TECHNOLOGY AND GEOPOLITICS

By Ralph Turner

The first of Friedrich Ratzel's seven laws for the growth of states is "The Space of States Grows with *Kultur*." Halford J. Mackinder, whose essay, "The Pivot of History," published in 1904, sets forth the theory of a geographical determinant of world political movement, observed at its close "The actual balance of political power at any given time is, of course, the product on the one hand of geographical conditions, both economic and strategic, and, on the other hand, of the relative number, virility, equipment, and organization of the competing peoples." Later, in 1919, when he laid down the fundamental generalization of the current school of geopolitics,

> "Who rules East Europe commands the Heartland,
> Who rules the Heartland commands the World Island,
> Who rules the World Island commands the World,"

he made "man-power" the conditioning factor affecting the power-situations of states. Thus he set in opposition to the geographical aspects of these situations the organizations of states, contrasting democracy with German *Kultur* as a basis of power. But this insight did not prevent his wishing that a cherub would sing his generalization into the ears of the Allied statesmen who were making peace with Germany.

It is the purpose of these remarks to examine briefly one element of culture, namely, technology, as a factor in the power situations of states and to suggest that for the analysis of these situations Ratzel and Mackinder were more nearly right in giving attention to culture than are the present devotees of geopolitics who, following Mackinder, emphasize the geographical aspects of these situations.

Inasmuch as the supreme power activity of a state is warfare, a few observations on the rôle of technology in the evolution of warfare will serve to indicate its importance for the organization of power.

When the chief weapon was a chipped stone ax, warfare and its economic support were not complex. Both the raw materials and the operations in shaping them were simple. However, those men with the easiest access to flint and sinew or rawhide were not necessarily the best armed, for superiority depended upon skill in fashioning them into weapons. At one point in the archaeological record it appears that an invention—a finely chipped point that served as an arrowhead or a spearhead—made possible a deep invasion of lands held by men armed

mainly with chipped stone hand-axes and knives. It is easily guessed that this invention altered greatly the methods of combat.

With the invention of metallurgy the geographical, economic, and technological basis of military action became widely organized both in space and in institutions. Workable deposits of copper were eagerly sought after. Transportation brought the ore or metal to the seat of the skills required for its shaping into weapons. A wider range of skills, resting on a larger body of knowledge, was required than for the production of stone weapons. This complex of actions was first organized in the ancient urban cultures which, in turn, rested on a capacity to produce an amount of food sufficient to permit some part of a population to devote its energies to activities other than those of agriculture.

On the one hand urban cultures embodied in the institution of slavery the control over workers that the scarce metal weapons gave to a few men. On the other hand urban cultures organized controls over extended geographical areas, thereby giving rise to empires. The seats of urban cultures and their empires were originally in geographical areas favorable to the agricultural production that supported the differentiation of a ruling class, not practicing agriculture, from a peasantry. Not one of these areas was in the so-called Heartland, and furthermore, the empires of the peoples of the Heartland were created only by the conquests of these areas which produced economic surpluses. An analysis of the relations of the peoples of the Heartland and of urban culture peoples suggests that conditions favorable for such conquests arose in a certain phase of the evolution of urban cultures.[1] It appears, therefore, that the state and its development internally as a class structure and externally as an empire rested upon the technological advances that created an economic surplus and differentiated a power-wielding class. Geographical factors were significant in this development only as they affected the actions which these technological advances made possible.

After the invention of metallurgy each technological achievement that increased the capacity to produce wealth, facilitated the transport of men and supplies, intensified social intercourse among peoples, and altered the types and designs of weapons affected the organization and development of urban cultures. Among these achievements, those

[1]See Ralph Turner, *The Great Cultural Traditions* (2 vols., 1941), ch. XX, "Structure and Process in Cultural Evolution."

which improved the mining of ores and the manufacture of metals were especially important for they reacted ultimately upon the production of wealth, the relation of social classes, the organization of the state, and the form of effective power.

The use of the horse for military purposes—the armed knight shortly after 2000 B.C., followed about two hundred years later by the charioteer—gave those who possessed metals and horses a distinct advantage over those who lacked them. The scarcity of tin and copper—the ingredients of bronze—limited the size of well-armed forces, a fact which quickly gave rise to new military classes. The first extended empires were organized by peoples ruled by these classes.

