MIS IN SOVIET INDUSTRIAL ENTERPRISES: THE LIMITS OF REFORM FROM ABOVE

The USSR has carried out a large-scale program to bring computer-based information systems, called Automated Enterprise Management Systems (ASUPs), to industrial enterprises. This program illustrates the extent to which computer-based information systems are inextricably embedded in the surrounding social, economic, and political systems.

WILLIAM K. McHENRY and SEYMOUR E. GOODMAN

Over the past 20 years, the Communist party and the government of the Soviet Union have orchestrated an unprecedented program to introduce computer-based information systems (CBIS) from the top down on the scale of an entire country. Billions of rubles have been spent to create more than 3000 CBIS at the enterprise level (ASUP) [37],[1] but the integration of these systems into the general economy of the USSR has been fraught with numerous difficulties. A reevaluation of the key aspects of the program was set in motion by a resolution of the Communist Party Central Committee in June 1983 [13]. Typical of the recent criticism is a 1984 article in *Pravda*, the Communist party newspaper, which pointed out that

> the time for noisy promises of transferring everyone and everything in the management sphere onto the shoulders of a computer and of improved multimillion ruble profits from ASU has passed. Instead there must be a sober evaluation of the expenditures and the fruit that is returned from them, and active participation, directed towards increasing the real effectiveness of information systems. [32, p. 3]

This unusually frank article could have said much more. The bulk of ASUPs have failed to live up to official expectations, and few changes have taken place in the actual management of enterprises [16, 37].

At the height of their publicity in the early 1970s, guidelines were issued mandating that ASUPs comprise as many as 12 functional subsystems [57]. ASUPs were envisioned as general-purpose, computer-based information systems that would be able to bring automation into almost all divisions of the enterprise, covering mainline and staff management functions. The most widely implemented subsystems were intended for operational production management (scheduling, production-status tracking, some forecasting and accounting functions), calculation of the annual plan, accounting, production engineering, and management of sales and inventory.[2] The majority of ASUPs were geared toward manufacturing industries.

Between 1965 and 1985, about 7500 ASUs were built throughout the Soviet economy. About 3300 are at the enterprise level, a few hundred are ministry-level systems, and most of the rest are for process control [44, 56]. Thus, of the approximately 44,000 industrial enterprises, only 7.5 percent have their own ASUPs. When compared to the approximately 580,000 enterprises, organizations, and institutions that the Soviets say have a need for comput-

[1] ASUP stands for *avtomatizirovannaya sistema upravleniya predpriyatiyem*, which means Automated Enterprise Management System. ASU, for automated management system, is the most common Soviet term for computer-based information systems. The enterprise is the lowest atomic production unit in the Soviet economy, ranging in size from a few workers to over 10,000. "Enterprise" also may include research and design organizations, trading establishments, and even warehouses. This research is largely concerned with industrial enterprises, as was the ASUP program.

This work was partially supported by IBM, Los Alamos National Laboratory, The Charles Babbage Institute, and The Prince Charitable Trusts/IIT.

[2] Other subsystems have included quality control, management of auxiliary production, personnel, finance, long-range planning, wages and labor, order execution, dispatching, and norms database [37].

ing in management applications, the number of ASUPs appears minuscule [52].[3] However, about one-third of Soviet enterprises with more than 500 employees have ASUPs, so ASUPs cover a disproportionately larger percentage of overall production. At the current rates of introduction of about 200 ASUPs per year, only a small minority of all Soviet industrial enterprises will have their own systems by the year 2000.

Although systematic comparisons with the United States are beyond the scope of this article, it is worth noting that virtually all U.S. enterprises of this class had some comparable applications running on their own mainframes by 1978 [48]. However, U.S. users have generally had more computers, larger configurations, greater reliability, better vendor support, and more access to time-sharing.

The great difficulties that have been encountered in absorbing ASUPs are not due to any one overriding cause, but represent a confluence of organizational, economic, and political constraints on the part of users, service suppliers, and higher level organizations. This program illustrates the extent to which CBIS are inextricably embedded in the surrounding social, economic, and political systems.

In addition to examining computer usage in one of the most important sectors of the Soviet economy, this research has a broader scope. First, it demonstrates the applicability of the web model (described below) at the level of an entire country. Second, the ASUP drive shows how the social meaning of a program can exert a significant influence on its outcome. Finally, and most importantly, the ASUP program shows the limits of "reform from above" when implemented via a complex technology. Even in what might be regarded as "the world's largest corporation," centrally formulated mandates and standards for CBIS could not alone ensure their successful diffusion and absorption. The final section of this article examines these conclusions in detail.

The diffusion of computing technology throughout one major stratum of an entire economy can be analyzed within the theoretical framework of a web model [26]. As the work of Kling and his associates has demonstrated, most computing research has been dominated by a discrete-entity approach, a paradigm that essentially holds that the key determinant of the success of a computer system in a complex organization is the nature of the computer system itself [25]. In contrast, "web models view computing developments as complex social objects which are constrained by their context, infrastructure, and history" [27]. Without the richer explanatory power of the web model, one might be tempted to think that poor hardware was the primary reason for the limited success of the ASUP program.[4]

In this article, the context is called the superstructure and is taken to be the organizations that surround the enterprise. In the USSR, these include higher level bodies such as the State Planning Committee, the State Committee on Standards, and an enterprise's parent ministry, as well as organizations with which the enterprise has horizontal ties (e.g., suppliers). The infrastructure consists of ministries that produce computers, research and design organizations that provide software services, and in-house divisions that provide custom applications software.

