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Soviet Design: The Neglected Partner of Soviet Science and Technology

According to my definitions, any society must combine "science," "technology," and "design" whenever it creates useful material objects. Science establishes principles which technology (with some admixture of common sense, and guidance from economics) embodies in physical components through manufacture. Design attends to the composition and arrangement of these components, as well as to the appearance and balance of qualities of the assembled product, with a view to satisfying consumers and other users. Given a conception of three essentially distinct elements, imports of advanced equipment by the USSR do not necessarily signify an inability to create original designs. The intention might rather be to put certain designs into production, using processes not offered by indigenous technology.

The term "design" can relate both to general principles and to specific objects; this essay will assume both meanings, but mainly the former. "Design" can also have the broader meaning, mentioned above, or simply external appearance; my normal meaning is the broader one. As a rule, I will attribute a concrete meaning to "design": that is, a particular type or model, the product of a design process. It will not mean, for example, plans of capital investment, unless its composition, layout, or external form are specified. Any procedure which results in a decision to adopt such a design will also be included.[1] The term refers to deliberate creations, including guided biological ones, an aspect that will be pertinent later in this essay. "Design" in this sense has important social as well as economic and military significance.

The relevance of the above to the USSR is that I propose adding an extra dimension—design—to the analysis of Soviet affairs. It would be inaccurate to assert that design has been wholly neglected in the literature; it is mentioned in fairly specialized studies, such as in studies of Soviet aircraft,[2] but has not been integrated into general analyses of Soviet development.

The redefinition is intended to enrich our understanding of the influence of design in Soviet circumstances, as well as of the consequences of its comparative neglect (both by Russians and by Western students of the subject). Subsuming almost everything under the term "technology" has had the result that the distinctiveness of design has not been recognized,[3] and thus its importance has

1. Similarly, when speaking of science or technology, one does not confine the meaning to their philosophy or social organization.

2. See, for example, Jean Alexander, *Russian Aircraft since 1940* (London, 1975).

3. Thus, in my terminology, "design technology" would have no clear or precise signification.

been underestimated. Consequently, the forces that have retarded Soviet development, that have enabled the USSR to do better in some directions than in others, or have compelled her to forgo a success that seemed within her grasp have not been understood as well as they might have been. This does not apply only to the USSR; the essential role of visual (nonverbal) thinking in Western development has also been underestimated.[4]

In general, different variants of a product can be produced with essentially unchanged equipment, either with minor adjustments or with the inclusion of particular processes or components. More substantial changes in the final design are often possible. Superficial variations—such as variations in color—require even less adaptation. A change in fashion, for example, requires an altered technology only when there is some fundamental change in the manufacturing process, such as the use of a novel material. The fact that an environment which discourages a novel technology can also encourage a novel design is attributable to social and economic circumstances, not to any identity of technology and design. Soviet designs tend to remain unchanged for much longer than is normal in a market economy, but this is because stylistic change is liable to disrupt an output plan which is very sensitive at the margin; even minor derogations from the stipulated output level cannot go unpunished. The longer the duration of the plan, the more deadening its stylistic results.

On the other hand, although essentially distinct, the three elements are interconnected. Equipment (like all other deliberately created objects) must be designed; the distinction must then be drawn between the envisioned process and the choice of components and materials that blueprint the corresponding equipment. It must also be possible to implement chosen designs of final products with available technology, or, like Leonardo da Vinci's, they will remain only inspired drawings. The interaction of technology with design is important. It is not static: automation and "process unity"—fashioning shapes so as to conform better to the design of the final product[5]—are two current Soviet trends that are tightening the connection.[6] The scientific contribution is also necessary. If any of these elements fails to match the standards of the others, any final product will be unsuccessful or at least nonoptimal: it might be too clumsy, too difficult to repair, not sufficiently accurate, too complicated to produce economically, or defective in some other way or combination of ways.

The proportional inputs of science, technology, and design can differ: for example, design makes a relatively large contribution in architecture. In any craft the scientific contribution is rudimentary, whereas in the electrical and electronic industries it is much greater. On the whole, the scientific share has been increasing historically. The absolute amounts of input can also differ, even when their proportional shares are the same. A new or more developed material

4. As is convincingly argued in Eugene S. Ferguson, "The Mind's Eye: Nonverbal Thought in Technology," *Science*, August 26, 1977.

5. Raymond Hutchings, "Soviet Technological Policy" in John Hardt, ed., *Soviet Economic Prospects for the Seventies* (Washington, D.C.: Joint Economic Committee, Congress of the United States, 1973), pp. 76 and 82. Military and military-associated manufacture was apparently the first to achieve success in this connection.

6. Compare S. Lieberstein's review of V. G. Afanasyev, *The Scientific and Technological Revolution,* in *Technology and Culture,* 18, no. 2 (April 1977): 260.

sphere normally requires larger inputs of all three elements, the clearest recent illustration of which is space exploration.

The element that takes the lead in enlarging its share is also significant. If design takes the lead, there might be a stunning breakthrough (such as the conversion of reciprocal motion to rotary motion), substantial gains in convenience or safety, or merely a new fashion. If technology leads, the results will probably include larger volumes of output and lower unit costs. The classic industrial revolution is primarily of this type. When science takes the lead, the outcome may be a new industry (such as the aeronautical industry) with far-reaching effects, a new research tool, or a more devastating weapon, or perhaps all three. Today, science is more often in the lead. Which element is retarded is also important; if it is science or technology, the remedies will include education, setting up higher educational institutions, and international academic exchanges. To rectify backwardness in design requires a broader cultural development and interchange, and, where there is a specific deficiency, espionage.

