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DECLARATION ON THE NUCLEAR ARMS RACE

Union of Concerned Scientists

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[Ed. note: This Declaration was composed and circulated by the Union of Concerned Scientists and is reprinted with their kind permission. The Declaration was signed by roughly 12,700 scientists, engineers, and other professionals and was transmitted to President Carter on December 20, 1977. It appeared in the March 1978 issue of the Bulletin of the Atomic Scientists *, a magazine of science and public affairs.]*

I. THE ARMS RACE

The nuclear arms race, a grim feature of modern life, has been with us since the devastation of Hiroshima and Nagasaki. Driven by a futile search for security through nuclear "superiority," this vastly expensive competition is increasingly a mortal threat to all humanity. Control of the arms race is one of mankind's most urgent needs.

The inventories of nuclear warheads are coupled with accurate, long range and relatively invulnerable delivery systems. Together their destructive capacity is immense. If used in war they would kill hundreds of millions of persons, carry radioactive injury and death to many of the world's nations, profoundly damage the environment of the Earth we live and depend on, and unhinge and devastate the target nations so effectively that they would no longer function as modern industrial states. Indeed, the superpowers' inventories are so great that even small fractions of them could produce damage far beyond any past experience.

Neither superpower could now launch a counterforce surprise nuclear attack to disarm the other. Enough of each side's forces will survive or are invulnerable that the return blow would still produce prodigious damage, so shattering that no first strike is remotely rewarding. Thus, a relatively stable but uneasy balance has resulted in the past, the state of Mutually Assured Destruction. This balance of terror, while morally repugnant to many, is a fact of modern life. The superpowers have recognized that the populations of the United States and the Soviet Union have become unavoidably hostage because of the ineffectiveness of defenses against nuclear-armed strategic weapons systems—and so their 1972 agreement, and treaty, in effect terminated efforts at active anti-missile defenses.

The security of the United States and the Soviet Union, and of the other nations across the globe, is only as high as the expectation that the nuclear arsenals will never be used.

Strategic nuclear arsenals could be drastically reduced while still retaining ample deterrent forces in a world devoid of real peace. However, the superpowers—while professing commitment to the principle of nuclear parity—continue to reach for nuclear superiority or at least for unilateral advantage through the development and deployment of new weapons and weapons systems.

IN THIS ISSUE

By and large the United States has been ahead in the superpowers' arms technology race: the first in nuclear and thermonuclear weapons, nuclear submarines, solid fuel missiles, and many other developments. The United States continues to forge ahead: developing the MX—an advanced, perhaps mobile, land-based intercontinental missile and multiple independently-targetable reentry vehicles (MIRV) of extreme accuracy, the neutron bomb, the air- and sea-launched strategic range cruise missiles.

Many of these innovations have been stimulated by uncertainty about what the Soviet Union was deploying. Soviet responses are clouded in secrecy and are possibly highly threatening. They have forced the United States to proceed.

In general, the Soviet Union has responded to U.S. technological innovations but with a lag—averaging over 4 years—in reaching U.S. levels. Their deployments then continue, exceeding the United States' and so raise fears of their gaining "superiority." The Soviet Union is developing and deploying **MIRV**ed missiles of ever greater range, accuracy and explosive power, perhaps greatly intensifying the civil defense of its population, and continuing other developments. The Soviet Union now has more strategic missiles and a greater nuclear throw-weight, while the United States exceeds in the accuracy of delivery systems as well as in numbers of nuclear warheads. The Soviets continue also to increase their conventional forces, raising fears of aggression aimed at Western Europe. This has stimulated responses in conventional arms and, especially grave, in dependence on nuclear weapons among the **NATO** nations.

The United States and the Soviet Union both are engaged in vigorous underground nuclear warhead test programs. The responsibility for the race is unmistakably shared.

The arms race is in full swing! The roughly 12,000 *strategic* warheads of today are likely to become 30,000 long before the end of the century, and the tens of thousands of *tactical* weapons augmented also. These increases and the improvements in missile accuracy, retargeting capability and invulnerability lead to greater "flexibilty"—and to the greater likelihood of starting nuclear weapons' use. What results is the undermining of the balance of terror. New weapons now in sight will further decrease the stability of this delicate balance and will make the monitoring of future arms agreements more difficult, if not impossible, without gaining decisive military superiority for either side.

The superpowers' belief that security rests with potent nuclear armaments is more and more shared by other nations. The strateic arms race stimulates the proliferation of nuclear weapons among nations, some of which may be weak or irresponsible, and thus more likely to resort to the use of nuclear weapons in a local war. Such wars could easily widen, thus adding to the likehood of a final immense nuclear holocaust between the superpowers.

More than ever it is urgent now to slow down and ultimately to stop the nuclear arms race, thus improving the stability of the nuclear stand-off and setting the stage for the reduction of the great inventories of weapons.