The arming and armoring of infantrymen capable of defeating armed horsemen and charioteers became possible about 1000 B.C. when iron-working was first widely developed. The first shift in power occasioned by this technological advance was organized in the Assyrian Empire. One Assyrian emperor is credited with having possessed as much as two hundred tons of iron.

Greece, Macedonia, the Hellenistic Kingdoms, and Rome achieved different military results as the techniques of iron-working and of transport advanced and as the designs of iron weapons improved. The engineers of the Hellenistic Kingdoms worked out the defensive and offensive potentialities of the then-existing knowledge of mechanics, setting the practices of siege warfare until the introduction of gunpowder. Rome owed an advantage in the Punic Wars to an iron-working industry which made possible the supplying of weapons to the other enemies of Carthage. In the second century of the empire, Rome's central military power weakened because ship design did not advance sufficiently to allow the transfer of adequate quantities of bulky goods from the more distant provinces to Italy.

Some time before A.D. 500 an advance in iron-working, probably in India, reached Europe by way of Persia, Syria, Egypt, and North Africa; it again made possible the arming and armoring of the horseman so that he could prevail against infantrymen. Both the Sassanian Persian Empire and the late Roman Empire displaced light-armed cavalry and mobile infantry with a heavily-armed cavalry. The cost of the new equipment was a decisive factor in limiting the size of armies and the strength of military classes. This development, together with the siege practices of the Hellenistic engineers, set the pattern of medieval warfare. Toward the end of the middle ages innovations in metal-working which contributed to the improvement of the crossbow tended

to decrease the supremacy of the armored knight over the infantryman.

When gunpowder, invented in China about 100 B.C., was adapted to military uses in Europe some time after A.D. 1200, developments now casually familiar to most students of economic and military history got underway. A note on the evolution of fire power will suggest the trend of these developments in so far as they are significant in the present discussion.

Gunpowder was originally more important for breaching defensive works than for combat; in fact, it was not until the last half of the seventeenth century that firearms finally displaced late medieval weapons. At this time the smooth-bore, muzzle-loading musket which fired a heavy ball came into general use. It was effective about two out of five times at one hundred yards; at two hundred yards it had no accuracy at all. This was the technological basis of eighteenth century warfare. The volley was the leading device for achieving a maximum fire power. Close order movement of highly disciplined troops was necessary in order to concentrate this fire power. For this reason manoeuvering became an essential element of generalship. To offset these offensive methods defensive masonry and earthworks were highly developed. Both the cost of weapons and the difficulty of supplying an army kept the armies small.

Napoleon took advantage of a development of artillery. His smooth-bore, muzzle-loading cannon which fired "case shot" had an effective range of four hundred yards; for this reason, his batteries, remaining out of range of the musket, could destroy the closed ranks of the old-style infantry. The English open-square, as well as the loose ranks introduced in the French armies, was an answer to this method of concentrating fire power. It was finally overcome by the development of the rifle that fired the conical bullet; against men armed with this weapon, which had an effective range of six hundred and fifty yards, the men of the old-style batteries had no chance.

The rifled gun barrel, invented in England, first came into common use in the English colonies of the Atlantic seaboard where its accuracy at a range of two hundred yards was especially useful to the woodsmen for whom it was both an economic implement and a weapon. Difficulties of manufacture prevented its wide adoption for military purposes.

The present relation of rifles to field pieces and heavy guns was established after 1850 when improved rifling and breech-loading devices were added to each. With trajectory-firing the range of field pieces

was extended to over two thousand yards and as a result the infantry and the artillery entered into a new combat organization which was first clearly worked out in the American Civil War. Advances in metal-working which permitted a high accuracy—to the forty-thousandth of an inch—supported these innovations in armaments. At the same time the other developments, summarized by the phrase "The Industrial Revolution," altered the conditions of manufacturing and transport having significance for military action.