Every component is necessary. If one is unavailable, this does not mean that its impact is lessened; the appropriate skill must then be obtained elsewhere. If one is unaware of the deficiency, and therefore does not take pains to acquire that skill, whatever has not been done consciously will be done unconsciously, under the influence of uncontrolled forces.

Because of the interaction and combination of *three* elements, studies of Soviet science or technology which excluded Soviet design could neither describe nor assess accurately Soviet ability (or inability) to create material objects. By contrast, the "threefold approach"—looking through a triangular prism of science, technology, and design—can help resolve certain problems in the analysis of Soviet performance. Although this approach may be unable to determine by itself whether a particular report is true, it offers a critique that enables an assessment of probability (any such assessment must, of course, be based on knowledge of all relevant circumstances) and provides safeguards against dismissing potentialities too summarily. The threefold approach would have reduced Western surprise over *Sputnik I*, because it would have provided recognition of Soviet concentration on designing artificial satellites, in spite of Soviet backwardness in some areas of technology. The potential inadequacy of Soviet capabilities in designing manned spacecraft—which eventually caused the USSR to fall behind in the space race—might also have been predicted.

In an earlier article in *Slavic Review*,[7] and then more deliberately in my book,[8] I set out to fill the "design gap" as it concerned Sovietologists. The present article will rely partly on previously cited examples, but it adopts a different framework and posits more plainly expressed conclusions.

To begin with what may seem a bold assertion: areas of material production where the USSR is backward typically have been and are those where the necessary input from design is large relative to the necessary inputs from science and technology. Exceptions will be found to this generalization, as to all others; what needs to be stressed at the moment is that it is approximately true, and, as far as I am aware, has not been formulated before.

7. Raymond Hutchings, "The Weakening of Ideological Influences upon Soviet Design," *Slavic Review*, 27, no. 1 (March 1968): 71–84.

8. Raymond Hutchings, *Soviet Science, Technology, Design: Interaction and Convergence* (London: Oxford University Press, 1976) (hereafter cited as *SSTD*).

The USSR has, in fact, been notably retarded (relative to the most advanced Western countries, with which she prefers to compare herself) in computers, small chemicals (dyestuffs, pharmaceutical preparations, catalysts),[9] automobiles, textiles, clothing, and handicrafts; nor is instrumentation a strong area.[10] With the exception of small chemicals, all of these products require relatively large inputs from design, although even the one seeming exception is not absolute: choosing dyes requires a sense of color combination (an aspect of aesthetics, which is a design ingredient), and design can also be critical in the production of chemical equipment. But the chemical industry, which currently accounts for as much as 32 percent of all Soviet industrial cooperation agreements with foreign firms,[11] is a special case.

By contrast, the USSR has been less backward, and in a few subareas not at all backward—or even advanced—such as in ferrous metallurgy, coal, oil, and electric power (for example, in the production of generators and turbines,[12] and high voltage DC power transmission).[13] The needed input from design, relative to the inputs from science and technology, tends to be smaller in this group than in the areas mentioned in the previous paragraph. According to another survey, Soviet coal mining, oil, building materials, and agriculture are relatively independent, while chemicals, computers, shipping, the motor industry, timber, paper and pulp, and light industry are relatively dependent.[14] Apart from timber and pulp and paper, which nonetheless are technically linked to the chemical industry,[15] this division conforms to my suggested distinction. Although the inclusion of shipping may seem to contrast with the fact that since about 1960 Soviet warship designs have become more original,[16] the USSR imports almost exclusively *merchant* vessels. Soviet backwardness in computers, including computer mathematics (which is weaker than most branches of Soviet mathematics)[17] is consistent with this assessment, since design is critical in miniature objects.

Although other generalizations are possible—for example, that the USSR is ordinarily more backward in producing final products than in producing raw or basic materials or fuels—the design hypothesis is simpler and more exact.

9. Antony C. Sutton, *Western Technology and Soviet Economic Development 1917 to 1930* (Stanford: Hoover Institution Press, 1968), p. 259.

10. Hutchings, *SSTD,* pp. 103–4. The weakness of Soviet instrumentation was stressed, although with qualification, in a presentation by T. Gustafson at the Ninth National Convention of the American Association for the Advancement of Slavic Studies, October 13–16, 1977, in Washington, D.C.

11. Maureen R. Smith, "Industrial Cooperation Agreements, Soviet Experience and Practice," in J. Hardt, ed., *Soviet Economy in A New Perspective* (Washington, D.C.: Joint Economic Committee, Congress of the United States, 1976), p. 775, table 4.

12. A. C. Sutton, *Western Technology and Soviet Economic Development 1945 to 1965* (Stanford: Hoover Institution Press, 1973), p. 380. Sutton states that this was due to successful scaling-up based on Western processes.

13. P. Hanson, "International Technology Transfer from the West to the U.S.S.R.," in Hardt, *Soviet Economy in A New Perspective,* p. 792; cf. Hutchings, *SSTD,* p. 95.

14. Hanson, "International Technology Transfer," pp. 800–801.

15. The chemical industry is in fact a number of separate industries. The various branches of the chemical industry exhibited very different degrees of seasonality (see R. Hutchings, *Seasonal Influences in Soviet Industry* [London: Oxford University Press, 1971], pp. 42–43, table 8).