THE HISTORICAL SETTING

The Soviet enterprise exists in an economic system that has been changed remarkably little since it crystallized under Joseph Stalin in the early 1930s. The essential features of this system are centralized production planning, price setting, and organization of supply, accompanied by dual hierarchical control through ministries and through Communist party organizations. The fulfillment of plan targets brings large monetary returns and other types of rewards to workers and managers, and new plans are most often performance-based increments to previous targets. Most research and design organizations are separate from production units, and the military sector is consistently given the highest priority.

Under Stalin, the chief indicator of performance was gross output, and the enforcement mechanism was administrative. Reforms enacted in 1965 emphasized economic self-interest and accountability (*khozrashchet*). Since the mid 1960s, the Soviets have engaged in a search for the right combination of economic levers that could unlock greater productivity [47], and this process of tinkering has become somewhat institutionalized [3].

In 1963, a large study of potential computing applications resulted in a plan for the implementation of a massive State Network of Computer Centers (GSVTs) and a pilot program for ASU. Because of technical and bureaucratic limitations, little progress was made on the GSVTs, but a small number of experimental ASUs were built during the 8th Five-Year Plan (1966–1970) [4, 34]. In 1966 the production of large mainframes was assigned to the All-Union Ministry of the Radio Industry (Minradioprom),

[3] At the end of 1980, computing investments in general were distributed in the Soviet economy roughly as follows: industry, 64.0 percent; transportation and communications, 9.1 percent; science and education, 3.5 percent; construction, 3.1 percent; agriculture, 2.8 percent; and other areas, 17.5 percent [35].

[4] See [18] for another application of the web model on the scale of a country.

which is within the military-industrial sphere. Smaller systems and applications software development were left to the USSR All-Union Ministry of Instrument Construction, Means of Automation, and Control Systems (Minpribor). In 1968–1969, a decision was made to functionally duplicate the IBM S/360 series computers rather than continuing with indigenous designs, all of which failed to meet users' needs in a variety of areas [8].

By 1971, the leadership had moved away from enterprise autonomy to greater centralized control based on managerial rationalism. ASUs were embraced as a means of increasing productivity without wide-ranging economic reform [1, 4]. The vision of ASUPs that emerged included a fundamental restructuring of enterprise management toward optimization of all activities. The following quotation from Nikolay Fedorenko, director of the Central Economics and Mathematics Institute, and one of the leading proponents of the ASU program, is typical:

> An ASU is not created in parallel with, or next to, an "ordinary" management system. . . . The process of designing an ASU is the sequential and step-by-step introduction of improved methods and hardware into the existing management system. The new methods and means must naturally grow into the structure of management, becoming its foundation, and the means by which it will function on a higher level. In such a way, standardization and automation of the design and creation of ASU is a most important direction of improving management systems at enterprises . . . , ministries and departments, on a nationwide basis. This path will guarantee the fastest transfer of the best practical experience from one organization to others, the use of well-designed and well-tested modules in management systems, and the choice of optimal decisions on the basis of using a greater quantity of information. . . . [12, pp. 1202–1203]

The paradigm for design included the idea of developing "standard design solutions" and "applications program packages" at "base" enterprises in order to facilitate the massive transfer of applications to similar enterprises. Standards were published on how ASUPs should be designed and built, including a mandatory list of subsystems to be included [57].

At the same time, the proposal for the GSVTs resurfaced in a stronger form—this time for the creation of OGAS, the Statewide Automated System for the Collection and Processing of Data for Accounting, Planning, and Management of the National Economy [6]. Although progress has been slow, some top-level planners continue to embrace OGAS [11, 45]. It represents the ultimate in the centralized use of computers and is eventually supposed to allow planning and statistical information to be sent up and down the hierarchy automatically, providing a flexible feedback mechanism by which the center can exercise finer tuned control of the economy.

Thus, by the early 1970s many of the essential features of the ASUP program had been set. At the infrastructure level, labor was divided among a number of organizations, and the decision had been made to functionally duplicate the IBM S/360 computers. The importance of the military guaranteed that some of the best products would be directed away from the general economy [17]. The centralized push for ASUPs was established at the superstructure level, which included a mandated set of tasks with emphasis on optimization and sweeping management changes, and links to higher level systems such as OGAS. This official conception of the ASUP program has changed little over the past 15 years [13].

THE DEGREE OF ABSORPTION OF ASUPs IN SOVIET ENTERPRISES

The Soviets have reported considerable data about the average number of computer applications, the sophistication of applications, technical characteristics of hardware and peripherals, and expenditures on automation. A wealth of qualitative, anecdotal evidence has appeared as well, which partially compensates for the handicap of not being able to perform surveys and other more active forms of on-site research. Further empirical support is contained in [22], [33], and [41], and the tables in [37].

The percentage of enterprises that have implemented ASUPs, discussed at the beginning of this article, demonstrates that the breadth of absorption is rather small. If anything, the official statistics overstate the number of ASUPs that are actually performing useful work.[5]

The functions that have been included in ASUPs are largely restricted to those that increase efficiency without substantially impacting effectiveness. Widely cited figures hold that about 75 percent of the tasks in ASUPs are for accounting/statistical functions; 20–24 percent are for planning; and 1–5 percent are for optimization [13, 31]. For the most part, the existing management system has driven the design of the applications. The main users of output from ASUPs are functional departments and lower level line management. In most cases these functions are not so critical as to shut down the enterprise if

[5] Figures given in [55] suggest that only 37 percent of the official number of process control systems are "honestly carrying out work." We do not know whether this ratio should be applied to ASUP, but the majority of unofficial counts have been around 14 percent less than the level indicated by official statistics [37].

the computer stops. A large percentage of the reports produced by ASUPs appears on a monthly, quarterly, or yearly basis. The small use of optimization methods in ASUPs has been one of the greatest disappointments of the program [13].