In the twentieth century the combination of the internal combustion engine and the gun has made a revolution in both sea and land warfare. Both the tank and the airplane stem from this combination. But their forms are also due to developments in chemistry and metallurgy which have produced new explosives and the lighter and harder metals, as well as having made easier the production and the shaping of ever greater quantities of all metals.

Today mere numbers of men, or the possession of raw materials, or the holding of strategic positions is not the essential source of power. Only those nations having scientists, engineers, and skilled workers who are masters of the knowledge and the skills required for devising and operating intricate machines and chemical processes can adequately equip armed forces. Armed forces are now the cutting edges of a vast social machine organized to achieve the maximum power which contemporary technology makes it possible to produce: thus total war. The present Global War differs from the World War 1914-1918 in its economics, politics, tactics, and strategy, largely because of the transformation of the base and the form of power this fact suggests.

When conceived in general terms the rôle of technology in warfare can be stated as follows: The determining factor in warfare is the capacity to put metal in motion in the largest amount and with the greatest speed and manoeuverability so that it will most effectively limit and reduce an enemy's capacity to accomplish the same ends. Every action from finding minerals in the earth and extracting them from it, through every process of manufacturing metals and shaping them, to all movements of metals to and upon the area of combat form a *grand technological sequence.* The organization and maintenance of this sequence is the central problem of waging total war. Subsidiary actions of all kinds must support this sequence and facilitate its operation.

For purposes of analysis this *grand technological sequence* may be regarded as having the four phases indicated in the following table:

1. Raw Materials	General Transport Services	2. Producers' and Consumers' Goods	Special Transport Services	3. Secondary War Materials	Special Transport Services to Combat Areas	4. Primary War Materials
Basic raw materials required in large amounts (including foodstuffs, fuel, powder, *etc.*) for quantity production. *Critical raw materials* required in small quantities in order to give quality to manufactured goods. *Secondary raw materials* required either in the process of manufacture or for the making of equipment for processing.		Industrial and transport equipment of all kinds required for the production of essential goods and services for the maintenance of the civilian population and for the supply of armed forces (including foodstuffs, shelter, *etc.*).		All special industrial and transport equipment (including new plants, special machinery, *etc.*) for the manufacture of any kind of primary war *matériel*.		War machines, munitions and all other supplies (including foodstuffs, medicines, *etc.*) required to maintain armed forces as effective fighting units under any and all conditions in combat areas.

The *grand technological sequence* is established by (a) the means of production, (b) the means of transport, (c) the means of communication, and (d) the means of violence. The means of production affects the output of raw materials and finished goods in each of its phases. The means of transport determines the rate of movement of raw materials and finished goods from place to place within the geographical area from which raw materials are obtained and where combat occurs. The means of communication permits the organization of complex cooperative efforts extending throughout the *grand technological sequence* and over the geographical area it occupies. The means of violence determines the kinds of war *matériel* necessary for combat and, consequently, affects the organization and movement of the *grand technological sequence* at every point.

If this sequence is conceived in terms of industries, such as the electric power, the steel-making, or the oil-refining, or the meat-packing, several classes of vulnerabilities can be recognized. In waging total war these vulnerabilities become points of attack for an enemy; the maintenance of efficient operation in spite of these vulnerabilities is the fundamental problem of organizing an effective war effort.

1. A well defined set of raw materials is required by an industry.—Some of these materials (basic) required in large amounts if production is to be adequate. Others (critical) are required in small amounts if the output is to have high quality. To lessen the supply of any of these commodities in any way is an effective act of war. When a people is

known to lack certain raw materials, interference with their obtaining them, however accomplished, is an effective act of war.

2. Technological "bottlenecks" exist in an industry.—In an industry there are points at which operations can be interfered with more easily than at others (a) because they are very complex, (b) because they may be concentrated in one or a few plants, (c) because they may require some rare raw material or an apparatus difficult to obtain and maintain, and (d) because they may require highly specialized labor. Since these technological "bottlenecks" may give rise to conditions greatly limiting output, to interfere with operations at such points is an effective act of war. Sabotage is most likely at these points.

3. An industry has a geographical extension.—The raw materials of an industry are obtained from certain places. Transportation follows certain routes. Plants are located at certain points. Enemy interference at various points in this geographical extension may be possible, but its effects at different points will be different depending on aspects (such as technological "bottlenecks," labor supply, and transport concentration) of the industry other than mere location.

