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Soviet and Western scholars have long recognized that one of the major stumbling blocks in Soviet research and development (R&D) is inadequate attention to experimental or prototype production. The August 28, 1983 joint resolution of the Central Committee of the Communist Party of the Soviet Union (CPSU) and the USSR Council of Ministers "On Measures to Accelerate Scientific and Technical Progress in the National Economy" noted that "pilot production and experimental facilities at many enterprises lag behind today's requirements." The resolution indicated that increased allocations had been included in the 1983 annual plan and the 11th Five-Year Plan (1981-85) to accelerate the creation of pilot and experimental facilities.

Structure and Mechanics of Experimental Production

A resolution of the Council of Ministers of October 1962 distinguished three types of experimental installations. Pilot or test-bench installations (pilotnye or stendovye ustanovki) are used in research institutes for developing new processes on a laboratory scale. Semi-industrial installations (polusavodskie opytne ustanovki) correspond to the Western notion of "semi-technical plants." Although they may not incorporate all of the aspects of final production plants, they are used for obtaining information on particular parts of certain processes. Finally, experimental production installations (optyno-promyshlennye ustanovki), or pilot plants, are scaled down versions of final production facilities or processes.

P. A. Sedlov estimates that branch ministries should devote 3-3.5 percent of their annual budgets to experimental production.¹ Most ministries allocate
allocate less than one percent in this manner, but the picture has not been uniformly bleak. A notable example is the chemical engineering industry, which allocates up to eight percent of its budget per year for experimental production. In addition, during the 8th Five-Year Plan (1966-70) the machine tool industry more than doubled its experimental capacity. By 1970, all of the leading research institutes in the machine building sector had experimental factories and the number of workers engaged in experimental work increased by 50 percent.

Inadequate attention to experimental production results in a variety of problems. Among the most important are an inefficient assimilation of designs by production enterprises; a lack of standardization and duplication of effort; fragmentation of the research-production cycle (i.e., a gap between design and serial production); and a depressed rate of capital retirement and turnover. Various studies suggest that the closer the linkage between production facilities and R&D experimental production work, the more efficient the assimilation. Lakhtin demonstrated that lead-times of research projects that originate in experimental shops of factories are assimilated on the average three times faster than those that are transmitted from outside the R&D establishment.

Experimental production facilities in civilian sectors of the Soviet economy are subject to output and sales plans. In the absence of prototype facilities, design bureaus must contract with producer factories. However, prototype production under contract competes with the production plans of these plants and may not receive top priority, especially toward the end of
the plan period. Such contractual arrangements are initiated by the approval of a "technical assignment" (tekhnicheskoe zadanie, or TZ).

Research and development projects can be funded in one of these ways. An Initiative Scientific Research Project (initiativnaia nauchno-issledovatel'skaia rabota, or Initiative NIR) is begun by the director of a design bureau, and prior approval by a state committee or ministry is not necessary. The Initiative NIR allows for a degree of decentralization in the Soviet R&D cycle. As its name indicates, such projects are initiated by scientists and engineers within a design bureau who will then write a TZ for approval by the director. Total project costs cannot exceed 20,000 rubles or five percent of the design bureau's total budget. Initiative NIRs are intended to support risky or promising research to create a so-called "scientific zadəl" (backlog). In practice, directors often use such money to support research not funded by their state committee or ministry, and in many cases to departments that have lost contracts.

The Scientific Research Project (nauchno-issledovatel'skaia rabota, or NIR) is directly supported by a state committee or ministry. Once a TZ is signed by the project's scientific leader and usually the chief engineer of the design bureau, it is subject to approval by the head to the corresponding main office in the state committee or ministry for projects less than 500,000 rubles, a deputy chairman of deputy minister for projects between 500,000 rubles, and by the chairman or minister for projects in excess of one million rubles. An NIR usually results in an extended research report and the creation of an experimental prototype (if the NIR calls for the design of
hardware) in order to demonstrate the product's feasibility. An NIR typically
is prerequisite for the third type of R&D project, the Experimental Design
Project (opytno-konstruktorskaia rabota, or OKR).

Experimental Design Projects are directly supported by a state committee
or ministry. After a TZ is signed by the project's chief designer and the
director of the design bureau, it is sent for approval to the head of the main
office or the chief engineer, with final approval offered by a deputy chairman
or deputy minister. An OKR usually results in a pilot prototype and
production documentation. It is usually considered prerequisite to full-scale
production.