16. Finding based on my unpublished work.

17. I am grateful to S. E. Goodman for this observation.

There are, of course, exceptions. Watches and machine tools, both of which began to be produced comparatively early (watches in 1930), require additional explanation: it has been possible in Soviet circumstances (though not necessarily with complete success) to concentrate on raising the standard of design in any priority field. Both watches and machine tools have belonged to this category, the former probably because of their military use (which also inspired setting up a watchmaking industry in Great Britain between the two world wars), the latter because of their essential role in the Soviet scheme of industrialization.[18]

Items for the Soviet armed forces constitute a more substantial and significant exception. Designs for aircraft, tanks, and rockets are illustrative. The T-34 tank has been described as probably the best design in the history of armored vehicles.[19] The AK-47 is the favorite of guerrillas throughout the world.[20] The Mig-25 interceptor fighter (or *Foxbat*) gained a high reputation in NATO circles, although a detailed examination confirmed this appraisal only in part.[21] Soviet warships have scored several firsts and have high fire power for their size.[22] Such items require a comparatively large design input, yet they seem excellent in certain respects. On the other hand, present-day Soviet weapons —such as the *Foxbat*, evidently intended only as an effective high-level interceptor—are often more specialized than their Western near-counterparts. Earlier, the assortment of Soviet weapon types had been much more limited: for example, Soviet aircraft in World War II presented no wide variety (although the rather stereotyped scenarios of the Eastern campaigns should be noted[23]), and increased specialization can be regarded as an attempt to break up the design task into more manageable assignments, which contrasts with the greater difficulty of design for NATO "flexible" weapons. (Increased specialization is, of course, also a reflection of the expansion of Soviet economic strength.) Weapons systems of great complexity, such as long-range bombers or aircraft carriers, have been developed by the USSR either relatively recently or from foreign prototypes, or both.

Even in the military sphere the exceptional situation of Soviet weaponry from the angle of design proficiency must be qualified by the fact that the Western contribution to its design has been by no means negligible, if the entire post-1917 period is considered.[24] Thus, only within the past twenty years can one discern what may be called creative originality in Soviet warship design. Even the much-praised T-34 "was derived directly from Christie's 'fast tank' concept of the 1930s," that is, from an American design (which, intermediately, had

18. Machine tools currently account for 9.1 percent of Soviet industrial cooperation agreements (see Smith, "Industrial Cooperation Agreements, Soviet Experience and Practice," p. 775).

19. Chris Ellis and Peter Chamberlain, *The Great Tanks* (London: Hamlyn, 1975), p. 52.

20. I was recently impressed by the handling characteristics of the weapon, in comparison with assault rifles made in various other countries.

21. M. Allward, *Air Pictorial*, February 1977, pp. 49–50.

22. Captain James W. Kehoe, Jr., "Warship Design: Ours and Theirs," *United States Naval Institute Proceedings*, August 1975, pp. 61–62.

23. Cf. Raymond Hutchings, review of Sutton, *Western Technology and Soviet Economic Development 1945 to 1965*, in *International Affairs*, 50, no. 4 (October 1974): 653.

24. A number of illustrations are provided in Sutton, *Western Technology and Soviet Economic Development*, vols. 1–3.

been developed by the Russians into their BT series).[25] Difficulties encountered by the Soviet space exploration program can be ascribed to weaknesses in design as readily as to other causes. Eventually, the Soviets signed a contract with the American designing firm of Raymond Loewy and William Snaith; although the Soviets may have envisaged multiple areas of collaboration, it may be significant that, according to one Soviet view, this was the American firm that had accumulated the most experience in designing equipment for space flight.[26]

Those Soviet military designs that are successful are sometimes the result of a combination of imported design and ingenious simplicity; the latter can be regarded as one of the characteristics of native Russian design. A good example is the pin, splayed out at one end only, which joined links of the T-34 tank. The pin did not ride out because, each time the track came round, a projection on the body of the tank knocked it back again. Thus, the track neither came off accidentally, nor was it complicated to remove if necessary.[27] But even to the extent that they deviate from the major proposition clearly relating to design, military goods do not form any exception to a rule that design effort has been focused on high-priority items.

But let us look at design through the threefold approach. Adding a third dimension—design—sets a stiffer examination for any evidence alleging that military goods are of higher quality than nonmilitary ones, because it becomes necessary to show that they are superior in design as well as from scientific and technical angles: any very wide gap would demand superior contributions by all three elements. At the same time, an additional dimension emerges by which higher quality can be demonstrated if it is in fact present.

Thus one may go on to inquire: To what degree are the three elements common to both military and nonmilitary spheres? In the West, the degree of commonality is probably higher in science and technology than in design, whereas in the USSR it will be lower in science (perhaps especially) and technology, but higher in design. The difference in science and technology would be a product of stricter and more pervasive security barriers, and the difference in design would be the result of keener concern with interchangeability in the USSR (within practicable limits) of military and civilian items. Although internal security barriers can be investigated only indirectly, interchangeability is more readily observable and has wider significance than has often been recognized. Soviet practice is to maximize interchangeability among both civilian and military products, an objective that seriously restricts opportunities for innovation.[28]

Maximizing interchangeability between peacetime and wartime applications appears to have been one of the chief objectives of all-out industrialization—Soviet style—and, therefore, heavy industry was accented. Branches where manufacturing capacity could be adapted for producing military goods (for example, tanks instead of crawler tractors) were consequently overexpanded; and, because of inertia, the resulting models persisted long after their justification had ceased.

25. Ellis and Chamberlain, *The Great Tanks*, pp. 43–53.

26. Hutchings, *SSTD*, pp. 239–40.

27. Ibid., p. 179.

28. Thus, according to a BBC television report, a vehicle with high ground clearance, developed by the giant Togliatti motor works, uses the same back axle and transmission as the factory's standard product, the Lada (BBC Television, "The Money Programme," November 11, 1977).

Thus, wheeled (as opposed to crawler) tractors rose from 21 percent of total tractor output in 1953 to 57 percent in 1964,[29] a steeper rise than any change in agricultural conditions (or in other branches that absorb tractors) could have justified.