ASUPs were generally implemented in a top-down manner, with an initial design for the entire system. Rather than building complete subsystems, a few tasks for each subsystem were created in each stage. Throughout the 1970s, the software industry delivered about 30 tasks for each ASUP, in comparison with standards mandating more than 200 tasks. The definition of task is unclear, but in some cases it represented a single report and, in others, a number of related reports. New ASUPs are apparently now going on-line with considerably more tasks. However, the average number of tasks remained low thoughout the 1970s, indicating that little development was performed on existing systems [37].

Consequently, in the majority of enterprises with ASUPs the bulk of each department's work remains manual. Tasks that are simplest and cheapest to implement have generally been chosen over those that give the largest economic return or demonstrate to the enterprise the desirability of using computers. The net result is an increase in work for management personnel, complication of the management system, and greater costs. The old management system cannot be dismantled because the new one is incomplete and, as will be shown below, unreliable.

The average cost of equipment, development, and implementation of an ASUP has been in the range of 1 to 2 million rubles, or $1.25 to $2.50 million at official Soviet exchange rates, with design comprising about 55 percent of the expense [54, 59]. Thus, about 6 billion rubles were spent to put ASUPs into operation. The corresponding levels of expenditures for training, maintenance, and operation are not known.

Cost/benefit analysis is performed according to a state-mandated methodology, the essence of which consists of predicting what unit costs and profits would have been without the ASUP, predicting what they will be with it, taking the difference, and declaring this to be the "savings" due to the ASUP [58]. The savings divided by the costs determines the payback period, which usually must be less than about three years in order for the ASUP to be approved. It is generally acknowledged that this methodology grossly overstates the actual effect [13, 29, 32]. Numerous individual statistics have also appeared in the press (e.g., [54]), but unfortunately, many of them are derived from calculations using the suspect methodology.

Thus, the Soviet statistics do not provide sufficient evidence to say that ASUPs have provided systematic benefits for their users. A wealth of anecdotal evidence indicates that, when benefits are present, they are related to relieving workers from the tedium of doing manual calculations. ASUPs have had little effect on decisions made by enterprise management [37]. A typical reaction to ASUPs was provided by the director of a construction organization, who in essence said, "Just give me enough materials and I can fulfill the plan" [50].

SUPPORT FOR APPLICATIONS: THE INFRASTRUCTURE

The Soviets have built a large computer infrastructure that has succeeded in delivering usable hardware and software to a large number of organizations throughout the economy. The infrastructure had the most success in building hardware [18], systems and applications software were next, and training a knowledgeable user base was last. Because responsibilities were divided among several ministries, certain functions fell through the cracks and many details were left to the users.

Until the late 1970s, the majority of ASUPs were based on second-generation computers. In many cases, magnetic tape was the only secondary-storage device. Departments maintained their own files, which were filled with redundant and sometimes inconsistent figures. Many of the second-generation, Minsk-32 computers, which were widely used in ASUP well into the 1970s, are still in operation today. Third-generation, Unified System (ES) computers, which functionally duplicated some models of the IBM S/360 line (and, later, the S/370 line), were a significant improvement, but failed to meet expectations for several reasons. Migration from the older machines was difficult, and many enterprises wound up maintaining them alongside of the new ones. The initial configurations were limited, and upgrading them was difficult or impossible [38].

Discrete entity analysis is most appropriate for understanding the impact of hardware shortcomings. The level of hardware impeded the introduction of complicated and integrated tasks, reduced the confidence of management in its ability to rely on the computer for anything critical, and lengthened the time needed to design and implement systems. The designs were chopped up into stages, with the first stage being a small subset of the total. Some of the limitations (e.g., for running optimization models) are illustrated by the specifications listed in Table I (next page). The full designs would have at least needed database-management-system (DBMS)

TABLE I. Selected Specifications of Computers Widely Used in ASUP

Model	In series production	Speed (KOPS)	Main memory	Cycle time (μs)
Minsk-22	1965–(1970)	4–6	4–16 kwords	—
Minsk-32	1969–1975	20–40	16–64 kwords	5.00
Ural-11	1965–(1975)	3–10	16 kwords	—
ES-1020	1972–1975	9–30	64–256 kbytes	2.00
ES-1022	1975–(1982)	80–107	128–512 kbytes	0.80–2.20
ES-1030	(1974)–1976	55–100	128–512 kbytes	1.25
ES-1033	1977–	140–250	256–1024 kbytes	1.20–1.50
ES-1035	1979–	100–200	256–1024 kbytes	0.85

Source: [37, p. 215, 235].

Ranges of values may represent discrepancies between authors. The Minsk-22 and Minsk-32 used a 37-bit word. The Ural-11 used a 25-bit word. The ES machines used an 8-bit byte. Parentheses in the production column indicate estimates. The Minsk-32 may have been delivered with disk storage after 1971. No disks were available for the Minsk-22 or Ural-11. The ES models through the ES-1033 had as little as 14.5 Mbytes on two drives. The Minsk-32 went for many years without disks.

technology and on-line terminals, both of which require considerably more main memory than was present. The available 7.5-Mbyte and 29-Mbyte disk drives (IBM 2311 and 2314 technology) were almost certainly insufficient for the full ASUP designs at large enterprises. One hundred- and 200-Mbyte disk drives (IBM 3330 technology) became available around 1980 [37].