II. CONTROLLING THE ARMS RACE

Several attempts have been made to bring the nuclear arms race under control but none have been successful in the face of the pressures that drive the competition. The 1960 treaty to demilitarize the Antarctic continent, the partial nuclear test ban of 1963 and the later treaties not to deploy warheads on the ocean bottoms and in outer space are but peripheral to the nuclear arms race. The Non-Proliferation Treaty of 1968 has not gained universal adherence and the superpowers have not carried out their implicit commitments in the treaty to seek nuclear disarmament.

The United States and Soviet Union have negotiated bilaterally in the Strategic Arms Limitation Talks (or SALT) with some yield: they have agreed not to interfere with their non-intrusive means of verification of missile launch inventories, to minimize the installation of anti-ballistic missile systems, and they have placed ceilings, albeit very high ceilings, on the numbers of deployed strategic missiles. The talks have provided a forum for continuing negotiations; but they have *not* stopped the qualitative arms race, and they have *not* reduced the huge inventories of strategic delivery weapon systems. While negotiations advance slowly, hindered by mistrust and endless maneuver for advantage, virtually unlimited competition for "strategic advantage"—through new and more deadly delivery systems—continues unhindered.

We believe that the key to a safer future lies in the *control of strategic weapons technology.* To protect the world from the disaster of a nuclear war the superpowers must halt the development of new weapons which frustrate attempts to curb the arms race. Because there is essential equality in U.S. and Soviet Union forces the superpowers *can still take effective steps* to stop the nuclear arms race. This must be done through mutually agreed on *and* through unilateral initiative actions.

III. RECOMMENDATIONS

We hereby recommend that:

- The United States announce that it will halt underground testing of nuclear explosives provided that the Soviet Union follows suit within a reasonable time.
- The United States announce that it will not field test or deploy *new* strategic nuclear weapons, nuclear weapons systems, or missile defense systems for a period of 2 to 3 years provided the Soviet Union demonstrably does likewise.

These measures, carried out with due care, do *not* jeopardize our security. The recommendations do not stem from blind faith in the good intentions of the Soviet Union. We already can detect Soviet tests of nuclear weapons smaller than the Hiroshima bonb with existing seismic sensors and can clearly distinguish them from earthquakes. Hence underground tests of strategic warheads cannot escape detection. Our satellites already inspect Soviet missile launches, missile site construction, and submarine arrivals and departures; thus we would know if the Soviet Union were not following our lead. Should the recommended initiatives not bear fruit, the interruption in testing would hardly degrade our security. It takes many years to develop and deploy strategic weapons systems and our strength is such that a short delay of the sort we recommend cannot put the United States at risk.

These measures, carried out with due care, can restrain the *technological* arms race. Without underground tests there is not enough confidence in the new warhead designs to allow deployment. New missiles also depend on more accurate guidance systems, and these can only be tried and perfected in repeated test firings. By reducing the number of missile test firings to those needed for maintenance, a major hurdle to new deployments would be created.

This is the moment for such moves. We are, once again, at a turning point in the nuclear arms race. Because SALT I succeeded in placing ceilings on the number of missile launchers, it stimulated an intense race toward more accurate and powerful missiles, and more warheads per launcher, the development of new and more potent bombers and submarines to replace existing fleets. Most importantly President Carter has displayed a more penetrating understanding of the dangers of the arms race than the previous leaders of the United States and the USSR, and has indicated a readiness to consider imaginative policies. Our recommendations do not only meet a current need, they come at a propitious moment.

The United States should take the initiative. The U.S. lead in new weapons technology in the nuclear era is a reflection of our overall superiority in creating new technologies and sophisticated industries. Under these circumstances, we cannot expect the USSR to take the initiative.

Our proposals would be an important step toward the controls of strategic weapons technology which are so essential to our short-term security. They would thereby create that base of confidence and stability which is a prerequisite to overall reductions of the nuclear arsenals.

We urge the government of the United States to demonstrate its dedication to arms control by initiating the unilateral, reciprocal steps we have recommended, that represent the first steps leading to a gradual disarmament. These actions, if carried out by the United States, would represent a policy of restraint of the greatest political significance and yet, for an interim period, be devoid of military risk. Should the Soviet Union reciprocate—and they, like the United States, have much to gain in so doing—a great step forward would be taken to diminish the threat of nuclear war.□

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NUCLEAR POWER AND WEAPONS PROLIFERATION—THE THIN LINK

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"Proliferation"—the current shorthand buzzword which describes the potential international spread of the production capability for nuclear weapons—has been a matter of national concern in the US since the closing days of World War II. But this recently-popularized concern now appears to be causing a reversal of a quarter century of US policy regarding the best means of preventing proliferation. Stimulated by the last presidential campaign, the US has been moving toward prohibiting, or severely restricting, domestic use of the civilian fuel cycle including plutonium reprocessing and postponing consequently the US breeder reactor option. This is being advocated on the ground that, if the US foregoes civilian reprocessing and use of plutonium and delays the breeder, other countries—energy-hungry though they may be—will voluntarily deprive themselves of the full benefit of nuclear energy to follow our "moral leadership."