Soviet military/nonmilitary interchangeability exhibits several other specific differences, as compared with the Western variety: (1) It encompasses some unusual and even unique directions. Thus, atomic explosions have apparently been used by the Russians for peaceful purposes on a scale exceeding anything that has been attempted elsewhere. The latest revelation is that a nuclear explosion successfully quelled a great underground blaze.[30] (2) Although the West also adapts military goods for civilian products or vice versa, Soviet-made items seem to be more commonly developed *first* for military purposes, or are first considered for that role. If they do not satisfy the military, they may be developed for civilian purposes. In the West, a civilian product more often comes first, and is adapted for military purposes if it succeeds in its civilian role, rather than if it fails. Thus, after the TU-95 was judged to be unsatisfactory as a bomber, it was developed as a passenger airliner (the TU-114),[31] whereas the Boeing 707, a successful commercial airliner, has since been developed as an early warning aircraft (the AWACS). (3) When interchangeability is not greater in the USSR than elsewhere, it still results from more deliberate national decisions. Helicopters are an illustration: Khrushchev insisted that their designs should be adequate for civil as well as military purposes (the priority should be noted).[32] (4) As compared with a Western society, improved designs and technologies pass more readily from the nonmilitary sector to the military one, but less readily in the opposite direction. This is attributable to a combination of higher priority for military goods and the prohibition of business secrets.

The last circumstance is one that tends to generate higher quality of Soviet military than nonmilitary output. Other such circumstances include: the weakness of any stimulus toward higher quality from the Soviet economy relative to a market-type economy (this affects primarily commodities for the civilian market); the superior ability of the military hierarchy—relative to any consumer group—to formulate requirements, assess performance, and expose defects; and more continuous experience in the design of military goods. (For about thirty years prior to 1962, there was no Soviet body concerned with design in general, except in such limited but important directions as scaling-up and adaptation to metric measurement. During this time, the principal carrier of design capabilities in general seems to have been the military. Existing organizations which heeded aesthetic aspects of design—such as architecture or clothing—were ideologically constrained and/or had no tradition of aiming at technical effectiveness. One of the institutional antecedents of current Soviet industrial design appears to have been a decision made around 1956 by the Ministry of the Shipbuilding Industry, which produced naval as well as nonnaval ships.[33])

29. Earl M. Rubenking, "The Soviet Tractor Industry: Progress and Problems," in Hardt, *Soviet Economy in A New Perspective*, p. 604.

30. N. Mishina, "Sil'nee Stikhi: Rasskaz o tom, kak ukrotili moshchnyi gazovoi fontan," *Pravda*, May 20, 1977, p. 6.

31. N. S. Khrushchev, *Khrushchev Remembers*, 2 vols., trans. Strobe Talbott (Harmondsworth: Penguin Books, 1977), 2:72.

32. Ibid., p. 67.

33. Hutchings, *SSTD*, pp. 148–49.

Recent reassessments—based on Soviet equipment captured by Israel—reportedly show military equipment to be unexpectedly sophisticated, such as the NBC (nuclear/biological/chemical) protection of Soviet tanks. This may be taken to indicate an unusually wide difference in quality between Soviet military and nonmilitary goods, but its nature must also be noted: it reflects larger inputs into scientific aspects of design, rather than the application of any superior technologies.

Thus, there is evidence for a particularly large design effort in the military sphere. Furthermore, tanks, warships, and most other weapons systems, especially the most advanced ones, absorb relatively large inputs from science, including its most highly theoretical branches. The NBC weapons are obvious illustrations of this proposition, but the continually increasing importance of electronics or other forms of guidance (such as radar and sonar) in composite weapons systems provides another excellent illustration.[34] Such reported proposals as the neutron bomb and a high energy-directed beam being developed by the Russians for missile destruction confirm the actuality of these trends.[35] Propaganda about a "scientific-technical revolution" obfuscates this situation for some Soviet citizens. The fact that a larger proportion of Soviet expenditures for science, than of expenditures for the economy, is normally devoted to military purposes (authoritative Western estimates of these proportions are, respectively, 50 percent or more and 11–15 percent)[36] is congruent with this interpretation.

In a sense, of course, more advanced NBC weapons or protection against them do not constitute evidence for a military/civilian technological *gap*, since there is no such thing as a civilian tank and there is scant hope of defending civilians against NBC weapons. However, the nonexistence of civilian applications at least confirms the presence of a difference in quality. Any large quality gap between Soviet military and nonmilitary goods is not easy to understand when viewed exclusively through an economic prism: such a gap would not seem to coexist harmoniously with a highly centralized system (although the organizational and property differences between the industrial and the agricultural [collective farm] spheres must be remembered). When such a gap is considered to be derived from differential contributions from design and from science, it becomes more plausible.

The strengthening of science (relative to technology) and of engineering design (relative to artistic design), especially during the Soviet period, conforms to this interpretation. At the outset, engineering design was probably less advanced than artistic design, which included such remarkable achievements as the Russian Ballet or abstract art that can now be reckoned to have been in the forefront of contemporary trends. The promising developments of the 1920s, which aimed to link engineering and artistic design, were terminated by ideo-

34. For example, in regard to the AN/SQS-53 sonar on U.S.S. *Spruance* type destroyers, see Ezio Bonsignore, *Aviation & Marine International*, Atlantic ed., May 1977, p. 62.

35. Clarence E. Robinson, "Soviets Push for Beam Weapon," and Robert Hotz, "Beam Weapon Threat," both in *Aviation Week and Space Technology*, May 2, 1977, pp. 11, 16–23; cf. R. Walgate, "Russia's Incredible Beam Weapons," *New Scientist*, May 19, 1977, p. 379.

36. The higher percentage is assumed by Hans Bergendorf and Per Strangert, in "Projections of Soviet Economic Growth and Defense Spending," in Hardt, *Soviet Economy in A New Perspective*, p. 414.

