

# **The Decline of Science in the United States**

**By**

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## **Abstract**

This short essay presents evidence that the United States dominance in science and technology is declining. Examples of, and some reasons for, such a decline are given. It seems likely that changing attitudes toward science in the United States, aided by the spread of information through the Internet are major contributors to this decline. The decline seems to be exacerbated by the current administration's view of the importance and the perversion of science. It appears that business interests and the agenda of the Religious Right have combined for very different reasons in an attempt to destroy the viability of science in the United States. Some effort is made to document the development and impact of this attempt to remove any science which does not suit a particular political agenda from influencing public policy. The decline of The United States' dominance in science will lead to its loss of world influence and the United States' ultimate inability to maintain the technology upon which it has become so dependent. It is possible that the increasing dependence on technology for the storage of information could enhance the rate of the decline and usher in the twilight of a new dark age.

## **Introduction**

In my youth I was taught that one could trace the rise and fall of civilizations through the flow of information, particularly scientific information, from one culture to another. Examples of the flow of information from Egyptian to Greek culture, then from Greek to Latin and on to Arabic were used to show the decline of the Egyptian civilization associated with the rise of the Greek. That was followed by the climb to eminence of Rome which witnessed the transfer of knowledge to the Moslem world as the Roman Empire fell. At the end of the Dark Ages in Europe information flowed from the Moslem world back through the scholarly language of Latin into Europe. More recently we have witnessed the dominance of English as the language of science resulting from the shift in scientific dominance from Europe to the United States after World WWII. Much of this shift occurred because of the anti-Semitism of European leaders, particularly Adolph Hitler, and had little to do with the scientific environment of the United States. The effect was a transfer of the center of scientific thought from Europe to the United States.

I would claim that we are currently witnessing the transfer of such knowledge from the United States to other areas of the world, particularly the East. In the conclusions section of the National Science Board's report on Science and Engineering Indicators for 2004<sup>1</sup> one finds evidence of this decline.

*“Although the United States remains the world's S&T (Science and Technology) leader, a collection of trends in indicators of U.S. S&T competitiveness paints a more differentiated picture. In R&D (Research and Development) performance, the United States is slowly widening the gap with other leading nations and regions such as the EU (European Union), non-U.S. G-7 countries, and non-U.S. OECD (Organization for Economic Cooperation and Development: a 30 member group) nations. However, some non-OECD economies, including China, the Russian Federation, and Taiwan, are slowly raising their spending relative to that of OECD members. In S&E research output, as measured by publications in the world's key journals, the U.S. share continues to decline, indicative of the development of cutting-edge research capabilities elsewhere. The overall U.S. world market share in high-technology products is steady, but the nation's aerospace industry is losing market share. Although the U.S. balance in intellectual products trade remains positive, it is showing signs of a gradual decline.”*

These conclusions point to the relative state of the United States' dominance in science and its child technology while a later paragraph actually addresses the flow of information.

*“A range of indicators traces a trend that shows growing competitive strength in the Asian region outside of Japan, chiefly in China, South Korea, Malaysia, Singapore, and Taiwan. Scientists based in those countries produce a growing share of the S&T articles appearing in the world's leading journals, and development of regional scientific collaboration (centered on China) is apparent. These Asian economies have an expanding world market share of high-technology production. In exports of high-technology products, they are gaining market share on all major industrial nations including the United States. They are increasing their production of S&E degrees with a special focus on NS&E, (Natural Science and Engineering) thus providing a growing stream of new technical talent for their economies. They have in place, or are instituting, policies and incentives to retain their highly trained personnel, attract expatriates, or otherwise benefit from their nationals working abroad, chiefly in the United States.”*

While flows of information can be traced through the publication of written material, the current flow is dominated by the Internet and less easily seen. However, even a casual look at the rise of Google and the dimensions of its “net” will show a steady and very rapid increase outside the borders of the United States. Another hallmark of this flow is the speed of its development. Twenty years ago Internet Traffic was largely limited to a very modest flow of EMAIL largely among academics and large transmission of data and knowledge within the Physics community. While these components are still present, they are dwarfed by the flow among other disciplines and members of the public at large. This has been particularly beneficial to some “third world” countries which now have relatively easy access to the collective knowledge of Western Civilization. Much of this flow has been the inevitable result of technological development. However, the flow of science and technology away from the United States has been exacerbated by cultural changes within the United States. The focus of these changes can be found in the governmental attitude toward and politicization of science and technology.