Software for ASUPs was provided by a network of institutes within Minpribor, by ministry research and design organizations, and by the enterprise itself. The Tsentrprogrammsistem Production Association (TSP) software house was set up in 1974 to bring about the wide introduction of software packages into the economy. It had difficulty in getting software developers to build software that could be formed into packages, deposited in its library, and used elsewhere (largely because of the lack of remuneration for the effort to make the software generic [5, 13]), and had no incentives to reject poor-quality software [42]. A lot of the applications software in the Soviet economy was made and used in just one place. Soviet ASUP software was often written in assembly language, poorly tested, and of low quality. The development of many ASUs has apparently stopped because "the burden of 'that which has been poorly worked out' does not permit further steps ahead" [28, p. 5]. Today TSP markets fewer than 500 packages [9].

Perhaps the greatest failing of the Soviet infrastructure was its ignoring the ordinary user. Users received insufficient training, both in computing itself and in management science more generally [1]. They had little interest in computing and little ability to influence the ASUP designs. Designers remained isolated from users. Their contact with the enterprise was through the ASUP department, which itself was removed from the mainstream of enterprise activities. Pieces of ASUPs were farmed out to different organizations, and overall enterprise interests remained unprotected without the direct participation of high enterprise officials [21]. Design organizations were not interested in correct specifications, testing, maintenance, and enhancement: Their plans were fulfilled once a certain number of tasks in a certain number of subsystems were built. Although these problems may sound familiar to U.S. users, their Soviet counterparts in general had far fewer options and almost no recourse if systems were built poorly.

At present, large disk drives, terminals, datacommunications peripherals, and the largest ES models are still in short supply [5]. The ES models that are in widest use still break down about once a week [49]. It is said that Minradioprom provides service on less than 40 percent of the computers it produces, Minpribor provides it on less than 12 percent, and Minelektronprom, the Ministry of the Electronics Industry, offers no such service [11]. In 1986 the Soviets exhibited a 317-Mbyte sealed disk drive (ES-5063.01), but production is probably at least one year away. Only within the past two years have descriptions of multilevel, multimachine, online CBIS appeared in the Soviet press [37]. It has been estimated that, to bring about the massive introduction of microcomputers throughout the economy, models that are at least two orders of magnitude more reliable than the ES machines will have to be created [20]. Once a microcomputer breaks down, it often "rests in peace" [19].

The shortcomings of the infrastructure continue to constrain ASUP, although not as severely as in the 1970s. However, solving the infrastructure problems and providing the best hardware will not eliminate the other significant barriers to their introduction and use, which is the subject of the next section.

THE SUPERSTRUCTURE: THE IMPACT OF ECONOMIC PERVERSITY ON ASUP

Computing threatens the way that business is done in Soviet enterprises on a number of levels, and it has met with resistance on all of them. At the upper levels of management, an ASUP is viewed as a huge risk that can potentially interrupt production and cause plan targets to go unfulfilled. The data on the economic payoff of computer systems do not reassure managers of great benefits. Intangible benefits, such as improving the quality of decisions, have not been extensively realized and do not serve as an additional inducement to adopt computers.

Why would a manager perceive an ASUP as a risk? Table II serves as a summary of the idealized "rational" goals (left side) set forth in the ASUP program and the typical "perverse" behaviors that managers often find necessary in order to meet their number-one target of fulfilling the production plan (right side) [2]. The manager who follows the "rational" course and operates close to true production capacity can end up much worse off in the long run because of the tendency to "plan from the achieved level." Without the guarantee of treatment by the ministry (which would take into account the new way in which the enterprise is being managed, including the provision of sufficient resources and the setting of appropriate plan targets), the manager is without strong incentives to adopt an ASUP. Managers who take on big targets and fail are at great risk.

The "perverse" behaviors often seem to be at odds with the very tasks that computers perform best. For instance, computer-calculated inventory replacement policies are of little value in an environment where almost all supplies cannot be procured without a central order, and where both the quantity and the quality of goods tend to be erratic. An optimal production plan can be rendered effectively useless by absent, late, or low-quality supplies, plan targets that are frequently changed by the ministry, or the mandatory use of centrally set norms that deviate from local conditions. Even computerizing simple accounting can be perceived as a threat. It is easier to hide inconsistencies when the accounting system is manual: It is slow and fragmented, everyone knows how it works, and repeating large calculations is out of the question. Subdivisions in Soviet enterprises have their own plans to fulfill, which makes them subject to similar pressures to supply falsified information. For optimization, accurate data are critical. U.S. experience suggests that MRP systems perform worse than their manual counterparts without the maintenance of a rigid workplace discipline that is hard to achieve even when all of the participants solidly support the system [26].

The Soviet manager must also nurture a carefully constructed network of informal links. Connections made through phone calls, ministry visits, expediters, influence (*blat*), and outright bribes can mean the difference between meeting and not meeting the plan. Sales departments know that they should ship first to customers that can do a favor for them, and not to those who are "optimal" based on "rational" objective functions. If the computerized books reflect these activities, local party officials, the ministry, or some other regulatory body that decides not to look the other way can easily document them. For

TABLE II. Idealized ASUP and Actual Enterprise Manager Goals Compared

Idealized ASUP goals	Enterprise manager goals
Maximize and optimize production	Fulfill the plan so that next year's targets can be met
Optimal, minimal levels of inventories	Acquire as many supplies as possible
Release labor	Hoard labor
Maximize plan flexibility	Minimize changes in plan targets
Realistically evaluate capacity	Understate capacity
Realistically evaluate actual performance	Overstate performance if necessary
Use computer to audit, control, cross-correlate, and analyze	Avoid dangerous revelations to superiors; find out as much as possible about subordinates
Improve data processing	Improve data processing

example, accounting procedures that will reveal how expediters who procure needed supplies outside of regular channels are financed will surely be circumvented or rejected.

