《会議報文》

Significance of Controllable Nuclear Fuel Burning for Humanity

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Abstract—*More than half a century has passed since the start of nuclear fuel burning (NFB). But judging from the current situation of developments in Japan and elsewhere, it is disappointing that humanity is still unsuccessful in reaching the goal to make it an established social element. In the analysis of the significance of NFB, the paramount issues were identified rather the questions of communication to and acceptance by the non-specialists than of assessment by the specialists. The nuclear policy in general, safety policy in particular tend to be formulated through a series of complex political processes but such a sophisticated technology shall be chosen in the end by laypersons who place trust in it; situations will differ over countries, but implications diffuse globally. As a result corporate social responsibilities of public utilities may have the greatest importance because they may be in the position of priest or soldier to protect each individual citizen from psychological fears.*

I. INTRODUCTION

It is probably not an exaggeration to say that technological civilization such as information technology (IT), biotechnology, nano-technology, etc. has mostly sprung from nuclear science and related technologies. Those who are concerned with nuclear science and technology must be responsible for the present and future of a highly sophisticated technological world.

More than half a century has passed since the start of Nuclear Fuel Burning (NFB).[1] It is unfortunate to say that humanity still needs time to reach its goal to make NFB a sufficiently acceptable tool for society. For example the current situation of nuclear power utilization in Japan is not convincing for laypersons in view of the power shortage forecast in the summer of 2003 due to comprehensive inspections of nuclear power plants for compliance purpose.

NFB is a technology based on the nuclear reaction that is characterized by a huge amount of power, radiation and long-lasting radioactivity, while Fossil Fuel Burning (FFB) is based on a chemical reaction, which produces carbon dioxide and other pollutants deteriorating the global and local atmospheric quality day by day. Utilization of each seems to have therefore complementary significance or impact on human civilization. In either case we have to suffer the influence in exchange for its benefit as a bargain.

Safety in a broad sense is the prerequisite of NFB including both non-proliferation of WMD (Weapons of Mass Destruction) and avoidance of a massive release of radioactivity as a result of facility attack. In addition, the psychological safety of NFB for laypersons is as essential as the physical one for the specialists.

In any event people seem to feel society to be more and more insecure not only because of the danger of radiation release, but also because of the uncertain future of the world with worldwide spread of IT and biotechnology, etc. It would be ironical however if some similar future developments by each high technology were to be ameliorated by the history of nuclear related human activities.

II. WITHIN THE NFB-WHERE ARE WE NOW?

From the outset, the connected dangers between the peaceful and war-like use of atoms were well acknowledged, and handled with special care (see Table 1); but sophistication of the safety philosophy for containment and control of fission-caused-radioactivity and radiation was delayed until we recognized the weakness in both technology and institutions for nuclear safety through the accidents which I refer to as "TCJ": i.e., the TMI-2 (1979), the Chernobyl-4 (1986), and the JCO (the 1999 nuclear criticality accident at the Japan Nuclear Fuel Conversion Co.). Each certainly caused both psychological and real fears for residents nearby and worldwide as well.

In the peaceful use of the atom, any safety philosophy including social factors had nothing to do with the war-like atom, while the government and the industry jointly converted the war-like atom into civilian power use with wishful thinking and rosy optimism. Industry itself was also interested in power production through NFB with optimism over the prevention of possible inadvertent accidental release of fission products, and the need of persuasion of descendants as to the risk of piling-up nuclear wastes. Guarding these negative impacts raised by the critics of NFB were therefore always delayed and band-aided and eventually lead to the mistrust of NFB by the public at large. It has been particularly the case worldwide since the experience of significant release of radioactivity in the Chernobyl-4 accident.

Not one technology under the sun has been identified as 100% safe. Technological excellence is mandatory but not enough. Even an excellent energy technology would only be sufficiently safe till some defects within the system eventually develop into an accident. Incremental safety improvements have continued therefore over the years in line with existing technologies and have already absorbed substantial development cost. At the same time, the use of a comprehensive passive scheme of safety procurement has advanced as an approach for securing facility safety.