Table 1. *Percentage Shares, Scientific-Technical Accumulation*

Period	Technology	Education	Science
1951–55	62.7	31.3	6.0
1956–60	64.7	26.1	9.2
1961–65	61.8	25.4	12.8
1966–70	59.6	25.9	14.5

Source: Iu. M. Kanygin, *Izvestiia Sibirskogo otdeleniia Akademii nauk SSSR. Seriia obshchestvennykh nauk,* vol. 1, no. 1 (1975), p. 5, table 1. The proportions are derived from ruble totals, expressed in prices of the 1971 plan and based on totals given in the annual statistical handbooks. These totals are stated to have been approximate.

logical intolerance, bringing about a rapid decline in the ratio of the standard of artistic design to that of engineering design. Similarly, both institutional and financial arrangements favored scientific rather than technological improvement (except within the limits of scaling-up and metrication). The latter trend, which took place in 1951–70, can now be documented from Soviet sources, which report percentage distributions of "resources of accumulation of the scientific-technical potential of the USSR" between these dates, computed by five-year subperiods, in technology, education, and science. Table 1 shows a continuous rise in a derived ratio of accumulation in science to accumulation in technology —from 9.6 percent in 1951–55 to 24.3 percent in 1966–70. This trend matches the stated goal of a more rapid growth of science than of technology, although that priority seems the reverse of what would best suit Soviet economic requirements.[37]

In regard to quantity of design (reckoned either in amount, or in the effort absorbed by it), data over any sustained period are lacking. Official statistics distinguished between projecting and design bodies, which possess an independent balance sheet, and design bureaus and sections, which depend financially on industrial plants. Betweeen 1962 and 1965 the latter group (measured by the number of groups reported) expanded twice as fast as the former: by an average of 4.8 percent annually, as compared with 2.4 percent. If these two categories jointly comprised design, while "scientific establishments and laboratories borne on the balance sheets of industrial enterprises" comprised science and technology, design grew faster over the same period: by an average of 4.4 percent annually, as compared with 2.5 percent.[38] However, this is a short period of time (no information has been provided under these headings since) and is very possibly atypical, since it immediately follows the founding (in 1962) of the All-Union Scientific-Research Institute of Technical Aesthetics (VNIITE), the national design organization. In any event, the denominator being technology *plus science,* it is not clear that design was progressing more rapidly than science, even at this time.

37. Hutchings, *SSTD,* p. 89.

38. Calculations are based on *Narodnoe khoziaistvo SSSR v 1965 g.* (Moscow, 1966), p. 67. In this source, data for design bureaus as well as for sections and laboratories which are financially dependent on industrial enterprises are given as of April 1, 1961; other entries as of January 1, 1962. My calculations assume the average annual growth rate to be unaffected by the change of reporting date.

Thus, on the whole (except in the military sphere), the development of design has been neglected. Let us examine more closely the circumstances that led to this result, and its consequences.

(1) The broadest circumstance was the Marxist stress on economics rather than aesthetics. To the extent that artistic traditions of material things survived the Revolution, they were associated with the avant-garde group, the Higher Artistic-Technical Studios (*Vysshie khudozhestvenno-tekhnicheskie masterskie*, or VKhUTEMAS) which soon ran into ideological shoals,[39] or else were associated with the peasantry whom the Bolsheviks despised and whose art had long been stamped with a mysterious but definitely un-Marxist imagery.[40] Acting out their industrializing slogan, "Technique decides everything," the Bolsheviks initially did not perceive the importance of the man/machine interface,[41] or of design, to the extent that the two were connected.

(2) The emphasis in economic development stressed engineering rather than artistic design.

(3) The system of planned economy did not favor design changes, which (especially if unforeseen) obstruct or complicate prevision of plan fulfillment. Consequently, mistakes were difficult to rectify.

(4) Fairly easy importation of foreign products (especially in capital goods) led to neglect of indigenous design ability and eventual atrophy of a fraction of it. Soviet participation in design in civilian industry consisted largely of planning buildings that would house imported machinery and converting foreign designs to a metric measure, a range of activities that provided inadequate on-the-job training.[42]

In general, foreign countries appear to have been chosen for their suitability as suppliers of technology, rather than of designs. It is, for example, difficult to account for the creation of a vast photographic industry (with the output of cameras rising from 29,600 in 1932 to 3,031,000 in 1975)[43] in a country that lacked retail processing facilities and prohibited photographing many things on security grounds, and where attitudes toward photography by foreigners verged on the paranoiac. Nor can one easily justify the urgent introduction of the large-scale manufacture of ice cream in one of the world's coldest climates, except on grounds of Mikoyan's firsthand acquaintance with the ice-cream industry in the United States. In these and other cases, design seems to have arrived as a fellow traveler with an exotic technology. This may be true even in the military sphere: although Soviet submarine forces in World War II did not score results com-

39. Hutchings, *SSTD*, pp. 141–43, 145, 148.

40. See Anthony Netting, "Images and Ideas in Russian Peasant Art," *Slavic Review*, 35, no. 1 (March 1976): 48–68.

41. Until the Stakhanovite movement, planned increases in industrial output were based only on the amount of capital investment, without taking into account workers' skill (see Hutchings, *SSTD*, p. 103).

42. Khrushchev, seeking to discover why Soviet industry was turning out tires with a much shorter life than was expected, found that departures had been made from the instructions left by the American firm that had introduced the process. When these instructions were reinstated, better tires began to be produced (Khrushchev, *Khrushchev Remembers*, 1:142–46). The discouraging moral for would-be improvers of foreign technology was that the foreigners always knew best.