In short, enterprises that play by the rules in the Soviet economy risk cutting their own throats; computerized management information systems are designed to help enterprises play by the rules. One critic summed up the situation this way:

> The reason for the low interest of a manager in introducing ASU . . . [is] the fact that under the existing order, even an enterprise with a well-operating ASU in the final analysis turns out to be in a worse position in comparison with the ones that have nothing to do with ASU. [15, p. 927]

A number of prominent Soviet observers think that the resistance to computerization among managers who do not already have ASUPs is even greater now than it was 20 years ago [13].

Given such circumstances, how did any ASUPs end up in enterprises at all? There appear to be four main reasons: the increasing inability of enterprises to handle calculating loads, the desire to appear progressive, imposition of an ASUP on an enterprise from above, and a true desire to perform well.

Demand for help in handling calculating loads is undoubtedly great. Large enterprises circulate 20,000–30,000 documents per year, and one Soviet study concluded that only 16–27 percent of these show up on time [51]. However, once the ASUP program was in full swing, enterprise directors flocked to appear progressive by requesting and accepting a computer:

> In the early 70s economic managers were hit by a wave of fashion for electronic computers. Without knowing the machines' specific features, capabilities and operating conditions, and interpreting the words 'thinking machine' literally, some executives hastened to buy computers and then announced that they had created ASU. Riding this wave, some were even able to pass for progressive managers. [39, p. 2]

In some cases the choice of which enterprises would receive computers was based on the enterprise's leading position in the branch, but in other cases the ministries assigned the development of ASUPs to certain enterprises in order to fulfill the ministry plans.

What happened to enterprises that made serious attempts to effectively use computers? Some enterprises, such as the Kama River Truck Plant and the Volga Automobile Plant in Tol'yatti, were created recently and did not have an entrenched bureaucracy with which to contend [37]. The designers of the Barnaul/Sigma ASUP, installed at the Barnaul Radio Factory (BRF), overcame the problem of inaccurate data by forging a direct link between output and norms data and workers' wages. Once the ASUP was introduced at BRF, for example, production losses in shop number one were cut from 20.00 percent to 0.06 percent [36]. The director explains what happened subsequently:

> Inside the enterprise, after introduction of the ASUP everything became clearer, whereas the situation became more complex in its external connections. In the ministry they were used to the fact that the figures presented by the enterprise were underestimated for output and exaggerated for needs. We now come out with accurate calculations: with the true labor-intensiveness and actual opportunity to reduce it, with true staffing, with a clear need for materials. But the ministry's approach toward us is the same as to enterprises not making more accurate computer calculations. But we are still standing firmly because we have new methods of accounting and calculation, because we have totally different arguments for evidence than when everything was done by hand in a single variant. But I think that the problems of the external order will remain until our system is hooked up with the sector ASU and suppliers' ASU. [40]

Could the ministry take any other approach? If it did, it would be sending a clear signal that enterprises need only to computerize planning in order to get padded plans approved. Is the risk and trouble of an ASUP worth it when the surrounding system remains the same? Many enterprises think not.

THE FUTURE OF THE ASUP PROGRAM

Near the beginning of 1985, the Communist Party Central Committee passed a program for computing development up to the year 2000. The program, which has not been published in full, apparently calls for better service, more hardware standardization, specialized computers, new training measures, the integration of process control/CAM and ASUP, and the introduction of computer workstations at the subenterprise levels [11, 43]. Development of OGAS will continue, but emphasis will be placed on process control, CAD/CAM, robotics, and flexible manufacturing. The creation of a State Committee for Computer Technology and Informatics (GKVTI) was announced in March 1986. According to Nikolay Gorshkov, its chairman, its mission is to bring about significant improvements in servicing, development, and use of computer technology. Gorshkov has stated that new regional servicing centers will be created that will report directly to the committee [9]. A new interbranch research and development organization is also being formed for personal computing.

Given the ability of the Soviets to concentrate resources on high-priority projects, these measures are likely to strengthen the performance of the infrastructure. No one can argue with the proposition that better hardware, training, and service will remove one set of constraints and thereby increase the chances for successful ASUP implementation. Enterprise managers face fewer dilemmas with CAD/CAM and robotics because they do not entail a total restructuring of management itself.

What of the superstructure? The Gorbachev administration has initiated a number of reforms that include eliminating one level of management between enterprises and ministries and creating new "superministries" for interbranch coordination. Greater enterprise autonomy is to be coupled with improved centralized planning [23]. According to Gorshkov, the GKVTI will attempt to persuade managers to use computers when needed, and to dispense with their use "for show" [9]. In order to improve the receptivity of managers to ASUP, a blue-ribbon panel on ASUP suggested developing end-user-oriented applications and large-scale demonstration projects to show relevance and to break down resistance, finding the "right" people with initiative[6] and involving the top management of enterprises in development [13, 14, 15].