Nuclear policy in general, and safety policy in particular tend to be formulated through complex political processes but any sophisticated technology shall be chosen in the end by people who understand and claim it. Situations will differ over countries, but the implications diffuse globally. Therefore an international promotional body for the safe and economical use of NFB is needed for people of developing countries which desire to have opportunities to share nuclear power. Enhancement of checking for nuclear activities in those countries by international regulatory bodies like IAEA is needed as well. On the other hand, in a nuclear-advanced country like Japan, however, capital

Table 1. An early and probably most honest accounting by a famous nuclear scientist, J. Robert Oppenheimer in 1948 [2]

(In this table each theme is named by the author and the page in the parenthesis is from the book 'The Atomic Age, Selections from 'the Bulletin of the Atomic Scientist.' edited by Morton Grodzins and Eugene Rabinowitch published by Simon and Schuster NY, (1965))

(1) Political Aspects	
1. Essence of NFB:	The development of atomic power could not be separated from technological development essential for and largely sufficient for the manufacture of atomic weapons. (p. 67)
2. Safeguarding of nuclear fuel:	Peaceful future of atomic energy were overshadowed by preoccupation for the control of atomic energy to the extent necessary to prevent its use for destructive proposes. (p. 67)
3. Inevitable growth:	It was quite clear that with nations committed to atomic armament, weapons even more terrifying and perhaps vastly more terrifying, than those already delivered would be developed; and it was clear even from a casual estimate of costs that nations so committed to atomic armament could accumulate these weapons in truly terrifying numbers. (p. 68)
4. Change of warfare character:	If the atomic bomb was to have meaning in the contemporary world, it would have to be in showing that not modern man not navies not ground forces, but war itself was obsolete. (p. 68)
5. As an instrument for peace:	What can be done with this development to make it an instrument for the preservation of peace and for bringing about those altered relations between the sovereign nations on the basis of which there is some reason to hope that peace can be preserved. (p. 68)
(2) Economical Aspects	
1. Thoughts on NFB during the war time:	Even at that time (*summer of 1945*) a great deal of thought had gone into what subsequently came to be known as the peaceful use of atomic energy. (p. 65)

(To be continued.)

2. Six decades were not enough:	The question of the usefulness of this (nuclear) power, the scale on which it would be made available, and the costs and general economic values, would take a long time to answer. (p. 66)
3. Picture of peaceful use of atomic power is dim:	Our picture of the peaceful uses of atomic energy was neither trivial nor heroic: on the one hand, many years, perhaps many decades, of development -largely engineering development- with the purpose of new sources of power; on the other hand, a new arsenal of instruments for the exploration of the physical and biological world and, in time, for their further control, to be added to the always growing arsenal of what scientists and engineers have had available. (p. 67)
(3) Sociological Aspects	
l. Mindset of participants:	It (the development of atomic energy) was marked from the very first by an extreme self-consciousness on the part of all participants, which has given it an often heroic, though not infrequently rather comic, aspect. (p. 65)
2. Anything good in the atom:	It was clear to us that the forms and methods by which mankind might in the future hope to protect itself against the dangers of unlimited atomic warfare would be decisively influenced just by the answer to the question "Is there any good in the atom?" From the first, it has been clear that the answer to this question would have a certain subtlety. The answer would be "yes" and emphatically, "yes," but it would be "yes," unconvincing, conditional and temporizing compared to the categorical affirmative of the atomic bomb itself. (p. 66)
3. Self-righteousness of specialists:	Only among the professional scientists for whom the interest in the development of atomic energy is rather immediate, could we have expected to find, and did we in fact find an enlightened enthusiasm for cooperation in this development. (p. 66, sic)

intensiveness and the long-range nature of development tend to preclude NFB from becoming an autonomous industrial activity. International institutions like WANO (the World Association of Nuclear Operators) may be instrumental to make NFB a worldwide industry. Human resources growing in the Asia-Pacific is the most imminent.[3]

As to the present situation of the acceptance of NFB by Japanese, its level changes from time to time according to the performance of recent operation and maintenance of NFB facilities. If it is found to be insufficient the restart of the plant is always delayed, but with time after remedial actions are taken, somehow a point is always reached giving way to permitting the restarting. The tendency of Japanese is to always give pardon for excuses and expect it in return when in reversed position. Consequently, not because of the real benefit that may accrue over cost, but because of the huge amount of past investment into NFB, Japanese are quite reluctant to abandon NFB.

III. NEED OF IN-DEPTH SAFETY CONSIDERATIONS

Today (as of June 2003), the NFB has grown up worldwide; 439 plants are in 31 countries with a total capacity of 360GWe supplying 16% of the electricity in the world.