43. Raymond Hutchings, *Soviet Economic Development* (Oxford: Basil Blackwell, 1971), pp. 302–3; *Narodnoe khoziaistvo SSSR v 1975 g.* (Moscow, 1976), p. 294.

mensurate with the number of boats available,[44] after adopting a version of the superior German Type XXI and German shipbuilding methods[45] since World War II the USSR has built a huge number of submarines—235 units of the W-class completed through 1957, more submarines than the number built by the rest of the world over the same time span.[46]

The conclusion that technology and its provenance has acquired an independent influence matches the fact that, in a Soviet-type economic system, supply and demand do not determine quantities and proportions as closely as they do in a market economy, so that technology has a wider scope to become influential. In fact, the effort to assimilate foreign technologies distracted attention from design (generally) to technology (generally). Newly introduced technologies could have enabled a fairly flexible choice of precise items to manufacture, if equipment had been imported primarily for extractive industry or for processing at earlier rather than later stages in manufacture. Although imported technologies were widely diffused between 1917 and 1930, their chief impact was in the raw materials, basic materials, and extractive industries. Between 1930 and 1945, however, the emphasis shifted to engineering, especially to its more complex branches such as machine tools, and to many final stages of manufacture. In these cases foreign designs were adopted along with foreign technology. Sutton states that "in sum, the Soviet industrial structure in 1945 consisted of large units producing uninterrupted runs of standardized models copied from foreign designs and manufactured with foreign equipment." Many complete plants were supplied. Between 1945 and 1965, large portions of German manufacturing industries were transferred to the USSR, after which attention turned to branches where acquisitions from Germany had been slight, such as the chemicals, computer, shipbuilding, and consumer industries.[47]

The Soviet era thus witnessed a shift from acquiring the earlier stages of production to acquiring the later ones.[48] This was accompanied by a decline in the flexibility of the designs associated with imported equipment. The sequence matches the transition from attention to design in the 1920s to its neglect during the ensuing three decades.

(5) Internal security barriers corralled design advances within the military sectors. (There were only small spillovers of innovations from the military and space programs in processes, materials, or hardware.[49]) This relationship—

44. J. Meister, *Soviet Warships of the Second World War* (London: Macdonald and Jane's, 1977), pp. 2–4.

45. S. Breyer, *Guide to the Soviet Navy,* trans. M. W. Hemley (Annapolis: U.S. Naval Institute, 1970), pp. 30–31, 146–48.

46. N. Polmar, *Soviet Naval Power: Challenge for the 1970s,* rev. ed. (London: Macdonald and Jane's, 1974), p. 90.

47. Sutton, *Western Technology and Soviet Economic Development 1945 to 1965,* pp. 411–14.

48. That technological imports now predominate in the later stages of manufacture is also suggested by the fact that Soviet/U.S. cooperation agreements have been signed mostly for radio, television, and electronic equipment (nine agreements), engineering (nine agreements), data processing (five), aircraft and parts (five), machine tools (four), and food product machinery (four) (see Lawrence H. Theriot, "U.S. Governmental and Private Industry Co-Operation Agreements with the Soviet Union in the Fields of Science and Technology," in Hardt, *Soviet Economy in A New Perspective,* p. 750).

49. Robert W. Campbell, "Management Spillovers from Soviet Space and Military Programmes," *Soviet Studies,* 23, no. 4 (April 1972): 606.

already discussed in connection with interchangeability—is also consistent with the delay in setting up any design headquarters. As long as indigenous design predominated in the military field, such a body either would have found its main data channels blocked by security barriers or would have been forbidden to function in the public eye. On the other hand, once official policy recognized design as a subbranch of legitimate knowledge, Communist enthusiasm for science probably assisted Soviet design to progress more rapidly in its more strictly scientific aspects (for example, ergonomics).[50] Finally, Soviet ideology, having instilled in its adherents the conviction that the USSR was compelled to confront the external world, inescapably instigated certain developments in design applicable to armaments, the space program, and associated branches of science and technology.

Though design is no less necessary than technology or science, its treatment over a long spell showed that it was regarded as far from an equal partner. But if design was indeed indispensable, how was this possible? One reason is that a little design can go a longer way if consumers or users cannot complain effectively. Poor design affects the utility of an object, or other qualities that are difficult to measure, rather than quantity of output or tonnage which in a Soviet-type economic system are the principal indicators of achievement.

To a certain extent, however, the apparent neglect of design diverged from the actual situation, at least in aeronautics and space exploration. The prominence and influence vouchsafed to some designers between the 1930s and the 1960s—a period during which design lacked a headquarters—is at variance with its institutional and documentary neglect. The last names (abbreviated) of leading aircraft designers were even hyphenated to type numbers as official designations of aircraft that emerged from their bureaus, a practice not followed elsewhere (with rare exceptions such as Sikorsky and La Cierva). Likewise, Korolev gained great influence, but for reasons of secrecy (he had been the chief designer of space vehicles) not prominence.

The fact that men such as Korolev or Iakovlev had to be very capable leaders and organizers in order to succeed shows what opposition and indifference they had to overcome initially. Their indispensability was recognized by the promotion of some of them to high administrative—and, in wartime, military—rank.[51] Even more significant was their direct access to Stalin: apparently there was no regular authority to which they could be subordinated. Designers' memoirs show that their teams' activities were barely accommodated by the existing administrative structures. Iakovlev, whose team had been installed in a bedmaking factory, succeeded like a cuckoo in ousting the bed producers and in taking over the whole plant. To gain his ends he had reached outside of the industrial hierarchy, even gaining support from *Pravda*.[52]

If designers, like many other citizens, fell foul of the system during the Great Purge, their indispensability to the state by no means disappeared; even while incarcerated, leading designers were assigned work within their specializa-

50. Ergonomics is the specialization of V. N. Munipov, the deputy head of VNIITE.

51. For example, in 1943 Alexander Iakovlev, already a deputy people's commissar and major general, was promoted to lieutenant general (A. Yakovlev, *The Aim of a Lifetime* [Moscow: Progress Publishers, 1972], p. 234).