Thus the US would in effect be saying to non-weapons countries including nearly all of those aspiring to a higher standard of living through more abundant energy, "We and the other great nuclear powers already have our weapons, but to prevent the danger of further spread of nuclear weapons we ask you to follow us in giving up the most economic use of civilian nuclear power." The contradiction of such a posture is too clear to require further comment. Unfortunately, it is a demonstration to non-weapons countries that having weapons can be an economic as well as a military advantage. This has already been noted publicly by senior spokesmen of several countries.

Proliferation is a serious world-wide concern. If any nation, large or small, could threaten its neighbors with massive and rapid destruction, international relations would become more frightening. However, it should be recognized that, with the technical capability so widespread, proliferation has been historically very much less than would be the case if the desire to have nuclear weapons was common. Clearly, to many nations nuclear weapons have only a marginal value—certainly less than that of a military air force which they all want and have. Perhaps history tells us that proliferation is likely to be judged by small nations as not in their self-interest. Of the 100 non-weapons countries which have signed the Non-Proliferation Treaty, about half already have the basic technology to produce weapons materials, and there is no indication that they have done so.

The Administration's recent policy announcement on nuclear power has the effect of promoting LWRs and delaying both plutonium recycle and the breeder. The basic premise of this policy is that a combination of known coal reserves and urnium resources yet to be found permit our future energy needs to be met through the turn of the century without recycle or breeder. The LWR fuel would pass through the reactor only once, and then be stored indefinitely. Because the uranium resource future is uncertain, many of us believe the insurance aspect of the breeder option (which requires recycle) should be fully developed now and subsequently used as required. All other advanced fuel cycles which give high utilization of uranium or thorium also require reprocessing. The Administration's counter argument is that closing the plutonium fuel cycle, as required for a fully-developed breeder system, would place the U.S. in the position now of endorsing plutonium recycle and thus encourage the development in other nations of a possible channel for supplying weapons material. It is also the Administration's contention that domestic pursuit of the breeder and recycle for US energy supply, and simultaneous discouragement of other nations would create an unacceptable double standard—although such already exists in the weapons field. Many of us have a deep concern that the Administration's position on plutonium recycle and the breeder will be internationally counterproductive and actually stimulate proliferation; and it may domestically damage our economy as well.

How real is the danger that reprocessing of civilian fuel would be used by non-weapons countries to obtain plutonium for weapons? A simple analysis of well-known facts shows that there are today no fewer than eight different ways available (Fig. 1) to produce weapons material—to *produce,* not steal. Among them, the route of commercial nuclear power using slightly enriched uranium fuel ranks eighth and low in desirability for a country that has made a political decision to establish a nuclear weapons capability. It is the most expensive route (five to ten times more costly), requires the highest level of support technology, the broadest base of support industry, and takes the longest to install and to yield material (three to five years longer).

By the 1980's, moreover, the world may have available several new, additional ways (Fig. 2) of producing weapons-grade fissionable material, adding even more routes to weapons capability. Several of these are likely to be easier. cheaper, and faster—for a nation bent on bootstrapping itself to acquire weapons capability—than is the route of nuclear fission power with reprocessing and recycling of fuel.

The question thus arises: if the dike is leaking in at least eight places, maybe more, why are some so desperately anxious to plug only one of the leaks? Why this effort to focus attention on an issue that does not go to the heart of the problem? Why not pick also on centrifuge or laser enrichment? The breeder and recycle are clearly essential for the eventual longevity of nuclear fission as a world-wide energy source. It has been suggested, therefore, that the focus on the nuclear power route to proliferation has been stimulated by those with an intense ideologic goal of stopping civilian nuclear power. Its opponents have failed to achieve this end on the issue of health and safety, on the environmental issue, on the waste storage issue, and on the plutonium hazard issue. Perhaps they have now fixed on the proliferation issue as a likely one to gain public support in the US—deliberately shrouding the inherent contradiction that, if a maverick foreign government should decide to establish its own weapons material production capability, the civilian nuclear power route would be among its least attractive choices.

On economic grounds chiefly, I am personally dismayed at the concept of selling reprocessing facilities to small nations. It takes a large number of nuclear power stations to supply the flow of fuel needed to make a present reprocessing plant cost-effective. Further, what would be done with the output of plutonium and uranium? If self-sufficiency is the reason for closing the fuel cycle, fuel fabrication facilities and possibly enrichment would also be needed. The total investment would be several times that of the initial power plant alone. Under these circumstances, such an unwise investment should be discouraged by conscientious supplier nations. How many auto manufacturers try to sell an oil refinery to their customers?

What is needed, of course, is an assured fuel cycle system, preferably under international auspices, operated so as to optimize the use of our world's resources and to inspire confidence in supply. I am disappointed that the supplier nations, and the US in particular, have not energetically proposed such a system, although it certainly must be under consideration. Clearly, this would make civilian nuclear power a negligible part of the proliferation alternatives. Compared to the Administration's present negative approach of deferring a program that is needed by most of the industrial world and eventually by the US, the internationalization of the fuel cycle facilities would be a positive step toward establishing an enduring trust in an international fuel supply. Such a system would provide a congruence of economics, national self-interest, and safeguards against proliferation. It is not obvious why this course has not been urged more forcefully, as it provides a long-term viable solution to the world-wide use of nuclear energy.