Research and development in the Soviet Union allows for flexibility in
subcontracting NIR's from an OKR, and vice versa. A contract TZ is usually
signed by directors or chief engineers of both the customer and contractor
organizations, and depending on the size of the contract, it is then approved
at a higher level, ranging from a main office to a chairman of a state
committee or minister. All the materials and equipment required for a project
must by provided by the contractor's state committee or ministry. Consequently, no design bureau is free to draw up contracts without prelimi-
nary agreement form its corresponding state committee or ministry.

When a design bureau relies on a production enterprise to conduct an
opytno-konstruktorskaia rabota (experimental design project), this is done
under a contract and the production does not count toward the enterprise's
production plan. Workers are not paid on a piece-work basis, but on a
time/bonus system. Sales of particular products from experimental production are used to offset development costs.

**The Roles of Experimental Production in the Soviet Economy**

In commercial non-defense sectors, experimental production facilities are often used to generate income and fulfill plan quotas rather than to test prototypes. In 1975, 40 percent of the budget of experimental plants in the chemical industry was derived from the sale of products from experimental production facilities. The Soviet popular press and specialized journals have noted a tendency for ministries to allocate scarce capital investment resources to maximize output, rather than experimental production. Throughout the 1960s, available resources in the chemical industry were concentrated on bringing new plants on line while leaving experimental facilities on the back burner.

In his recent and widely publicized Pravda article, Academician Abel Aganbegian of the Academy of Sciences of the USSR (AS USSR) stressed the need for "integral" research, development, and production associations. He cited the exemplary achievements of Elektrosila, Leningrad Optical Mechanics (LOMO), Ivanovo Machine Tool Production Association, and the Paton Institute of Electric Welding. However, he also noted that research institutes in the coal industry lack a large capacity design and experimental production base.

The stress on the need for more experimental production facilities was also reinforced recently by Academician Nikolai Sergeievich Yenikolopov in a
prominent article in Izvestia. Yenikolopov is the director of the USSR Academy Institute of Synthetic Polymer Materials, chairman of the Scientific Council of Synthetic Materials of the Presidium of AS USSR, and chairman of the USSR State Committee for Science and Technology Council on the Use of Polymers in the National Economy. He noted that the Soviet Academy of Sciences does not have a single experimental production center in the field of polymer chemistry. If scientists working under the auspices of an academy project wishes to test an innovation, they must utilize the facilities of a branch institute. Branch institutes normally will permit this only when the project is of clear commercial interest--i.e., when it relates to improving an existing technology. Yenikolopov argued that there exists a serious need for pilot-production facilities within the academy where most of the Soviet Union's scientific and R&D talent is concentrated.

Yenikolopov also notes the detrimental impact of "departmentalism" on innovation and experimental production. For example, the Balakovorezinotekhnika Production Association Developed a new technique for recycling rubber products. It adopted the technique on an "experimental basis," but was prohibited from introducing it into regular production because the process required the consent of the Scientific-Research Institute of the Rubber Industry of the USSR Ministry of Petroleum-Refining and Petrochemical Industry, which did not allow the new technique to be implemented. According to Yenikolopov, Deputy Minster M. P. Parfenov told him that "We have no need for your method. We will develop our own."\textsuperscript{10}

Experimental production can be used to increase self-sufficiency and
autarky in various branch ministries. The Minister of the Electronics Industry A. I. Shokin noted that when his ministry could not get adequate measuring and testing equipment from outside suppliers, they set up their own research-production facility for special "experimental" production. To fulfil its internal requirements, the Ministry of the Electronics Industry is now producing equipment that would normally fall under the jurisdiction of the machine tool, electrical equipment, chemical, radio-technical, non-ferrous metallurgy, instrument, and building-materials industries. According to Shokin, "it has proven well worth the effort" and a number of other branches are following the lead of the Ministry of Electronics. In addition, a former research engineer in the Leningrad Design Bureau reports that it was always Shokin's plan to create a self-sufficient "conglomerate" modelled after Litton Industries—a firm with which Shokin had some dealings and which he greatly admired.

Experimental Production in the Defense Sector

Unlike the civilian sectors of the economy, Soviet defense industries have close ties between design bureaus and production plants. Experimental production facilities in the defense sector are not subject to output or sales plans, but work on goal or task oriented projects established by contract. A Scientific-Research Institute (nauchno-issledovateiškii institut, or NII) devoted to a defense project can pay up to 40 percent of workers' monthly salaries in bonuses. Salaries are paid quarterly up to 120 percent of one's nominal salary when bonuses are included. However, such bonuses come from savings in the NII's salary fund. Consequently, NII directors are confronted
with the choice of reducing the size of their staffs and paying higher bonuses, or paying a small bonuses while maximizing their staffs. One recent Soviet emigre scientist indicated that the typical bonus is 30 percent per month.\footnote{12}

There are essentially two different models for the linkage between design bureaus, experimental facilities, and production plants in the defense sector. In the first model, which typifies production under the Ministry of Defense Industry, experimental shops are incorporated into the production plant. In the second model, which has been adopted by the aviation industry, design bureaus are autonomous of production plants and have their own prototype production facilities.