52. Ibid., pp. 29–31.

tions (Soviet aircraft in the late 1930s was designed mainly within three special prisons!).[53] The correct, if rueful, deduction would be that extending unusual privileges to the designers was unavoidable, although one must also wonder how much better Soviet aircraft would have been, had normal facilities for designing them been provided.

I will now discuss the difficulties that resulted from the subordinate status of design. These difficulties were far-reaching:

(1) Stylistic development was interrupted and distorted. In many visual respects, the USSR, even after World War II, seemed frozen in pre-World War I styles—such as in interior design or in popular attitudes.

Any full survey of the influences upon Soviet design falls outside the scope of this article; briefly, however, these influences might be divided into five categories: (a) folk art and tradition, (b) ingrained predilections, (c) imports, (d) market preferences, and (e) scientific rationality. The very limited role allowed to market preferences has resulted in emphasis upon the influence of the others. Recent institutional history of Soviet design has particularly accented scientific rationality. As regards the complete scene, a complicated interlacing is discovered, but this will have to be the subject of a separate study.

Meanwhile, in the absence of a coherent set of principles, design analogy—the imitation of apparently valid parallels, without exploring what was required—retained too firm a hold. Characteristics of many Soviet designs such as largeness of scale, and horizontalism/verticalism—which I define as a propensity to build large things horizontally rather than vertically, and to prefer horizontal to vertical motion, unless a spectacular effect is intended, in which case there will be an exaggerated preference for the vertical[54]—stemmed partly from design analogy.

(2) In a society where important matters can be initiated only by the center, the absence of explicit and coherent directions relating to design allowed surrogate instructions to infiltrate from the adjacent area—technology. Because of the essential difference between technology and design (as previously defined) these instructions might easily point the wrong way, and yet might be accepted as valid, especially if they were not recognized as substitutes. This can be illustrated by Lenin's dictum about electrification and Soviet power. The availability of electric power must match that of electrically operated appliances, components, and electricians. One may, however, distinguish between the power used for processing in the course of manufacture and that used to drive the completed object; for example, electrically powered tools may produce a gasoline-powered automobile. Technology would encroach upon design if an instruction to electrify were understood to apply to the vehicle's final drive as well as to the processes of its manufacture. In the USSR the effects of such a misunderstanding may have included, in addition to relatively early decisions to electrify the railroads, an aversion to producing nonelectric-powered means of transportation, such as automobiles. Similarly, a proliferation of groups involved with automatic steering

53. G. Ozerov, *Tupolevskaia sharaga,* 2nd ed. (Frankfurt/Main: Possev-Verlag, 1973), especially pp. 24–29.

54. In regard to the Soviet navy, the match between these propositions and actuality is rather good, as I hope to illustrate in a forthcoming article.

and remote control[55] may have spilled over from attention to automating production processes.

(3) Foreign decisions were copied too servilely relative to what would have best suited Soviet operational needs, although that very feature may have economized indigenous design effort. Faults of an original were often reproduced along with its virtues.

(4) Neglect of artistic aspects of design contributed to the overemphasis on production of capital goods by comparison with consumer goods: since poor design stood in the way of Soviet exports, there was less possibility of exporting in order to import. Reciprocally, the secondary importance of consumer goods in Soviet economic expansion aggravated this neglect. A further result of the emphasis on capital goods was fragmentation of the design effort, accentuated also by the fact that individual institutes were interested in their specific technical fields, not in the kind of breakthrough to which an improvement in design can sometimes lead.[56] Another result was an enlargement of the total effort relative to the results achieved. This aspect may have remained in the mind of the director of VNIITE when he claimed advantages that would accrue from contracting the assortment of consumer durables.[57]

(5) Poor design lowered the effectiveness of resources allotted to consumer welfare; for example, the production of heavy (and ornate) furniture, using large amounts of materials, instead of light and compact fitments which, aside from saving material, would be more suitable for small apartments.

(6) Poor design probably encouraged measurement by inappropriate indexes, such as weight, area, or volume. Any index is liable to distort performance in a way that satisfies the index better; when the initial design is weak the tendency will be only weakly resisted, whereas if it is soundly based (for example, anthropometrically) there will be less likelihood of succumbing. Again there will be a reciprocal influence: the more deeply bad designs become entrenched, because they are more compatible with unsuitable indexes, the harder it will be to replace them. These relationships match the fact that periods during which concern was expressed for design and certain successes were actually achieved did not coincide with the epoch of all-out effort in industrialization; the successes in the latter case were tallied by such crude indexes as tonnage of coal or steel, or square meters of window glass.

(7) Lack of systematic attention to design disrupted the fulfillment of economic plans. Normally, in Soviet development, economic capacity, rather than the stage reached in design, has tended to be the pacemaker. When the First Five-Year Plan was adopted, only one-fifth of its scheduled schemes had been projected in detail.[58] The result was that costs tended to be inflated as projects were made more complete, and especially in the course of implementing the projects.[59]

55. Hutchings, *SSTD*, pp. 28–29.

56. This point is partly based on remarks by Bruce Parrott, in his presentation to the Ninth National Convention of the American Association for the Advancement of Slavic Studies, October 13–16, 1977, in Washington, D.C.

57. Hutchings, *SSTD*, p. 175.

58. B. Sukharevskii, *Planovoe khoziaistvo*, 1937, no. 11–12, p. 35.

59. These phenomena are documented in R. Hutchings, "Studies in Soviet Industrial Development" (Ph.D. diss., University of London, 1958), pp. 321–34.