4. An industry requires a specialized labor force.—This specialized labor force consists of both occupational and degree-of-skill groups which, of course, have a proportional relation to one another. These groups must be available at certain points in the technological sequence of an industry and, consequently, at certain geographical locations. A deficiency in any one of these groups will seriously disturb the operation of the *grand technological sequence.*

5. An industry operates under a system of controls originating partly with government, partly with owners, and partly with laborers.—The efficient operation of an industry depends upon the organization and direction of effort made possible by this system of controls. Controversies among the various groups sharing power in an industry are likely to decrease its efficiency. Foreign influence among owners (cartel agreements for example) and among workers (propaganda of various kinds) is almost certain to prevent an industry from contributing fully to a war effort. Sabotage is likely to have origin in discontent or disloyalty among these groups.

6. An industry depends on some industries and, in turn, supports others.—The raw materials and equipment of an industry are derived from other industries, and its products in turn become the means of

carrying on other industries. A nation at war requires an integration of many industries in a continuous service to its war effort. Full mobilization requires that this integration work smoothly at top speed and at maximum output. In some industries interference with the supply of a raw material, or the operation of a production process, or transport, or labor supply, or management may seriously disturb the production of primary war *matériel* or, in some others, may cause a deterioration of overall productive capacity.

To deliver a full war effort a nation must operate the *grand technological sequence* efficiently from beginning to end. Its vulnerabilities must be protected against both internal and external interference. Its managerial and labor forces must achieve a high degree of cooperation. One industry must not be out of balance with others. Military and civilian needs must be met according to the availability of raw materials and the demands of the military situation, not according to a civilian standard of living. The limit to the decrease of a standard of living should be set not by the morale of the people but by the energy required to operate the *grand technological sequence* at the required level of efficiency for success in war. Military organization and direction in combat areas affects the final utilization of the power which a nation can produce through the sequence.

When viewed in its geographical extension the *grand technological sequence* of a nation may be seen as forming at least three classes of critical economic areas, that is, regions in which interference with its operations will affect adversely the nation's war effort: (a) critical raw material areas, (b) critical transportation areas, and (c) critical production areas. A critical raw material area has a high concentration of the facilities of production of basic and/or essential raw materials. A critical transportation area has a high concentration of the transportation facilities required for moving raw materials, finished goods, and war *matériel* through the *grand technological sequence.* Logistics is only the final aspect of this movement. A critical production area has a high concentration of the facilities of production of war machines, munitions, and other supplies required by armed forces.

When the organization and activities of a nation at war are analyzed in the foregoing terms, the ways in which technology conditions its entire effort may be summarized as follows:

1. Technology gives usefulness to a raw material, establishes the proportions of it required for use in combinations with other raw mate-

rials in the production of various commodities, and, consequently, fixes the amount of it that is needed for a given war effort.

2. Technology makes possible the development of substitutes for raw materials that are in short supply. Usually these substitutes are more costly in labor and less efficient in action than the materials they replace. To force a nation to resort to the use of substitute raw materials means increasing its difficulties in carrying on a war.

3. Technology gives importance to geographical regions accordingly as they supply raw materials or a combination of raw materials required for a given war effort or as they domicile the facilities, including the labor supply, required for the production of war *matériel.*

4. Technology establishes the means of transport and, thereby, determines the routes over which raw materials, war *matériel,* and other supplies required for a given war effort, are shipped. It fixes, therefore, the amounts of these commodities that can be concentrated at any given point.

5. Technology fixes the kinds and amounts of labor required for a given war effort. It sets, therefore, the problem of allocating a nation's population at the various tasks that constitute this effort. In these terms the armed forces a nation can organize and maintain are discovered to be relative to the efficient operation of its *grand technological sequence.*

6. Technology determines the forms, fixes the qualities, and limits the quantities of war *matériel* a nation can produce and place in combat areas. Above all it establishes technological differentials in war machines and munitions, thereby giving advantages to the armed forces of the nation possessing the most advanced application of science in the production of arms and armiment. Today differentials in the manoeuverability and fire power of airplanes, in the muzzle velocities of guns, in the toughness of armor plate, in the designs of warships, in the volatility of gasoline (along with hundreds of other technological items) enter into the making of a nation's war potential. The widespread interest in "secret weapons," as well as the intensive research in the scientific aspects of war, indicate the dependence of military effort upon technology.