Just as quixotic is the argument that by self-denial we can motivate poorer, less-developed countries to renounce optimum use of civilian nuclear fuel. Reprocessing technology has been set out in ever-growing detail and shared at international technical conferences since the US first reported on the design and operation of the Idaho Chemical Processing Plant in 1955 at the first US International Conference on Peaceful Uses of Atomic Energy in Geneva.

It must not be forgotten that the US actively pushed the Non-Proliferation Treaty, by which 100 countries have pledged that they will not make nuclear weapons, *in return for* international cooperation and nuclear interdependence on civilian nuclear power. Now the US is proposing in effect to reinterpret unilaterally its own commitments under that treaty and to withhold the pledged cooperation on civilian nuclear power, thus stimulating other nations to establish nuclear independence. To do this in the hope of motivating other countries to couple renunciation of nuclear power with previously pledged abstention from nuclear weaponry is provacative to the disadvantaged nations involved.

At a conference in New York last month on International Commerce and Safeguards for Civil Nuclear Power, speakers from country after country explained that for them nuclear power is not a debatable option but an indispensable necessity, and that reprocessing is an essential.

Said a West German: US denial of reprocessing or breeder technology at home would create greater pressure on others to move even faster with their domestic reprocessing and breeder programs.

Said a French spokesman: Nuclear power is indispensable to developing countries, and France will provide and guarantee fuel cycle services without any pressure on other countries to forego development of nuclear capability alone. For France, reprocessing is absolutely essential, and she is not even studying the option of storage of spent fuel. The imposition of new conditions on exports merely serves to create greater distrust among suppliers and importers, which becomes an impetus to proliferation.

The Spanish spokesman declared: There is not justification for creating a problem with such serious consequences without at the same time suggesting an urgent and immediate solution. Any delay in making a decision to this effect may cause irremediable damage to countries that cannot take part in these decisions.

Said the speaker from Japan: Japanese confidence in dealing with the US appears to have been shaken. Strategic considerations exceed economics, as 60% of Japan's electricity is generated from imported oil; therefore, the breeder is an indispensable part of Japan's nuclear program, which is the only option available to protect its energy capability.

At the same meeting, Commissioner Kennedy of the US Nuclear Regulatory Commission said he believed that restricting US exports or imposing restrictive criteria would destroy US influence in the world market and lead to loss of whatever control the US might have on weapons proliferation.

There is overwhelming logic against the change in long-established US policy.

1. The world's long-term needs for energy-not only in resource-starved countries, but in a few decades also in nations now exporting oil—do not permit ineffective or uneconomic use of nuclear fuel resources. US willingness to use its own nuclear resources ineffectively and/or

uneconomically is hardly likely to persuade resource-short countries of the merit of our moral and ethical leadership and to stimulate them to follow such patterns.

2. Embargoes or stringent restrictions on civilian nuclear power cooperation and supply of materials and services by the US and other supplier countries will only accelerate further the nationalistic trend toward construction of independent indigenous fuel cycle capabilities—both enrichment and reprocessing—and thereby lose or reduce the likelihood that effective international controls and safeguards may be accepted.

3. In any country, the civilian nuclear power program is separable in timing, resources, and institutions from a program to obtain nuclear weapons capability. Historically, the major nuclear weapons powers all made weapons first and developed civilian power later.

4. The existence of spent fuel from power reactors in any country does, to be sure, represent a potential for deriving low-grade weapons material. However, as already stated, if a nation decides to produce weapons material, there are at least seven other routes available, not involving power reactors, that are much less costly and more rapid and flexible than civilian power plants as a source of such material.

5. Denying a government access to civilian reprocessing does not erect a significant obstacle or delay in implementing a decision to produce weapons. Spent fuel from *either* research *or* power reactors can be reprocessed rapidly and with relative ease—*especially so* if it is done without the various commerical and legal constraints that apply to civilian reprocessing plants. With the "once through" type of fuel cycle, diversion does not even disturb the productivity of the power cycle.

6. To minimize the possibilities of proliferation of weapons as a by-product of civilian power, it is most desirable to place the sensitive parts of the civilian fuel cycle under internationally-supported and cooperative safeguards. Control of the fuel cycle, not control of reactor operations, is the key to safeguards. This means control of enrichment, spent fuel storage, reprocessing, refabrication, and shipment for recycle.

7. One of the most evident and increasing causes of international tensions is energy malnutrition, as evidenced by increasing oil imports, worsening foreign exchange deficits, and the limitations on costs and productivity associated with them. Inhibiting the effective use of civilian nuclear energy supply in countries that have limited energy options open to them can result in enhancement of their propensity for international conflict.

8. The US, with its extensive coal resources and remaining oil reserves, may find it less constraining than other nations to delay further the effective, full use of nuclear resources including reprocessing and the breeder. But the costs of delay will include further erosion or loss of what remains of US influence on the course of world development of effective nuclear safeguards.