Obviously all aspects of NFB are already a reality including even the consequences of TMI-2 and Chernobyl-4. We now know NFB plants could crash like airplanes causing an influence, which is enormous and hard to bear for any society. Dr. Weinberg commented in 1986[4], "By 2050, 1850 GWe plants may be in the world. Even if the core-melt probability is as low as 10^{-7}/RY (reactor year), the frequency worldwide is then roughly 2×10^{-4}/year." Although the 2003 capacity is well less than he expected, can the world society place trust in this number after experiencing 2 core melt accidents during 7 years and 3 major accidents during 20 years if you include the accident of JCO? In any event, because the number 10^{-7} is in a sense abstract and the uncertainty is large and difficult to verify by any means, this approach may not be enough.

We therefore need such sophistications as were discussed in the Ascona meeting in 1990[5]. (See its brief essence in APPENDIX A) It aimed "To establish and/or develop an interdisciplinary method for risk assessment, evaluation and management, allowing comparisons to be made within regional safety schemes; the results were to be presented in a form of suitable for applications and understandable to the general public". The meeting shook the fixed opinion of many a participant, or cast some doubt about it. The general outcome was that one was unable to continue in any of the problem areas under discussion; however, alternatives were not yet in view.

In this connection we can see, as a background, some salient features of the current situation as follows[5]:

1. Actual action is mostly determined by the local habit (of committee); alternatives are often ignored altogether.

2. Many people refuse to understand the frame of mind of others; judgments of value are often excluded.

3. The procedures of working and communicating are not up to the complexity of the problem area.

4. Taking no action is often considered to be a solution; the consequences are not studied nor investigated into.

5. There is an ever-widening chasm between the worlds of the specialists and of the layman.

Dr. Kröger drew the following lessons as the conclusions from the meeting[5]:

1. The acceptance of the nuclear energy can be reached by way of an improvement in plant security-if at all only if catastrophic disasters can honestly be excluded.

2. The acceptance crisis of nuclear energy must be seen in the context of "technological progress" and "nonfunctioning communication". In the long run, the problems are not solvable by putting aside, but on the contrary by highlighting the difficulties; in particular, not by over-simplification.

3. There are no ready-made recipes; therefore, parallel avenues should be followed.

4. The nuclear energy should be embedded within the whole field of risk; in the proof that it is necessary and acceptable also alternative solutions should be considered.

5. It takes time and patience to improve the general opinion on nuclear energy.

Dr. Kröger said that the highest priorities were: accident-free running of all plants in the world ("benefit"): open discussion of scientists and engineers with sociologists and intellectuals ("intellectual atmosphere"), while the seemingly unmovable external influences might be changed (problem of energy vs. environment).

IV. SOME SOCIAL FACTORS OF NFB

In this section I will focus on some of my thoughts on socio-political factors of NFB in general.

IV. A Lack of Understanding of the Totality

Indeed the debates over NFB issues have been polarized distinctively among the optimists, the pessimists, and the skeptics. It should be remembered that only few of them have the expertise and experience of all phases of NFB activities; only few have engaged in designing, installing, decommissioning, dismantling and entombing the facilities as well as in licensing: only few have so far touched upon all aspects of NFB as part of their business. Consequently they tend to enter a pitfall of controversies owing to ignorance of the understanding gaps between them. Lots of documents and references at our library, and introductory books written both by nuclear proponents and opponents can only present a general idea of the whole picture. Alas indeed, they can not convey real difficulties, dangers, concerns, and their amounts relevant to the each part of NFB activity, simply because troubles may appear even tens or even several hundreds of years later after their retirement.

In this sense, almost no specialists are sufficiently prepared to understand and fulfill the totality. At this stage, it is ironically safe to discuss through paper-work which emits no radiations at all. This suggests that the NFB industry is destined never to come to a matured status like the automobile and airplane industries and will always remain in the stage of development. I must voice that we are still in the learning stage of NFB and need hereafter an institution that dares to perpetually commit to the whole aspect of NFB to cope with this situation.