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Several important postwar redirections of the Soviet economy—particularly changes not foreshadowed in the contemporary long-term economic plans, as if their origins were external to these—seem to have reflected reevaluations of developments in science, technology, and to some extent design, and in effect have placed greater emphasis on one element or another. Thus, the new and much enlarged program of residential building, announced in 1957, stressed technology (prefabrication) as, in the main, did a vast program of expansion of the chemical industry, revealed in 1958.

Eventually, a conscious effort was made to improve and strengthen Soviet design. This effort (which first came to my notice in September 1957) may also have been launched during the interregnum of the long-term plans. A rather long gestation followed, until a central design institute, VNIITE, was set up in April 1962. Its cumbersome title reflected the official insistence that design existed at the junction of technology and aesthetics, and this perpetuated the idea that the status of design was inferior to that of technology. Once again, however, the real status of design in the USSR exceeded its nominal one. VNIITE was set up as a grade 1 institute (the highest of four grades); its unusually favored status is shown also in the fact that it was released from the usual harness of annual and long-term plans, and was permitted to adopt a peripheral organization not exclusively on a republic basis, in contrast to the peripheral organization of Soviet science.[60]

Besides veritable accessions of care to design, there have been instances—both earlier and later—of claiming nonexistent potentialities. As previously defined, science influences *directly* neither the way things are made nor the balance of their qualities or their arrangement. One aspect of T. D. Lysenko's unorthodox biological theories was, however, the claim to be able to effect certain transformations in plants—the vernalization process—a throwback from Darwinism to Lamarckism.[61] In my scheme, direct influence on the composition or layout of an end product is the province of design. Although in the cited instance the end product envisaged by Lysenko was biological, my definition restricts design not to man-made items but to deliberately fashioned ones. Hence, from the angle of the threefold approach, the Lysenkoist claim amounted to an encroachment of science upon design. More recently, in the framework of what the Communist Party calls the scientific-technical revolution, Soviet philosophers of science have claimed that science can influence economic development directly, that is, without passing through the intermediate stage of technology.[62] According to my definition, this is impossible: the claim must be assessed as an encroachment of science upon technology. Both this claim and the Lysenkoist claim amount to an overassessment of the potentialities of science, as seen from the angle of the threefold approach; the two claims thus have something in common with each other. To recall the caveat mentioned in the beginning of this essay: the definition does not enable one to determine the truth, or otherwise, of a particular claim. How-

60. Hutchings, *SSTD,* pp. 20–21, 156, 166.

61. Zhores A. Medvedev, *The Rise and Fall of T. D. Lysenko,* trans. I. Michael Lerner (New York: Columbia University Press, 1969), pp. 7–8, 12–17, 151–55.

62. For example, see L. M. Gatovskii, *Ekonomicheskie problemy nauchno-tekhnicheskogo progressa* (Moscow, 1971), p. 118.

ever, recognition of this similarity can aid in the assessment of either of these claims.

To summarize my argument: (1) The USSR has tended to be backward in areas of material creativity where the necessary input from design, relative to the necessary inputs from science and technology, tends to be large. (2) The chief exception to this rule, although not unqualified, has been defense goods. (3) At the outset of the Soviet period, design, especially engineering design, was, on the whole, backward. Later, the balance tilted in favor of engineering design and against artistic design; however, native designers did not acquire comprehensive capabilities in engineering design and the overall inferiority therefore persisted. Over a long period, all-around capability in engineering design was largely confined to the military sphere. (4) The system adapted to this situation by maximizing interchangeability with civilian and military goods and between them, and by making other adjustments, both genuine and spurious. Veritable adjustments at first included bypassing the administrative apparatus, but subsequently included administrative changes, including the establishment of a new design organization. Other claims can be viewed as encroachments of the conceptual sphere of science upon technology or design. (5) As long as backwardness in design continued, it lowered effectiveness in various areas of the economy, indeed, in the national life. (6) Surrogate instructions tended to be accepted from technology, including imported technology, which sometimes influenced design in inappropriate directions, resulting in the production of not urgently needed items. (7) Over time, a shift in types of technological imports has tended to reduce the flexibility of designs associated with imported technology. (8) The gap between Soviet military and nonmilitary goods may be wider from a scientific angle (although narrower from a technological one) than has been believed. This feature is becoming more important, while interchangeability of civilian and military goods has simultaneously declined and weapons have become more specialized. (9) Neglect of design, although sometimes less thoroughgoing than it seemed, had insidious, diverse, and cumulative consequences, especially in diverting development from the route it would otherwise have taken. (10) Noncoincidence of the periods of concern for design and of all-out industrialization was not accidental. The negative link is highlighted by the title of the Tenth Five-Year Plan—"Plan of Quality"—which foreshadows unprecedentedly low rates of growth.[63]

Altogether, the threefold approach can contribute toward a solution of several problems, among which the following seem the most far-reaching: First, the possibility of the coexistence of two economic sectors—one military and one civilian, with the former turning out goods of higher quality than the latter—appears less puzzling if the military sector is seen as receiving a much larger input from science than the nonmilitary sector, and still less puzzling if it is seen as also receiving a larger input from design. Second, it has become evident that the Soviet scientific-technological complex is unable to provide benefits for the economy that could substitute intensive for extensive sources of growth, and

63. In this connection, see Raymond Hutchings, "World-Wide View: USSR," *Design*, January 1976, pp. 48–49.

there appears to be much evidence of a widening gap between Soviet and advanced Western technical levels.[64] The shortcomings of Soviet design, and its orientation, now emerge as bearing significant responsibility for this situation.

Altogether, design and its interrelations with science and technology appear to comprise an important link in the study of how the Soviet system has performed, and of why it has achieved so much more in some directions than in others.

64. See, for example, Hanson, "International Technology Transfer," pp. 786–812.