## Some Examples in the Change in Dominance of Science in the United States

Let me begin by dealing with the so-called physical sciences; those sciences that focus on the description of the physical world and generally do not have the word science in their name (i.e. Physics, Chemistry, Astronomy, Geology, etc.). Some of the most dramatic examples of the national change in these sciences can be found in the journal *Science*. Even here, the onset of the effect is fairly recent. Today, it is difficult to pick up an issue of *Science* without finding some hint of the changing support for science in the United States. This is in marked contrast to 2004 when there was a more bullish view of the future of American Science<sup>2,3,4</sup>. However, by 2005 it is difficult to pick up an issue of *Science* without finding a note of concern for the future.

The year 2005 began with a report of funding cuts to NOAA for the gathering of long term climate data intended to provide a definitive long-term climate record for the United States. *Science*<sup>5</sup> reports the administration's message as "*If the outcome of a scientific study is unlikely to fit your agenda, stop funding it*". April saw a number of announcements describing the decline of High Energy Physics just when it seems to be on the verge of major advances. The stage for these reports was set by a marvelous editorial in *Science* by Donald Kennedy<sup>6</sup> titled "Twilight for the Enlightenment". The situation for High Energy Physics was concisely summarized in a *Science* "News Focus" article titled "High-Energy Physics: Exit America?"<sup>7</sup>. A specific example was reported three weeks later describing a new state of matter that has preliminarily been detected by the Relativistic Heavy Ion Collider, but notes that budget cuts jeopardize completing the study in this country<sup>8</sup>. The Senate's attitude seems summed up by the July announcement that it cut the NSF's budget increase below even that requested by the Bush administration to 1% with some specific restraints placed specifically on High Energy Physics and the support infrastructure of Antarctic research<sup>9</sup>.

In May we saw the announcement of the site selection in France of the most expensive science project (ITER) ever undertaken<sup>10</sup> as well as announcements on the likely scaling back of Hubble's successor the Webb Telescope. This led one of the Principal Investigators for the Webb Telescope to remark that the suggested scaling back will eliminate the need for the telescope entirely<sup>11</sup>. This is followed a week later with a quote from the retiring National Academy of Science President Bruce Albers saying "*It seems likely to me that China and India will become the dominant scientific power ...*"<sup>12</sup>. The month of May also brought an editorial in *Science*<sup>13</sup> from Lazowaska and Patterson noting how the change in DARPA's mission to push technology over basic and innovative research will interrupt "The Endless Frontier" predicted by Vannevar Bush in 1945. In an informational Email from the American Astronomical Society<sup>14</sup> details the effect of recent budget cuts on the ability of NASA to pursue the science it has already committed to doing. These are but a few of the recent negative reports relating to the future funding of science in this country.

## The Changing Government Attitude toward Science

The examples that I have given above represent specific events that began to concern me during the year 2005. Since then I have become aware of an evolutionary relationship between

government and science spanning several decades<sup>15</sup>. Chris Mooney gives an excellent and highly documented account of this change.

After WWII science was regarded as largely being responsible for its conclusion. It is often said that radar won the war and the atomic bomb ended it. While many historians have seconded guessed United States decisions regarding the conduct of the war, few will disagree that radar effectively won the U-boat war of the North Atlantic. I have yet to meet a veteran of WWII who disagrees with the dropping of the atomic bomb. The result was that Science was highly regarded in the United States and much was done to improve its standing. The development of Nuclear weapons by the Soviet Union and the launch of Sputnik further pushed the science-development and education in the United States.

However, the increased developments of science led to it playing a larger role in government policy. The establishment of a Presidential Science Advisor with the title of Deputy Assistant to the President by John Kennedy and later the formation of the Congressional Office of Technology Assessment (OTA) further demonstrated the governmental acknowledgement of the importance of competent scientific information in the formulation of public policy.