IV. B Need to Foster Priesthood with Longevity of a Millennium

Decent people have studied for years the potential risks of NFB including fuel cycle activities. Although we have had a history of failure and success in NFB development, such accidents like "TCJ"' were not expected to happen so soon or so frequently. The concept of Defense in Depth (DID) was originally thought sufficient to preclude either such accidental damage to the reactor core (the Severe Core Accident) or accidental release of radiation but in vain. Indeed, we are destined to keep on seeking a better management strategy for the development of NFB in general, and high level nuclear waste (HLW) in particular, because it is hard to say by any means that the DID will be 100% effective in this particular case. Facilitating further use of NFB is anyway limited; it is impossible to experience the entire life cycle of NFB as is the case in demonstration and accelerated mode testing of other conventional technologies. Rather we are destined always in a position of doing experiments on NFB and of learning the problems connected to it as well.

On the other hand, in view of the characteristic time frame ranging from centuries to millennia associated with nuclear waste, its management should be coordinated with a matching time perspective. Alas it is at least 10 times longer than an ordinary human life. Still there may be said to be a social responsibility not to transfer debt to later generations, and our descendants may prove our perspective inadequate.

IV. C Fragmentation of Responsibility

Each country has its national commissions both for promotion and regulation; and safety regulation is particularly central. In the nuclear field it cannot be known how high a level of responsibility a regulatory committee should assume.

Today, nuclear safety is widely discussed in an international arena, seeking consensus on standards formulated at IAEA, OECD-NEA and others. In any country a NFB plant is still politically too hot and socially too controversial to be freely marketed and easily sited. NFB is neither a technology like the automobile nor the airplane. Typically, for example, no utility related corporation is willing to run a private repository to be used for HLW. Long-range responsibility cannot rest on national governments whose budgets are unfortunately limited nowadays.

In any event, in practice government has to depend on the utilities and the service companies for plants' safety. This type of blind dependence tended to raise either interplay or fragmentation of responsibility. When something wrong happens, it is almost like a volley ball game where no ball dropping is allowed at all. Then, what sort of economic/ organic model would be the best to ensure the safety of a NFB plant? Is there such a model? That is the question.

Many faults were experienced in the past but were concealed by employees of a nuclear related company including its subcontractors. The 1999 JCO criticality accident was typical. The immediate causes of this accident were several cases of misconduct by the company's workers. It seems however that the nuclear safety commission at that time did not require safety analysis for the criticality of full spectrum of facility configuration with 20%EU solution. Most probably they failed to predict the possible configuration of criticality because of a tacit mindset that the facility should have been strictly operated under a fixed pattern of operation. Indeed they lacked imagination which we need.

V. PUBLIC UTILITY NEEDS TO GAIN "CORPORATE SOCIAL RESPONSIBILITY[6]"

As the fossil thermal plant emissions are carefully controlled always, so with the NFB plant: the system must be so safe that the releasable inventory of fission products (the source term) must be at any moment sufficiently small as was evidenced in a sense by the accidents of TMI-2 and JCO, but not by the Chernobyl-4. This can be expected with the special safety philosophy for precluding the precariousness of both mechanical and human elements by adopting a design with ample margin that depends on passive safety.

However, the public demands decency of corporate risk governance as well, meaning that corporations must take full responsibility for sustaining citizens' safety. These practical social factors are, by fact, as much as or much more important than the simple reduction efforts of conceptual risks. From this point of view, it makes sense to say that the public utilities are in the position to remain in the priesthood to protect each individual citizen from psychological fears. (See APPENDIX B)

VI. CONCLUSION

It is timely to revisit a comparison of the benefits of nuclear fuel burning (NFB) for humanity against the cost of controllability of NFB in the interests of nonproliferation of nuclear weapons and the worldwide nuclear safety.

After the end of cold war, the war-making atom is identified more as a threat to humanity and less as a deterrent, while the peaceful atom is tested for its viability. NFB is a unique human activity which has only been experienced briefly in human history. Society does not have the temporal context to understand sufficiently the cost/benefit comparison of NFB.

Safety of NFB in particular depends on both institutions and human nature in the operation and maintenance of the technology. An individual citizen cannot rely for his or her safety only on the regulatory actions by government and industry. One of the most important prerequisites for the future of NFB is therefore the obvious corporate social responsibility of nuclear priesthood. Public utilities themselves must begin to act like priests and like soldiers to protect citizens from psychological as well as real fears.

