markets for computer services, facilities management, or online services.

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<sup>132</sup> A. D. Chandler, Jr., *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*. Cambridge, MA: MIT Press, 1962.

<sup>133</sup> J. Piña Garza, Interview, September 19, 2009.