It is too early to say whether these reforms will "stick" or whether the bureaucracy will thwart them as it has done with previous reforms [15]. In order for enterprises to function with more autonomy, they must operate under conditions of increased certainty about supplies and orders, and ministries must be willing to relinquish some of their control. While it is possible to satisfy the need for regular and high-quality supplies to a certain portion of industry, doing it across the board will require that these new reform measures be implemented extensively and that they work. Enterprise managers must be convinced that conditions have really changed and that extensive use of the computer will now bring benefits.

Besides the pronouncements that ASUPs should be integrated with all other forms of automation in the factory, the Soviet authorities have had little to say about the fate of the ASUP program. The rate of introduction of new ASUPs has slowed dramatically from its peak in the 1970s. The new policy seems to emphasize regional service centers as a means of providing limited enterprise data processing and effective computer center management. At the same time, attempts at "reform from above" continue through new guidelines for standard tasks within the accounting subsystem of ASUPs [37].

[6] However, if a manager with "initiative" means someone who tries to play by the official rules, then such a person is not likely to succeed. See [53, pp. 211–221] for an extraordinary example of this.

CONCLUSIONS

The ASUP case demonstrates the applicability of the web model on the scale of an entire country. At any given point in time, all four parts of the web—historical exigencies, the enterprise itself, the infrastructure, and the superstructure—have influenced the results of ASUP.

The dynamics of this interaction can best be described using a two-tier model.[7] The superstructure is the top tier and is in a vertical relationship with the second tier, which is the enterprise and the computing services infrastructure. The top tier introduces constraints that shape the extent to which the enterprise is able to adapt computing to its own needs. Without corresponding changes in the incentive system, the Soviet manager has little motivation to incur the risks involved with implementing ASUP. The same kinds of constraints that influence the enterprise affect the performance of the infrastructure. Within the second tier, the horizontal interaction of the enterprise with the infrastructure determines how well acceptable applications are actually designed and implemented. Historical exigencies, such as the Stalinist system (which created an elite-centered, hierarchical economy) and the slow conversion to third-generation machines, introduce constraints at both levels.

The discrete-entity approach proved to be worthwhile for analyzing the specific impact of the inadequate infrastructure on the resulting CBISs. Adequate infrastructure support is a necessary, but not sufficient, condition for the success of CBIS. The web model highlighted the incongruity between the formal system of management implied by ASUP and the informal system practiced by enterprise managers, which is necessitated by the surrounding economic, social, and political system. The web model predicts that the Soviets will have to deal with a new historical exigency: widespread disillusionment about the efficacy of ASUPs.

The failure to incorporate and use optimization applications, which was one of the major ways the party leadership had hoped to make enterprise management more rational [13], illustrates the applicability of both approaches. Four of the reasons for limited use of optimization that have been cited are slow mainframes with insufficient memory, the dif-

[7] This model is similar to the Danziger et al. technology-environment model (TEM) [7]. The TEM sees technology as being constrained by, and impacting, the internal and external environment, but does not specifically distinguish between them.

ficulty of collecting sufficiently accurate data, the inapplicability of optimal plans when the surrounding system is inconsistent, and the undesirability of optimization because of the risk in running an enterprise close to the edge of its production function. Only the first problem can obviously be solved by better hardware. Accurate data might be collected (at a high cost) by the use of sensing devices, but even this could be subverted by an uncooperative work force. The third problem might be attacked by sufficiently sophisticated models if an enterprise manager dared to acknowledge the way the system really works by modeling it. The fourth must await changes in the superstructure.

The ASUP program also shows the influence of the social meaning of a program on its outcome. The program has had the effect of meeting an important need for demonstrating "progressiveness" on the part of enterprise directors who accept computers, and ministries that have high rates of usage at their enterprises. In this respect, the ASUP program is an outstanding example of what has come to be known as a campaign, or a large-scale effort on the part of Soviet authorities to promote a new technique that is portrayed as having great benefits. A generalized life cycle of such an effort can be depicted as follows: Initial euphoric press reports about early results and expected gains give way to accounts of isolated difficulties and then to more general conclusions about serious problems with the program.

U.S. users have been subjected to similar advertising campaigns, raised expectations, and disillusionment.[8] However, adoption of the technology is not an official state policy, users cannot generally afford pseudo-CBIS in highly competitive industries, the infrastructure usually provides technology that is sufficient (even if it does not meet all expectations), and CBIS can provide real gains when management is not subject to perverse economic and political constraints.

Soviet managers are accustomed to waiting out campaigns. Without changes at the level of the superstructure, the incentives for using the new technology remain cosmetic. As the program fades out of view, incrementalism takes over; slow improvements are made, but without the hope of the massive returns as in the beginning. The campaigns tend to drag on and are never fully abandoned because the power of the symbolism attached to "progressiveness" remains.

This phenomenon is particularly acute for computing. The ideology of the so-called scientific–technical revolution has placed computing in the forefront of technologies that will put social management on an even more scientific, Marxist–Leninist basis [24]. Therefore, the ASUP program in particular and computing more generally persist as important symbols of Communism that cannot be abandoned or significantly altered. Locked into the paradigm of managerial rationalism [7], the Soviets have greatly limited the extent to which the discourse on ASUP can involve questions of the organization of the superstructure.

The ASUP program was a massive, unprecedented attempt to use computing to impose "reform from above" and failed to live up to its goals. As computer-based information systems become more complex, the extent to which they must be deeply embedded in the organizations they serve in order to be successful also increases. ASUPs were highly complex and encompassed a wide range of functional subsystems. Computing does not appear to be a particularly good technology for introducing changes into an organization from without.