APPENDIX A. CONCEPTS OF RISK AND SAFETY OF TECHNICAL SYSTEMS FROM THE 1990 INTERDISCIPLINARY MEETING AT ASCONA TICINO SWISS [5]

First of all, a currently used two-parameter concept of risk,

R (risk) = D (damage) × P (probability of occurrence),

was judged inappropriate at the meeting both in view of a dialogue with the public as from a scientific point of view. It does not consider the particular problems inherent in catastrophic disasters, and disregards the aversion of the general public against just such events. In the case of nuclear energy this aversion seems to be due to the inclusion in the damage value of a danger to the whole of the population, a responsibility with regard to 'others' (e.g. offspring) and the very nature of the damage (invisible radiation-cancer). It is suggested to introduce "aversion factors", and to take several measurable quantities into consideration for the determination of the damage. For instance, besides the quantity of released toxic substances and the extent of (immediate or subsequent) loss of health or life, there should be taken into account also the evolution in time of the deployment of the damage, its extent both in time (over several generations?) and in space (across national boundaries?), ancillary damages and hazards, the extent of irreversibility, and the dependability of any previsions. At the same time, doubts are about the practical feasibility of such a multi-parameter estimate. At any rate, probability of occurrence and level of damage should be studied and judged separately.

Following technical/conceptual attitudes are necessary to increase the acceptance of large-scale technology, in particular of the nuclear industry:

1. A change of leading motive: a security standard aimed at should not be determined by the technology, i.e. setting as a goal what can possibly be reached within the state-of-the-art, but by the solution of the problem set by the public (e.g. no catastrophic releases), or by setting their formulation as the goal of development.

2. Major disasters should not only be very unlikely to occur, but impossible or "inconceivable".

However neither the strict "inconceivability" of catastrophic disasters nor actual obtaining of a "zero-risk" should become a determining principle. Accordingly, some kind of boundary to what is taken into consideration and to what is deemed plausible should be established. This appears to be acceptable even from ethical points of view.

It is difficult to properly deal with technical risks because:

1. The subjective estimate of a hazard by the public often stands in no relation to the objective risk. This also makes it very difficult to establish priorities and to assess the relevance of measures taken to reduce the risk in presence of budget limitations.

2. The relevance of benefit as an argument is judged differently by different people, and probably depends also on the structure of the risk. (Tradeoff between risk and benefit may be acceptable only in a technical field which involves no catastrophic disasters; at least, the argument from benefit should carry less weight with increasing gravity of the accident.)

3. It is an open question on whom to refer the risk of an industrial plant whether to individual persons and or to the society. By the same token, it is open to dispute how to cope with the fact that often only the population in the vicinity of a plant would be affected by an accident, while the benefit of the plant accrues to the whole nation. (A suggestion is to involve the directly endangered people in the risk analysis.)

4. Any discussions often take place on entirely different levels, and are inhibited by fear on

the one side and "mathematization" on the other. Ethical arguments are eminently suitable to mask deficiency of knowledge and to carry symbolical messages, and are indeed used to this purpose.

Regarding communication and evaluation of risk the present situation is unsatisfactory. An increasingly stronger aversion of the public ('moratorium mentality') stands against an increasingly rapid development of technology and of uncontrolled progress. The "common man" sees no way out not due to a lack of information, but rather due to being flooded with information without proper screening. The same applies also to politicians; it was felt to be very important to hold preliminary clarifying discussions.

It is important to establish procedures for the implementation of the necessary changes. Participation of the public should be sought, and a greater part should be allotted to commonsense in the decision process. The scientists should make proposals, but they are not the paramount leaders of the discussion: risk problems are not solvable on a purely scientific basis, risk analyses are not the only one, but just one criterion for decisions; when comparisons are made the question of comparability must have been dealt with beforehand.

As an improvement on the present procedure, it was recommended to:

1. Formulate anew the objectives of protection (from specialists to politicians);

2. Demonstrate the achievement of protection objectives while including alternatives (specialists);

3. Estimate the value/acceptance of technical solutions (from an input by specialists to competent committees and over to citizens participating in politics).

It is essential that the participants be taken earnestly and have a real chance of influencing the decision. The time schedule must be planned accordingly (it is extremely counterproductive first to decide on construction and go ahead with it and discussing afterwards); the participants to the discussion must be tolerant and willing to learn.

Concerning the question of the modality of the discussion, some sociologists voiced considerable opposition to the "discursive model". This model, originally proposed by German philosopher Habermas, builds on a "society without ruling class" and aims at general agreement. To this was opposed the "resources model" developed by Luhmann, which considers universal agreement to be unobtainable, while decisions result from the competition of the dominant groups within a society, with its media (politics-power, industry-money, science-rational plausibility); the public at large participates in the discussion as a 'spectator with possibility of getting involved' ("arena model").