Perhaps the inevitable result of the use of such information in the formulation of public policy is a conflict with those institutions that are affected by that policy. While abuse of science in the formulation of policy can be traced back to times not long after WWII, perhaps the evolution of the current state can be said to have begun during the Reagan Administration. The presence of the Religious Right can be seen in the administrations order to the Surgeon General C. Everett Koop to refrain from saying anything about AIDS during Reagan's first term<sup>16</sup>. The pro-industry mood of the Reagan Presidency is illustrated by the appointment of James Watt as Secretary of the Interior, the development of "hit-lists" of scientists to keep off science advisory panels and the forming of a committee on "regulatory reform" to address industry's complaints about over regulation<sup>17</sup>. After The White House Office of Science and Technology Policy (OSTP) produced a damning report on acid rain the OSTP was eliminated by the administration<sup>18</sup>. Reagan's dream of what became commonly known as Star Wars further broadened the gulf between the policy making branch of government and the scientific community.

During the 104<sup>th</sup> Congress, Gingrich Republicans issued an all out assault on science under the mantra of "**Sound Science**" which should not be confused with good science. A clear definition is generally never made, but it is usually used to disparage any scientific result that doesn't conform to the requirements of the speaker's agenda. Perhaps one of the most alarming uses of the term **Sound Science** is Congressman Greg Walden's Sound Science Bill, which he announced he planned to re-introduce in March 2005, for enforcement of the Endangered Species Act that currently requires the best "scientific and commercial data available" for establishing an endangered species. This bill would require any study to "give greater weight to scientific or commercial data that is empirical or has been field tested or peer-reviewed". The bill would also require that decisions to list species as endangered would require "field Data".<sup>19</sup> Such requirements would eliminate any use of modeling of species reproductive capacity since such

results could not be field tested until the issue no longer mattered. The antonym of **Sound Science** clearly is “**Junk Science**”. A considerable number of Conservative Think Tanks such as the George C. Marshall Institute appear during this time. Their primary function seems to be showing that science that may potentially lead to government regulation is “**Junk Science**”.

After Gingrich successfully dismantled the Congressional Office of Technology Assessment (OTA), such think-tanks aided individual Senators in finding individual scientists to support their particular agenda. The OTA had too successfully represented the mainstream thought of scientific results and thus was a threat to the politicization of science<sup>20</sup>. The major driving force to discredit science for the purposes of making policy initially arose from the Tobacco industry and their attempts to avoid regulation and prosecution for the problems arising from smoking.

Perhaps the height of the politicization science can be found in the present Bush administration. Indeed, this politicization gave rise to most of the examples I presented in the last section. This administration has seen the arrival of a successor to the Shelby Amendment fostered by Gingrich Republicans and known as the “Data Quality Act”. Both were added quietly to budget amendments without congressional debate. The former allows the Freedom of Information Act to obtain “all data produced” by any publicly funded agency<sup>21</sup>. The latter passed in 2000 appears to only ensure the “quality, objectivity, utility, and integrity” of government information<sup>22</sup>. However, in practice it has been used to require additional studies before employing government regulation. This approach has been characterized as “paralysis by analysis” by at least one reporter. It has been used to thwart numerous attempts at government regulation including recent assaults on the Endangered Species Act. Further examples of the misuse of the Data Quality Act include suppression of regulations of certain pesticides, other toxic substances<sup>23</sup> and to discredit good science. The general strategy is to label any science that doesn’t have zero error tolerance to be “**Junk Science**”. Should the science be really conclusive, then the data on which it is based can be subpoenaed and reanalyzed by a non-peer reviewed group who may obtain different conclusions. Since there is now disagreement about what the data show, the original work can be labeled “**Junk Science**” and dismissed from any use for regulation or policy determination. These attitudes of the government toward science have been described as abuse in *Scientific American*<sup>24</sup>.

Another indication that this attack on science is evolving came just after the 2004 election. In an article based on an interview with Bush’s science advisor, John Marburger, very tough language towards scientists who opposed Bush’s election is used by Marburger<sup>25</sup>. The message seems to be that they should expect revenge and it will be all their fault. This seems likely to be a response to the report of the Union of Concerned Scientists reported by Peter Harwood<sup>26</sup>. He indicated that the Union of Concerned Scientists gave a number of earlier examples of the Bush administration attitude toward science. These concerns were presented at a February 18<sup>th</sup> 2004 press conference as documented by Chris Mooney<sup>27</sup>. An example involves highly qualified appointees to the National Institute on Drug Abuse and The Army Science Board who were rejected because their political views were not congruent with those of the Bush administration. In two cases the appointees were asked if they had voted for George Bush. In a

survey by the UCC of more than a thousand federal employees of the U.S. Fish and Wildlife service about two hundred replied that they had been “directed for non-scientific reasons from [making] findings that are protective of species.” One out of five agency employees added that they had been “directed to inappropriately exclude or alter technical information from a USFWS scientific document.”<sup>28</sup>