One would think that the Soviets, by virtue of national centralized control, would have had a much better ability to impose these reforms. However, the Soviet economy has reached a degree of complexity and diversity in which it is extremely difficult to impose uniform policies from above. Such was the case with the widely heralded economic reforms of 1965, the effects of which were dissipated by the ministries, whose officials are comfortably entrenched in the status quo and wield an enormous amount of power [46]. Although ministry officials desire to exercise as much power over their enterprises as possible, they also depend on good enterprise performance, which means that they, too, may work against the managerial rationalism of ASUP.

The Soviets, it seems, have yet to fully determine what to do about ASUPs. The goal of "reform from above" apparently remains unchanged, but new ASUPs are being introduced at a trickle. Yet, if the USSR is to realize the 150 percent increase in productivity that General Secretary Gorbachev desires by the year 2000 [10], it must make much more effective use of computing at the enterprise management level. The web model underscores the necessity of improving both the infrastructure and the surrounding environment in order to achieve this goal.

[8] USAC, a program to bring integrated, portable CBIS to local government, provides some striking similarities with the ASUP program [30]. Both tried to build complete systems, both were in some sense top-down, including an element of "reform from above," both relied on outside contractors for software, both had a goal of transferability, both involved a large number of players and agencies, both tried to combine basic research and ultimate implementation, both used measurement criteria such as tasks produced, both found the task to be much more complex than expected, and both were perceived as failures.