There was agreement on the statement that the willingness to follow arguments and processes of marketing diminishes as the risk or the damage of a possible accident increase. Unconditional premise for a successful communication and for the acceptance of a "feared" technology is the credibility and dependability of the participants, in particular of the scientists. However, some critics thought it part of their business to sometimes refuse assent, and maintained that even to foster diffidence might sometimes be useful.

APPENDIX B. ON PRIESTHOOD

Dr. A. M. Weinberg described the essentials of nuclear energy as follows; "When nuclear energy was small and experimental and unimportant, the intricate moral and institutional demands of a full commitment to it could be ignored or deferred. Now that nuclear energy could be on the verge of becoming our dominant form of energy, such questions as the adequacy of human institutions to deal with this marvelous new kind of fire must be asked and answered, soberly and responsibly. The entire controversy that now surrounds the whole nuclear power enterprise therefore hangs on the answer to the question of whether nuclear system can be made to work properly; or, if faults develop, whether the various safety systems can be relied upon to guarantee that no harm will befall the public.[7]" It lead his famous advocate for the need of "nuclear priesthood". In this connection also the rest of this APPENDIX is drawn from an essay written by Prof. David J. Rose in 1980.[8]

Nuclear Priesthood

The metaphor of a nuclear priesthood has been used to dramatize the idea of a long-lasting cadre of professional persons to handle nuclear power and its wastes. The image was seized upon by the anti-nuclear movement, as supporting their argument that nuclear power has indeed all the evils of Faustian bargain (with no redemptions), that it would require perfect care and trust forever; since such standards cannot be met, nuclear power is socially unacceptable. Perhaps worse than that, control of that power falling into the hands of elitist and secretive human priests conjures up visions of mad horror movies seen on late-night television.

The idea has also been dismissed by most nuclear technologists, who, if they comment at all, point out that what we need is not bad theology and metaphors, but good engineering and technology assessment applied to the problem plus acceptance of the fact that nothing else is perfect either. There is much more to it than that; both sides and perhaps even the proposers of the allegorical metaphor do it a disservice. But we must step back to see things in perspective. Let us not prejudge what we mean by the term "priesthood", but use it as a symbol for a concept to be explored. As Einstein reportedly replied to an initial question of what relativity meant, "Think anything you want about it, provided that it doesn't conflict with what I'm going to say about it."

Social Purposes of Priesthoods

Priesthoods serve many gods and many purposes. Principal among the purposes is matching people and problems that have different time perspectives and different participants with different perceptions of winning and losing. One example is legitimizing and gaining consensus for a code of behavior, which, while it limits the action of individuals, helps to sustain the civilization. The priesthood helps in the recognition of and accommodation to fundamental paradoxes, which will not go away the impermanence of people and the longevity of civilizations and their problems. The mismatches between selfishness and social norms, dominion vis-à-vis stewardship, short-term exploitation vis-à-vis long term conservation are a few examples. These paradoxes cannot be removed by painting one part red, one part green, one part yellow and one part blue then insisting that only one color is permissible. Such actions avoid the necessity of real study, difficult introspection, and hard work.

These ideas occur both in religion and secular philosophy. Both Buddhism and the Judeo-Christian religion are redolent of it. The laws of Moses, and especially the Jewish Talmudic writing deal with the paradoxes. Kant's categorical imperative arises similarly: "Act as if the maxim from which you act were to become through your will a universal law." Thus arise moral imperatives based to some extent on logical analysis and consideration of social good. Recently, the theologian and philosopher Hans Jonas has pointed out that Kant's categorical imperative has for the most part been applied to effects near at hand and near in time, reflecting the general view of the world in eighteenth century Königsberg that man's efforts could not change the whole world very much or for very long. That is no longer the case, Jonas writes, and we need to extend the concept to the whole world and to the effects of our actions on future generations; otherwise how will we behave responsibly to succeeding generations? "Who is my neighbor?" The lawyer asked Jesus (Luke 10, 29-35); our neighbors live not just near at hand, but everywhere that people of good will exist, both in space and time. Two thousand years ago, Titus Lucretius Carus wrote in De Rerum Natura: There is a perpetual need for raw material to provide for the growth of later ages. Life is given to none of us in freehold; we all hold it only in usufruct.

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