An additional example, involves research carried out by the USDA describing the hazards to human health from airborne bacteria associated with farm waste. The results were ordered withheld by the Bush administration which found them to be “politically sensitive and controversial issues requiring discretion”<sup>26</sup>. Perhaps the most pervasive example of the politicization of science since the deceptions by the tobacco companies can be found in the prevailing discussion of global warming and resultant climate change. The impact has generally been viewed by many industrial interests as a threat to their normal way of doing business. The history up to about 2005 is nicely summarized by Mooney<sup>15</sup> and is too lengthy to recount here. However, it serves as an excellent example of the evolution of the distortion of science to achieve a non-scientific goal. Early objections simply used honest scientific uncertainty limits to label the results as “**Junk Science**”. The difference among complex models involving very complicated and often uncertain physics served this argument. The fact that these uncertainties have steadily decreased over time is ignored. The only real “outlier” model of about a half dozen actually places the amount of global warming significantly above the mean of the other models.

The approach of exaggerating the uncertainties of models was soon supplemented with “experts” representing fringe science to further the uncertainty. Refinements in this approach include obtaining industrial experts with degrees from diploma mills whose actions only serve to creatively muddy the waters. Creative selections of comments from authoritative reports, when taken out of context, also lend confusion to the argument. More recently as described below, direct harassment of scientists whose results challenge the political agenda of those who deny human involvement in our changing climate is going on. The results of this ploy are yet to be fully played out. However, a strong indication of their success can be seen in the final budget appropriations earmarked for science in 2006. Although the enacted total federal R&D expenditure for FY 2006 climbed by 1.7% to \$134.8B compared to FY 2005, 97 percent of the increase goes to only defense weapons development and human space exploration technologies.<sup>29</sup>

As an indication that there has been no change in the administrations approach to science can be seen in the attempted muzzling of NASA’s respected climatologist James Hansen<sup>30</sup>. While the NASA administrator Michael D. Griffin issued a strong statement a week later calling for “scientific openness” throughout NASA<sup>31</sup>, one can only wonder if it will have a significant impact as evidenced by Hansen’s recent speech where he revealed that NOAA insists on having “a minder” monitor its scientists when they discuss findings with journalists. Hansen said “It seems more like Nazi Germany or the Soviet Union than the United States,”<sup>32</sup>

## **Chronic Mismanagement**

To what extent should a government attempt to support scientific research? I recently reread a deft article I wrote more than a decade ago titled “The Death of Science”. It was a moderately optimistic article noting that the end of science had been forecast many times in the past particularly at the end of the 19<sup>th</sup> century and noting how premature such forecasts had been. However, it did point to problems with the government’s funding of science particularly through the National Science Foundation (NSF). In a prescient short story Leo Silzard<sup>33</sup> described a way to insure the end of imaginative science in any country through the establishment of a foundation that would award grants to deserving researchers. His picture, not coincidentally, mirrors the NSF and his thesis was that such an organization would inevitably only fund “safe science” leading to mediocrity and the end of any real creativity. Half a century later David Mermin<sup>34</sup> suggested with characteristic good humor that all individual government grants should be abolished and the money directed to the academic institutions themselves as they could better determine its best disposition.

While much of what Silzard and Mermin say makes logical sense, since its foundation the NSF has by and large significantly advanced science in the United States. Some of Silzard’s criticisms have occurred, but more recently there has been a push to move the NSF’s mission in the direction of technologically based development rather than the support of basic science for which it was established. While such pressures were not anticipated by Silzard, I am sure he would understand them as the logical force to be exerted by any administration that clearly does not understand science, its goals, needs, and function. Continual dictation of the role of science by those outside the scientific community who refuse to learn the scope and limits of science can only lead to the fulfillment of Silzard’s worst predictions.