REFERENCES

1. Beissinger, M.R. The politics of convergence: The diffusion of Western management ideas in the Soviet Union. Ph.D. dissertation. Dept. of Government, Harvard Univ., Cambridge, Mass., 1982.
2. Berliner, J.S. *The Innovation Decision in Soviet Industry.* MIT Press, Cambridge, Mass., 1976.
3. Berliner, J.S. Planning and management. Chap. 18. In *The Soviet Polity in the Modern Era*, E.P. Hoffmann, and R.F. Laird, Eds. Aldine, New York, 1984, pp. 476–509.
4. Cave, M. *Computers and Economic Planning: The Soviet Experience.* Cambridge University Press, Cambridge, Mass., 1980.
5. Chumachenko, N.G., et al. *Organizational Forms of the Use of Computers.* Naukova Dumka, Kiev, 1984.
6. Conyngham, W.J. Technology and decision making: Some aspects of the development of OGAS. *Slavic Rev. 39*, 3 (Fall 1980), 426–445.
7. Danziger, J.N., Dutton, W.H., Kling, R., and Kraemer, K.L. *Computers and Politics: High Technology in American Local Governments.* Columbia University Press, New York, 1982.
8. Davis, N.C., and Goodman, S.E. The Soviet bloc's unified system of computers. *ACM Comput. Surv. 10*, 2 (June 1978), 93–122.
9. Delphic Associates. New computer committee presents program. *USSR Technol. Update* (May 21, 1986), 1–2.
10. *Economist.* Nikita's ghost. *Economist* (Feb. 14, 1986), 50–51.
11. *Ekonomicheskaya Gazeta.* Horizons of computer technology. *Ekonomicheskaya Gazeta* 15 (Apr. 1985), 2.
12. Fedorenko, N.P., Ed. Round table of the editors: Problems of the development of automated management systems. *Ekonomika i Matematicheskiye Metody 10*, 6 (Nov.–Dec. 1974), 1200–1219.
13. Fedorenko, N.P., Ed. Round table of the editors: Problems and prospects for the development of automated management systems. *Ekonomika i Matematicheskiye Metody 21*, 3 (May–June 1985), 542–556.
14. Fedorenko, N.P., Ed. Round table of the editors: Problems and prospects for the development of automated management systems (continued). *Ekonomika i Matematicheskiye Metody 21*, 4 (July–Aug. 1985), 740–754.
15. Fedorenko, N.P., Ed. Round table of the editors: Problems and prospects for the development of automated management systems (continued). *Ekonomika i Matematicheskiye Metody 21*, 5 (Sept.–Oct. 1985), 920–934.
16. Fel'zer, A.B. The manager and the document: Who will win? *Ekonomika i Organizatsiya Promyshlennogo Proizvodstva* 9 (1985), 171–179.
17. Goodman, S.E. Software in the Soviet Union: Progress and problems. *Adv. Comput. 18* (1979), 231–287.
18. Goodman, S.E. The information technologies in Soviet society: Problems and prospects. Univ. of Arizona, Tucson, July 29, 1986.
19. Gromov, G. The maxi-problem of microprocessors. *Izvestiya* (July 20, 1985), 2.
20. Gromov, G.R. Professional applications of personal computers. *Mikroprotsessornyye Sredstva i Sistemy* 2, 3 (July–Sept. 1985), 9–15.
21. Gromyko, O. Why are automated management systems operating at half strength? *Pravda* (Aug. 23, 1982), 2.
22. Guneyev, G.S., et al. *The Scientific-Technical Level of Automated Management Systems of Associations and Enterprises.* Statistika, Moscow, 1977.
23. Hanson, P. Superministries: The state of play. *Radio Liberty Res. Bull. RL 167/86* (Apr. 21, 1986), 1–8.
24. Hoffmann, E.P. Soviet views of the "scientific-technological revolution." *World Polit. 30*, 4 (July 1978), 615–644.
25. Kling, R. Social analyses of computing: Theoretical perspectives in recent empirical research. *ACM Comput. Surv. 12*, 1 (Mar. 1980), 61–110.
26. Kling, R. Defining the boundaries of computing across complex organizations. In *Critical Issues in Information Systems Research*, R. Boland and R. Hirscheim, Eds. Wiley, New York. To be published.
27. Kling, R., and Scacchi, W. The web of computing: Computer technology as social organization. *Adv. Comput. 21* (1982).
28. Kompaniyets, V. Many nannies at the ASU. *Pravda* (Jan. 1, 1985), 5.
29. Kopylov, V.I. The automated control system: The responsibility of the client. *Sotsialisticheskaya Industriya* (Jan. 21, 1982), 2.
30. Kraemer, K.L., and King, J.L. Requiem for USAC. *Policy Anal. 5*, 3 (Summer 1979), 313–349.
31. Lapshin, Y.P. *The Development of Automated Management Systems in Industry.* Ekonomika, Moscow, 1977.
32. Levita, R., and Orfeyev, Y. Having thrown away the savings on paper: Problems and discussion. *Pravda* (Feb. 2, 1984), 3.
33. Makhrov, N.V., et al. *Parameters of the Development of Modern ASUP.* Nauka, Moscow, 1974.
34. Maksimenko, V.I. Basic tenets of the state network of computer centers. In *State Network of Computer Centers*, V.V. Malekhenkov, Ed. Znaniye, Moscow, 1982, pp. 5–18.
35. Maksimenko, V.I. The effectiveness of the use of computer technology in the national economy. *Vychislitel'naya Tekhnika Sotsialisticheskikh Stran 16* (1984), 86–94.
36. Marchuk, G.I., et al. *Adaptive Production ASU (ASU Sigma).* Statistika, Moscow, 1981.
37. McHenry, W.K. The absorption of computerized management information systems in Soviet enterprises. Ph.D. dissertation, Dept. of Management Information Systems, Univ. of Arizona, Tucson, 1985.
38. Myagi, A.R. Computer technology: It's not pieces, but configurations! *Ekonomika i Organizatsiya Promyshlennogo Proizvodstva* 4 (Apr. 1981), 135–139.
39. Novikov, I. With the gavel went the ASU. *Pravda* (Mar. 13, 1978), 2.
40. Podkopayev, V.S. Wider opportunities. *Ekonomika i Organizatsiya Promyshlennogo Proizvodstva* 5 (May 1979), 71–74.
41. Pogrebnoy, V.P. *The Effectiveness of ASU.* Nauka, Moscow, 1979.
42. Popsuyev, A.N. Experience and prospects for centralized supply of software for ASU designers. *Upravlyayushchiye Sistemy i Mashiny* 78 (July–Aug. 1985), 9–14.
43. *Pravda.* In the politburo of the CPSU central committee. *Pravda* (Jan. 4, 1985), 1.
44. *Pravda.* We will successfully complete the five-year plan. *Pravda* (Jan. 26, 1985), 1–2.
45. Ruban, V.Y., et al. *Systems Design of ASU.* Tekhnika, Kiev, 1983.
46. Ryavec, K.W. *Implementation of Soviet Economic Reforms.* Praeger, New York, 1975.
47. Schroeder, G.E. The Soviet economy on a treadmill of "reforms." In *The Soviet Economy in a Time of Change*, J.P. Hardt, Ed. Joint Economic Committee, U.S. Congress, U.S. Government Printing Office, Washington, D.C., 1979, pp. 312–340.
48. Seligman, D. The great Soviet computer screw-up. *Fortune 112*, 1 (July 8, 1985), 32–36.
49. Semenov, V.A., and Shumilin, V.F. Operational reliability of third-generation universal computers. *Energetika i Elektrifikatsiya. Seriya: Sredstva i Sistemy Upravleniya v Energetike* 9 (Sept. 1984), 13–17.
50. Shcherbak, M. ASU: Returns, problems of development. *Narodnoye Khozyaystvo Kazakhstana* 6 (1983), 62–65.
51. Shvartsman, V.O. *Electronic Mail.* Radio i Svyaz', Moscow, 1986.
52. Simchera, V. Use of computer technology in the national economy. *Voprosy Ekonomiki* 6 (July 1984), 55–60.
53. Simis, K.M. *USSR: The Corrupt Society.* Simon and Schuster, New York, 1982.
54. Sinyak, V.S., et al. *Automated Management Systems and the Manager.* Statistika, Moscow, 1983.
55. *Uchitel'skaya Gazeta.* The second literacy. *Uchitel'skaya Gazeta* (Jan. 15, 1985), 1.
56. *USSR National Economy in 1983, Statistical Handbook.* Finansy i Statistika, Moscow, 1984.
57. USSR State Committee for Science and Technology. *General Branch Guidelines for the Creation of Enterprise and Production Association Automated Management Systems.* 1st ed. Statistika, Moscow, 1972.
58. USSR State Committee for Science and Technology and USSR State Planning Committee of the USSR Academy of Sciences. *Methodology of the Definition of the Economic Effectiveness of Automated Management Systems of Enterprises and Production Associations.* 2nd ed. Statistika, Moscow, 1979.
59. Zhimerin, D.G., and Myasnikov, V.A. *Automated and Automatic Systems of Management.* 1st ed. Energiya, Moscow, 1975.

CR Categories and Subject Descriptors: J.1 [**Administrative Data Processing**]: *business; government*; K.4.3 [**Computers and Society**]: Organizational Impacts; K.6 [**Management of Computing and Information Systems**]

General Terms: Management

Additional Key Words and Phrases: Discrete-entity model, USSR, web model

Authors' Present Addresses: William K. McHenry, School of Business Administration, Georgetown University, Washington, DC 20057; Seymour E. Goodman, Dept. of Management Information Systems, University of Arizona, Tucson, AZ 85721.