9. Effective international cooperation on safeguard systems for spent fuel storage and for reprocessing have strong world-wide mutual motivations for both internal anti-terrorist security and economic reasons. Strong and timely leadership by the US (and other nuclear supplier countries) can help bring such systems into being.

10. There is no nuclear fuel cycle that is inherently "diversion proof" once the relative ease of military-style chemical reprocessing by a government is recognized (although the possible variations in fuel cycles do differ in their requirements for manipulating materials.)

11. The so-called "tandem" fuel cycle which some have urged as a "technical fix" for weapons proliferation is counterproductive as it requires widespread construction of heavy-water reactors. This type of reactor has been widely used as a plutonium factory and as a tritium factory (needed for thermonuclear weapons), and can be run with natural uranium, easily available everywhere.

12. Similarily, the U-233 cycle is of very limited use as a "technical fix" being logistically unavailable for at least 20 years. There now exist neither the U-233, nor the reactors, nor the reprocessing plants required for producing the amounts that would be significant for energy purposes. Such facilities are uneconomic at present. They would require large subsidies to get started. In addition, U-233/U-238 reactors could still be used to make enough separable plutonium and U-233 to make weapons, so that the need for effective physical site safeguards would not have been diminished.

13. As for the "terrorist" threat, effective safeguard systems have been in use for more than 30 years for military reprocessing of nuclear weapons materials, and for the weapons themselves. In the US, even with civilian reprocessing, the total inventory of separated reactor plutonium would not reach 10% of the already-existing military quantity before the year 2000, and need never exceed 20% of the already-existing military stock if the plutonium is recycled. (It has long been a truism in the industry that the safest place to keep plutonium is to burn it in a power reactor.) Highly effective safeguard systems are also applicable to civilian-produced material.

To conclude:

It is certain that neither the US nor the world has the choice of severely limiting nuclear power, and that the reprocessing technology and breeder issues have only a thin and controllable link to proliferation. These facts, unpalatable to some though they may be, must be constructively addressed—politically and institutionally.

It is a disservice to the people of the US—and the people of the world—to create the illusion that by putting restrictions on civilian nuclear power we have somehow solved the proliferation problem. Unintentional though it may be, such steps would undoubtedly be counterproductive to their stated objectives by creating resource conflicts, removing faith in the US umbrella to protect the welfare of its allies, and stimulating the expansion of indigenous nuclear capabilities abroad including enrichment and reprocessing.

Figure 1

Eight-Fold Ways Available For Weapon Material Production

	Required		
	Cost	*Technology*	*Industry*
RESEARCH REACTOR	Small	Small	Small
PRODUCTION REACTOR	Medium	Medium	Medium
POWER REACTOR	Large	Large	Large
DIFFUSION CASCADE	Large	Large	Large
CENTRIFUGE CASCADE	Medium	Medium	Medium
AERODYNAMIC JET CASCADE	Large	Medium	Large
ELECTROMAGNETIC SEPARATION	Medium	Large	Medium
ACCELERATOR	Medium	Medium	Medium

Figure 2

Potential Added Routes To Nuclear Weapons Materials (in the 1980's)

U-235 SEPARATION
- Laser
- Chemical exchange
- Jet membrane

Pu or U-233 PRODUCTION
- Plasma fusion-fission
- Inertial fusion-fission
  - Laser implosion
  - Electron beam implosion
- Accelerator (I.N.G.)

Finally, one may well ask, who would benefit from such a policy? The oil-exporting nations, of course, and those nations which are continuing to develop all their nuclear power options without restriction. Our national policies continue to be flexible enough so that it is timely to urge a more comprehensive and realistic assessment of our planning options.□

ALGORITHM FOR DOMESTIC TRANQUILITY

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Abstract. Dependence causes crime. Independence assures domestic tranquillity. Easy access to the economic mainstream is basic to independence. Application of macroeconomic concepts provides two modes of easy access.

Introduction

"It is not as much the police that prevents the commission of crimes as the having as few persons as possible to live upon others. Nothing tends so much to corrupt mankind as dependency, while independence still increases the honesty of the people."[1]

These words were used by Adam Smith to introduce a course of lectures. These lectures by the father of modern economics formed the substance of the classic *Wealth of Nations.*

A most striking feature of an industrial society is the high average level of affluence. Another feature is the relatively large number of citizens denied appropriate access to the economic mainstream. In specific urban areas, unemployment often reaches distressingly high levels. This stress is particularly acute for those with physical, mental or other handicaps, such as youth, race, and sex. Too many live in a state of dependency. Easy access to the economic mainstream can reduce crime and promote domestic tranquillity. Macroeconomic theory provides an algorithm for access.

The Access Equation

Development of the access equation will be found in the appendix. In final form, it is expressed in Eqn. 1.

$$T = \frac{20}{1 - U - 1.3R}, \qquad (1)$$

where T is time, workweek length in hours. U is unemployment, expressed as a fraction of work eligible population; and R is the rate of taxation, expressing federal tax level as a fraction of Gross National Product.

From this single algorithm can be derived three distinctly disparate bases of political economy. The cardinal feature of each is that one of the three variables is held fixed at an appropriate level.