## **Changes in the Public Attitude toward Science**

In a recent editorial in *Science*<sup>35</sup>, the Chief Executive Officer of the American Association for the Advancement of Science (AAAS) discusses the rise of a belief system known as Intelligent Design (ID) that is masquerading as science in the United States and elsewhere. He draws perhaps the clearest and simplest distinction between belief systems that are not subject to test and the notion of a scientific theory that I have yet seen. He properly expresses concern over redefining science so as to call ID science and thereby teach it in the science classroom. The concern is that the next generation of Americans will not be able to tell the difference and thus not be able to make rational decisions concerning policy matters based on science. Such problems as global warming and stem cell research come to mind. Perhaps the administration’s view on these subjects is best evidenced by The President’s endorsement of ID<sup>36,37</sup> and the recommendation that it should be taught in the classroom as an alternative to evolution. Thus, it would seem that the President is also unaware of the basic characteristics of science. This view seems to have affected a wider political audience including Ohio’s Governor Taft<sup>38</sup> and Senate Majority Leader Frisk<sup>39</sup> who both appear to believe that ID should be taught as an alternative to evolution. A blazing irony to this approach can be found in the 2005 December issue of *Science*

which heralds the “Breakthrough of the Year” to be “Evolution in Action”. One should at least read Kennedy’s editorial on the subject<sup>40</sup> to begin to appreciate the irony.

So as to demonstrate the absurdity of the imposition of “faith based science” Peter Harwood<sup>26</sup> points out that an element of the religious right is leading an effort to repeal the 2<sup>nd</sup> Law of Thermodynamics. Calling the second law of thermodynamics *"a deeply disturbing scientific principle that threatens our children's understanding of God's universe as a benevolent and loving place,"* Kansas State Senator Will Blanchard is spearheading a nationwide grassroots campaign to have the law removed from high-school physics textbooks. The plan has already met with significant support in the state legislatures of Kansas, Oklahoma, Missouri, Tennessee, Georgia, and Mississippi. Such attempts of those claiming absolute knowledge of the world and morality may seem laughable, but their persistence throws a chill on any who would choose to challenge it for, as has happened in some churches in Colorado, they will be declared heretics from the pulpit. It is likely that we have progressed beyond burning heretics, but there are numerous public sanctions that can be nearly as deadly. For example, what was the reason for U.S. Rep. Joe Barton, chairman of the House Committee on Energy and Commerce had in generating a congressional demand for detailed documentation on the scientific work and professional history of three researchers whose studies suggest temperatures in the Northern Hemisphere are warmer than they have been for a thousand years? Alan Leshner, CEO of the AAAS and Executive Publisher of *Science* seems to feel that act gives the impression of a search to discredit the scientists rather than to seek understanding of their work<sup>41</sup>. For a full text of the AAAS’s response to Representative Barton see the WEB site<sup>42</sup>. Is this yet another misuse of the “Data Quality Act”? Before becoming complacent about the civility of Western Society, we should remember that we are less than a century from the era of public lynching.

Evidence of an even wider view of this problem is given by Kennedy<sup>43</sup> who bemoans the cavalier treatment by the media of Climate Change and its confusion with weather. The administration’s chronic disregard for science in this area is once again summarized recently by Kennedy<sup>44</sup>.

## Conclusions

It seems clear that the continued net flow of information away from the United States along with the mismanagement of the scientific environment in the United States can only result in its fall from dominance in science and technology. The reasons for this decline can be traced to a mixture of diverse causes which gather together in an unholy alliance focused on the discrediting of science and its findings.

When I began this article, I found numerous examples of the decline of support for the physical sciences, but remained relatively ignorant of the causes. Certainly the increased communication of the current age and the natural competitiveness of other countries would be sufficient to challenge the continued dominance of science by the United States. What was not clear to me is the extent to which our own government has aided and abetted this decline.

There has been an understandable reaction to the events of 9/11 to limit the access of foreigners to high-tech information in the United States. This has resulted in visa and export restrictions that have led other countries to find solutions to their problems elsewhere. Business has found it economically useful to outsource increasingly higher technology jobs to countries where the labor costs are much lower. This has provided a strong incentive for those countries to elevate the educational level of their working class in order to supply the workers to meet the demand. There are many other providers outside the United States eager fill such educational needs. The elevation of an educated working class also increases the pool of potential scientists. This will lead to increased activity and advances in science in those countries.