7. Technology conditions military tactics and enters deeply into the determination of military strategy. The German *blitzkrieg* was a utilization of the new military machines, the tank and the airplane, in a new method of offensive warfare. New tactics were devised for the

units using these weapons and for the units cooperating with them. New tactics have been introduced steadily as the present war has progressed. In so far as the war is a struggle between the "have not" and the "have" nations, its strategy has been influenced by the need of the "have not" nations to obtain new sources of raw material supplies. Japan's campaign in Southeast Asia and the East Indies was determined partly by her need for certain raw materials and partly by a desire to deprive Great Britain and the United States of the sources of certain raw materials. The important point in this connection is that strategy is affected quite as much by the means of military action possessed by a nation as by the geographical situation in which the action must be organized.

In the present undeveloped state of geopolitics in the United States it is proper to raise questions about its potentialities as a science and, therefore, about its significance for the shaping of national policies.

If geopolitics is an attempt to find a geographical determinant for world political movement, it is regarded from the point of view of this writer as a useless enterprise. If Russia's power situation is offered in support of the concept of the Heartland, it can be replied that this position rests upon technological achievements that utilize the great subsurface resources of the Caucasus and Ural Mountain areas and of the Donetz Basin. Furthermore, the high mobility of land power on the steppes, emphasized by Mackinder in the article "The Pivot of History," is now amplified or offset by the far greater mobility of air power. The opposition of land power and sea power which conditioned Mackinder's thinking is now greatly reduced for each is entering into a new complex based on air power.

Geopolitics may be described as a pseudo-science justifying Germany's expansion at the expense of her European neighbors. In so far as the concept of the Heartland played a part in the making of the decision to attack Russia, it may be said that it played Germany false. Considering the factors in the situation Germany faced in 1941, victory probably lay more in a seizure of Northwest Africa to Dakar than in an invasion of Russia. As events have turned, this seems undoubtedly to have been the case. At any rate the seizure of West Africa would have forced the Anglo-American combination into a death struggle to keep control of the North Atlantic Ocean. Such a move might have saved Germany from a two-front war and, with Japan's aid, may have broken the Anglo-American control of the seas.

If geopolitics is regarded as a method of analyzing power situations with geographical factors in the decisive rôle—"applied political geography"—it may be argued that the method is limited in view and lacking in proper emphasis upon relevant factors. To argue that geographical factors always remain the same is scarcely correct when it is comprehended that both position and space are relative to the means of transportation. Mackinder's attempt to make the horse-riding and the camel-riding areas decisive for world politics can hardly be made good in an air age.

If geopolitics is made an assembling and classifying of data significant for the analysis of power situations, it performs a useful service because it requires an intensive effort to bring together an array of facts as complete as possible. The authorities responsible for national defense should recognize this service and develop as quickly as feasible an organization to perform it. The economic, social, political, psychological, and military analyses required for national defense should be conceived as the function of a single agency having access to the complete assembly.

Finally geopolitics may be understood as an effort to think about national existence in world terms. As Mackinder said in 1904, nations, henceforth, will have to deal with a closed political system world wide in scope: "Every explosion of social forces, instead of being dissipated in a surrounding circuit of unknown space and barbaric chaos, will be sharply echoed from the far side of the globe, and weak elements in the political and economic organism of the world will be shattered in consequence." For America's embryonic geopolitical science, this is the essential point, namely, thinking in world terms. But to seek a static factor like the Heartland as the determinant of the world power situation will certainly be misguiding for, in fact, a dynamic factor, such as exists at the moment in American productive capacity, will always be the most important element of any power situation.

American geopolitical science should seek a theory of political dynamics applicable to the world power situation. The development of an analysis which will make clear the technological differentials between nations would seem to be, at least to this writer, the first step in this quest.