Constant Workweek Length

In this case workweek length, T, is held constant at 40 hours. The resulting curve indicates a tradeoff between unemployment and tax rate. Domestic tranquillity requires that unemployment be low. As shown in Fig. 1, it is impossible to have both low tax rate and low unemployment. At best there is a compromise between moderate unemployment and moderate tax rate. This defect characterizes a system based on constant workweek length.

The curve of Fig. 1 has been developed from theoretical considerations. It should be noted that the indicated tradeoff between unemployment and tax rate is similar to that indicated by the empirical Phillips curve.[2] Appeal to the Phillips curve is made by economic policy planners to justify the unhappy compromise which calls for an uncomfortably high average unemployment rate, a rate which is disastrously high for selected portions of the population.

Constant Unemployment

A brighter scene is evident when unemployment is held constant. In Fig. 2, unemployment is set at eight percent. Workweek length and tax rate are allowed to float. Rather than a 40-hour standard workweek, a standard unemployment rate is set. Eight percent unemployment rate corresponds to recent experience. This rate can be set much lower than the eight percent shown in Fig. 2.

The critical feature is the positive slope of this curve, in contrast with the negative slope in Fig. 1. This indicates that when the length of the workweek is reduced, the tax rate also falls. Implicit in the access equation is a constant standard of living; a

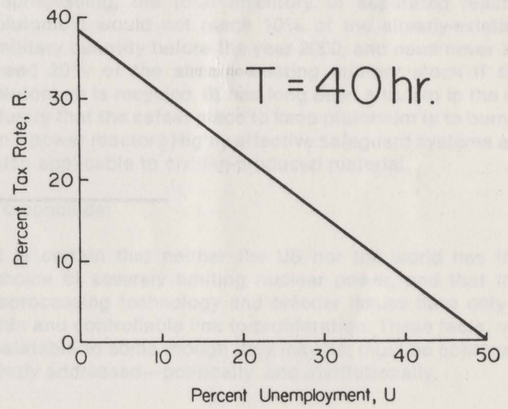

Figure 1. When workweek is held constant, unemployment can be reduced only at the expense of taxes.

[Presented at the 1978 Carnahan Conference on Crime Countermeasures; May 17-19, 1978; Lexington, KY. Prof. Jackson is Chairman of the Carnahan Conference and he is also Chairman of the CSIT Working Group on Crime Countermeasures. This paper is reprinted with his permission.]

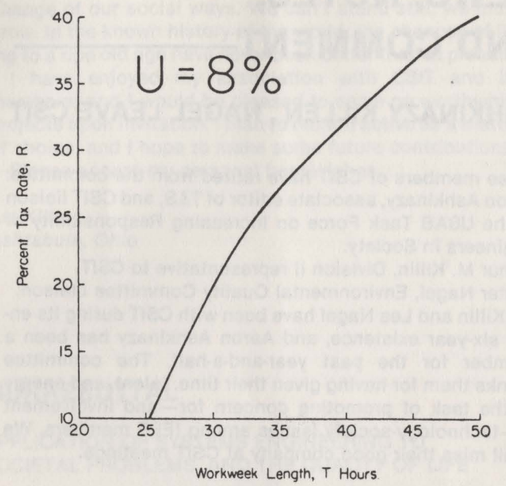

Figure 2. When unemployment is held constant, tax rate declines as workweek is reduced.

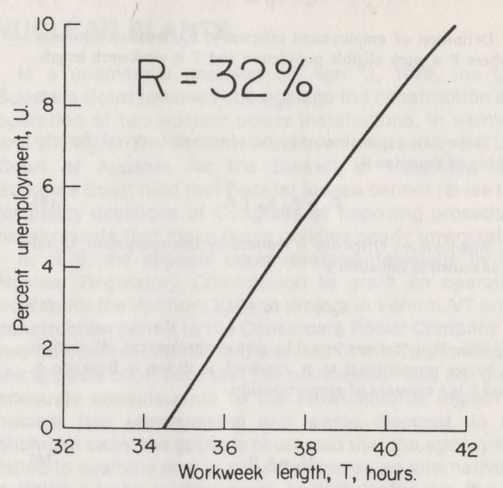

Figure 3. When tax rate is held constant, unemployment declines as workweek is reduced.

shortened workweek does not result in a reduction of wages. A minimum tax rate of 10 percent is indicated. This corresponds to an irreducible minimum of service to the public provided by the government. Except for the last three decades, the average tax rate has been much lower than this 10 percent minimum.

Constant Rate of Taxation

This third system is based on the same access equation as the first two. Here, rate of taxation is held constant. Workweek length and unemployment are then subject to change. In Fig. 3 rate of taxation is set at 32 percent. This figure corresponds to recent experience; it could, of course, be set at a lower or higher rate. With this condition of constant tax rate, a curve with positive slope again results. This curve explicitly indicates that a reduction in workweek length causes a reduction in unemployment.