Firdman notes that technological innovation even under military contract tends to flow upward. Technical experts present proposals to Soviet military officials, making clear to them how the technical features of the proposed innovation will benefit them. "Classified" projects designed for military use are more likely to receive funding than unclassified R&D projects. Consequently, designers have a tendency to prefer military projects and understate possible civilian applications.\footnote{13}

Firdman claims that in the field of microelectronics, a conscious decision was made by top-level planners and policymakers in the early 1970s to reduce stress on the research and development of indigenous microelectronic technology and to shift attention to reverse engineering of Western technology. The Main Scientific-Technical Office of the Ministry of
Electronic Industry had a Department of Specimens that was organized to receive and plan the copying of Western technology. Consequently, funds for original R&D work dried up and the efforts of NIIs and design bureaus shifted to this task.

In the mid and late 1970s, the Leningrad Design Bureau (LKB), attached to the Svetlana Production Association, maintained only three "cleanrooms" for the manufacture of electronic microchips. One was used for production of photo masks; one was used for actual chip production; and another was reserved for experimental work. In 1980, LKB and Svetlana manufactured more than 100,000 microcalculators. The chips used in these calculators came from LKB's experimental laboratories because Svetlana did not have the necessary cleanrooms for serial or mass production. Shokin ordered LKB to continue to utilize its experimental facilities for the mass production of chips to fill military and non-military orders until Svetlana could gear up for the mass production of its own microchips. Military inspectors (voenpredy) monitor the quality of microchips coming out of experimental facilities. Chips that do not meet their quality standards are used to fulfill civilian plan quotas.¹⁴

Finally, experimental production facilities can be utilized for their ostensible, intended purpose--the research, development, testing, and introduction of new technologies. An example of a design bureau using its experimental facilities in this manner is the Central Design Bureau of Experimental Machine Building (TsKBEM). This complex, which researches and develops components and materials for the Soviet space program, has a pilot plant that occupies three sites in Kaliningrad. Most of its experimental work goes on
within the Materials Studies Section, which is charged with developing new
types of structural, ablative, refractory, heat insulation, corrosion-
resistant, erosion-resistant, and heat-radiation materials. One of the
laboratories of the Materials Studies Section conducts research on organic
coatings, lacquers, paints, polymers, and plastic materials for rocket parts
and assemblies. This research is conducted in conjunction with several
scientific-research institutes outside TsKBEM and the Ministry of Aviation
Industry, such as the Mendeleyev Institute of Chemical Technology, the USSR
Academy Institute of Organic Chemistry, and the USSR Academy Institute of
General and Inorganic Chemistry. These relationships are based on contracts
to utilize the latter's facilities to test prototypes for temperature, pressure, humidity, and vibration, etc. Other laboratories contract with
enterprises and institutes to utilize their test facilities. One such
facility, the Ukrainian Academy of Sciences Institute of Problems of Materials
Studies, has facilities located in the buildings of a former monastery in Kiev
and maintains test sites consisting of rocket stands with two or three rocket
engines.

There is no indication that any commercial income has been generated by
experimental production at TsKBEM. In fact, apparently there is no connection
to a mass or serial production plant. All reentry vehicles are produced by
the experimental plant. This is accounted for by the relatively small numbers
involved, a necessary lack of standardization of the end product, and the
obvious absence of general consumer demand for the product.
Conclusions

Preliminary research indicates that experimental production plays five distinct roles in the Soviet economy. Experimental production has been used for actual prototype testing of defense and space technologies, revenue generation in the chemicals industry, plan fulfillment in the machine tools industry, technological self-sufficiency in the electronics industry, and high quality, high technology production of microelectronic technologies.

My present research on Soviet experimental production and R&D is an attempt to systematically account for the differences in the utilization of experimental facilities in the USSR by looking at consumer demand of specific products, the degree of product standardization, rates of technological advance, and plan incentives or disincentives in experimental and non-experimental production in various economic sectors.*

*The author would welcome any comments or criticisms of this research as well as any suggestions that may assist him as he carries on this project.
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