Beginning some time ago an evolutionary process began mixing concerns of the Religious Right with attempts by Business to avoid government scrutiny, regulation, and interference in the way they conduct business. Early attempts during the Reagan Presidency were rather clumsy and somewhat transparent. Business interests were led by the Tobacco industry while the Religious Right focused largely on AIDS and Sex Education. The Religious Right seeks to discredit anything that is in conflict with its dogma ensuring that the next generation will not challenge that dogma. Various business interests seem bent on using the Data Quality Act to prevent regulation by government. The appropriate tactic seems to be discrediting the science used for establishing that regulation. However, the initial efforts of this unholy alliance have become much more refined by eliminating government offices that were charged with providing reliable science information, invoking innocuous sounding legislation that could be used to obstruct government action, and attacking scientists whose work conflicted with the desired results of the alliance. More recently their strategy has expanded to include “packing” of scientific advisory committees with personnel whose political philosophy is aligned with the alliance and recruitment of individuals with dubious credentials representing themselves as “scientists”.

The isolationism inspired by 9/11 along with business interests attempting to maximize profits while minimizing government regulation have combined with the goals of the Religious Right to produce a continuing escalation of attacks on science, its results, its philosophy and its practitioners. The anti-science pressure that results can only lead to a decline in the quality and quantity of science generated in this country. Besides the obvious detriment to the development of the sciences, the distortion of science can only serve to confuse the public in general. Even the most conservative view must concede that a confused electorate cannot be expected to make wise decisions concerning policies which will increasingly rely on an understanding of the underlying science and technology on which those policies are based.

This will lead to a concomitant loss of the United States’ influence in world affairs. It seems fair to assume that such a decline would also be accompanied by a decline in the standard of living toward the world norm. However, the speed of the present information flow and change in cultural values could signal an even more far reaching decline of western values in general. Such an outcome becomes more likely with the rise of evangelical fundamentalism and its attacks on science in order to promulgate its agenda. When this is combined with the attempts by

business interests to avoid governmental regulation it would seem likely that those pursuing science will tend to find more friendly environments in which to further their studies. The loss of basic science will lead to the loss of technological development. It is not far fetched to suppose that the ultimate fate of such a decline is the inability to maintain the technology upon which our society rests.

While such a decline can be accelerated by the rise of competing countries and natural disasters, there is an additional threat to the continued dominance of science and technology that is of our own making. The technology upon which we have learned to depend may actually lead to its own destruction. That technology depends on the continued availability of information. Such information must be stored in a manner that ensures its survival. Hard copies are likely to be non-existent within a century. Current storage mechanisms have become increasingly dependant on high technology for their continued existence. The ephemeral state of preservation of current information could lead to the inability to recover that information on a grand scale that would dwarf the burning of the library in Alexandria during the Roman Empire. Recovery from the ensuing “Dark Ages” would be far more difficult due to the depletion of the physical and environmental resources of the planet. The transfer of science and technology is in the direction of the less developed countries. It is ironic that trailing the United States in technology may actually reduce the impact of a technological collapse on the third world thus enhancing their ability to recover from the new Dark Age.

While information flow does not imply a flow of wisdom, in the past it has always been accompanied by an increase in the technology of the receiving culture. The end of the Dark Ages in Europe lead to a rapid increase in the art of war which itself enhanced the development of technology. Forecasting the impact of the present flow of information and science away from the United States is a very cloudy enterprise at best. However, given the present view of the United States held by much of the world; it is hard to be optimistic about its outcome.

It would seem that involving the recipients of this knowledge in the general global progress of the human race would be the only chance we would have of preserving some of the more noteworthy aspects of western culture. Given the present cultural climate and its apparent direction of development in the United States, this seems unlikely.

Some are likely to contrast my views presented here with the more optimistic view of the development of science that I held over a decade ago. The two are not really in conflict for my earlier stance was that science was likely to continue to develop wonderful and frightening new views of our universe. However, my current view is that it seems those advances are increasingly likely to take place outside the United States. It is also not clear that we, as a race, will have the wisdom to assimilate that knowledge for our own well being. What is perhaps more chilling is that the views of some professing absolute knowledge of what one should think will lead to an acceleration in the loss of science in dealing with the manifest problems of the 21<sup>st</sup> century. Such a loss will merely be one manifestation of a general loss of personal freedom.

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