Conclusion

Easy access to the economic system is basic to crime reduction and domestic tranquillity. The access equation indicates that these goals may be reached by reduction of workweek length. A salutary feature of such policy is that taxes are correspondingly reduced.

References

1. Adam Smith, **Lectures on Justice, Police, Revenues, and Arms**, edited by Edwin Cannan, Clarendon Press, Oxford, 155 p., 1896.

2. A. W. Phillips, *"The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957,"* **Economica,** Vol. 25, pp. 283-299, Nov. 1958.

Appendix

Terms used in derivation of the access equation are here defined.

Definition of Terms

E_e **Employment efficiency.** Ratio of number of usefully employed workers to total work eligible population.

E_p **Production efficiency.** Ratio of goods available, G_a, to work quantum, Q. This is an expression of the effectiveness of the facilities of management and fabrication.

G_a **Goods available.** Produce of farms, factories, and service industries available per week per man. Dimension is hours.

k **Constant of proportionality.** Ratio of total tax rate to federal tax rate, R. Total includes federal, state, and local taxes.

P **Work eligible population.** Ratio of total number of eligible workers to total population. The work eligible population will typically be reduced by physical, mental and other handicaps such as youth, race and sex.

Q **Work quantum.** Total number of man hours of work available per week per total population.

R **Tax rate.** Ratio of federal tax appropriation to gross national product.

T **Workweek length.** Hours of work per man specified in the standard workweek.

U **Unemployment.** Ratio of number of unemployed workers to total work eligible population.

U_c **Cryptounemployment.** Ratio of number of workers employed in public sector to total work eligible population.

Algorithm for Rational Economic Control

The definition of production efficiency, E_p, leads directly to Equation 2, where Q is work quantum and G_a is available goods and services.

$$G_a = E_p Q. \quad (2)$$

Definition of employment efficiency, E_e, leads to Equation 3, where P is work eligible population and T is workweek length.

$$Q = E_e T P. \quad (3)$$

These two expressions may be combined to reveal the relationship of Equation 4.

$$G_a = E_p E_e T P. \quad (4)$$

Employment efficiency is reduced by unemployment, U and U_c, as shown in Equation 5.

$$E_e = 1 - (U + U_c). \quad (5)$$

Now U_c is defined as public sector employment. As such, it can be set proportional to R, tax level, as shown in Equation 6, where k is a constant of proportionality.

$$U_c = k R. \quad (6)$$

These last two expressions can be combined to display the relationship of Equation 7.

$$E_e = 1 - (U + k R). \quad (7)$$

Combination of Equations 4 and 7 results in the access equation

$$T = \frac{G_a}{PE_p [1 - U - k R]} \quad (8)$$

Appropriate constants are G_a = 200, P = 1, E_p = 10 and k = 1.3. The access equation then appears as originally expressed

$$T = \frac{20}{1 - U - 1.3R}. \quad (9) \square$$

Editor's comment: My first reaction was to question Professor Jackson's assumption that G_a is a constant (independent of government spending) since G_a is an increasing function of disposable income. However, if the increased government spending is matched by increased taxes, then disposable income remains unchanged. Therefore Jackson's assumption is completely valid, provided we neglect secondary effects like the change in the aggregate G_a-vs-DI curve caused by income redistribution.

NEWS, NOTES, AND COMMENT

ASHKINAZY, KILLEN, NAGEL LEAVE CSIT

Three members of CSIT have retired from the committee: Aaron Ashkinazy, associate editor of T&S, and CSIT liaison to the USAB Task Force on Increasing Responsibility of Engineers in Society.
Arthur M. Killin, Division II representative to CSIT.
Lester Nagel, Environmental Quality Committee Liaison.
Art Killin and Les Nagel have been with CSIT during its entire six-year existence, and Aaron Ashkinazy has been a member for the past year-and-a-half. The committee thanks them for having given their time, talent, and energy to the task of promoting concern for—and involvement in—technology-society issues among IEEE members. We shall miss their good company at CSIT meetings.

F.K.

FAREWELL REMARKS OF ART KILLEN

[Ed. note: Art Killin has been an electrical engineer for forty-six years and still works part time as an industrial consultant. He is active in IEEE, participates in numerous local civic activities, and is a volunteer advisor to the Small Business Administration.]

I have appreciated the opportunity of representing Division II on CSIT and to have participated in the development of CSIT. Through committee membership, I have recognized the sincerity of the members of CSIT, and I believe that CSIT provides the proper opportunity for expressing thoughts and concerns regarding social issues of electrical engineering.

In terminating my tenure as a committee member, I would like to share some observations noted over the years as an electrical engineer and a member of the Institute.

a) Over the 90-some years of its existence, IEEE has been highly successful in providing a means of sharing electrical technology on a voluntary basis, and society and mankind have reaped the benefits.

b) The success of IEEE is especially significant because it is a voluntary organization and its members work together directly through the democratic process to make the policy of the Institute.

c) The future continues to appear more challenging and promising than ever—especially in light of present technology. During my lifetime, it has been a privilege to observe the development of electronics, aircraft, and nuclear technology, which barely existed when I entered the engineering field. All fields have risks, and sound judgment is needed to control the risk factor.

d) The social implications of technology appear not to be new. They may have started with the discovery of fire or the invention of the wheel, when the first human was accidently injured. In the electrical area, Thomas Edison, with the start-up of the first public electrical power generation and distribution system in 1882, played a major part in the change of our social ways. We can't stand still; we must grow. In the known history of the world, the chances of living to a ripe old age have never been better than at present.

I have enjoyed my association with CSIT and its members, and I would be pleased to serve on worthwhile projects upon invitation. I plan to remain active as a matter of choice, and I hope to make some future contributions.

Please accept my personal best wishes.

Art Killin
Ashtabula, Ohio

SURREBUTTAL

APPLICATION OF SYSTEMS ENGINEERING TO SOCIETAL PROBLEMS, AND THE QUALITY OF LIFE

I believe we all know what systems engineering is, and Dr. Rabow's defining comments (T&S, December 1977, p. 12) do little to address the issue of concern. And that issue is: When one has systemized anything in an optimal functional sense, one limits (by incurring some penalty) opportunity of excursion into other experimental realms. Society advances not by design but by heuristic evolution. History tells us of the dangers of a systemized society, and I believe Dr. Rabow overlooks an inescapable partner in any systemized social design—government. Certainly, as unholy an alliance as can ever be found!

Leland Anderson
Denver, CO

SUPREME COURT CLEARS WAY FOR NUCLEAR PLANTS

In a unanimous decision on April 3, 1978, the U.S. Supreme Court removed obstacles to the construction and operation of two nuclear power installations, in Vermont and Michigan. The obstacles had been imposed by the U.S. Court of Appeals for the District of Columbia. The Supreme Court held that Federal judges cannot revise major policy decisions of Congress by imposing procedural requirements that make those policies nearly unworkable.

In 1976, the appeals court reversed decisions by the Nuclear Regulatory Commission to grant an operating license for the Vermont Yankee project in Vernon, VT and a construction permit to the Consumers Power Company for two nuclear reactors in Midland, MI. In the Vermont case, the appeals court held that the commission had not given adequate consideration to the environmental impact of nuclear fuel reprocessing and waste disposal. In the Michigan case, the appeals court said that the agency had failed to examine energy conservation as an alternative to building a large nuclear plant. In both instances, the appeals court sent the license applications back for further study.

The Supreme Court ruled that the appeals court judges had exceeded their authority. Associate Justice William H. Rehnquist wrote for the Court, "Nuclear energy may some day be a cheap, safe source of power, or it may not. But congress has made a choice to at least try nuclear energy, establishing a reasonable review process in which courts are to play only a limited role."

The future of the two nuclear installations remains in doubt, however, to be resolved in further proceedings in the lower courts.

ref: *New York Times*, April 4, 1978. ◘

CSIT SPEAKERS BUREAU

Some CSIT members have given talks to groups of engineers and other interested citizens on aspects of the social impact of technology. We have found that this is an effective mechanism for promoting awareness and understanding of technology—society issues, and therefore CSIT has set up a SPEAKERS BUREAU.

Anyone wishing to arrange for a speaker or a discussion leader should write or phone:

Len Zimmerman
Bell Telephone Laboratories
Room 2C-414
Holmdel, NJ 07733
(201) 949-5737

At present, speakers are available to talk on: Solar Energy, Nuclear Energy, Ethics and the Engineer, An Overview of the Social Impact of Technology, and Computers and Privacy.

Volunteers are needed to talk on these or other topics so that the load on any one speaker will be limited, the list of topics can be broadened, and a wider geographic area can be served efficiently. If you can give some of your time, please send your name, address, phone number, and topic or topics to Len Zimmerman at the above address. □

SORRY WE'RE LATE AGAIN

I'm very sorry that T&S has been running behind schedule and that the March issue is so late. You will get the June issue in about a month, and I expect that T&S will be back on schedule with the September issue. I ask readers to please bear with me until then.

Frank Kotasek, Ed.

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"SOLAR ENERGY PROGRESS & PROMISE"

'Solar Energy: Progress and Promise' is the title of a 52-page report recently released by the President's Council on Environmental Quality. The report asserts that solar technologies—including solar heating, solar cells, windmills, small dams, and biomass—can supply 25% of the nation's energy needs by the year 2000 and more than 50% by the year 2020 if the U.S. makes a strong commitment to these goals and to energy conservation. These conclusions are based on recent developments in solar technologies and on expected rises in the costs of competing energy sources. The report details the technical status of each solar technology. Copies of the report are available from the Council on Environmental Quality, 722 Jackson Place, Washington, DC 20006.

CSIT MEETING, SEPTEMBER 9, 1978

The next meeting of CSIT will be held on Saturday, September 9, 10am to 3pm in New York City. CSIT meetings are open to all IEEE members, and we hope you will take this opportunity to become better acquainted with us and with our activities. Light lunch will be provided. If you plan to attend (and to find out the precise location of the meeting), please notify Richard Jerril, IEEE, 345 East 47th Street, New York, NY 10017, (212)644-7895.
