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Challenges of Globalization for Science and Research

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Globalization challenges all social systems in all nations – how then could it spare the sciences? A question however is: what is new about this? Has not this happened throughout history? And a further question is: what is special for the sciences in all this? Although globalization may not be a new thing, with a population of over 6 billion people its impact becomes all-pervasive and its consequences are severe. It is not only that science enters into all cultures, whether advanced or less developed. Humans also come to depend on it more and more, and this for better or for worse. Science is literally vital to human beings in that they have come to rely upon it for food, potable water, energy, and security in their environment, or in old age. All people, in ever-increasing numbers, therefore have to be instructed in science so that they become aware of how dependent they are from the continuing progress in science, and to what extent innovation and advantages in economic competition depend upon their abilities to make the best use of science. In fact, science has become so powerful an influence on all ways of life that it can no longer be left to the scientists alone. Their power has to be constrained by morals and by laws, and it becomes inevitable that economists and lawyers, and above all politicians intrude upon what the scientists often regard as their exclusive turf. This may in time be the biggest challenge of the globalization of science.

Globalization poses a challenge to the economies, the social systems, the financial markets, the media, the politics, and the laws of all nations; in fact to everything and everyone and everywhere. How then could the sciences be exempt from this? The question then is whether globalization affects sciences all over the world in any new, any special way? Of course, a thousand-fold increase in the number of scientists active in research over less than ten generations must in itself already change this world, even if only through the increase in total

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output realized, especially so as this is cumulative. Will Karl Marx (as other philosophers before him) thus finally be vindicated: will quantity eventually turn into quality? The human ability to permanently store knowledge, and to let science grow ever faster by the interaction of scholars and students from so many disciplines and of all nations, will even further increase the impact of this knowledge, the more so as human population keeps growing – at the rate of 75 million per year now – as both the consumption of resources (some might call it greed) and economic achievements relentlessly increase, and as the sciences – biomedical to natural, technology to informatics – crucially impact this growth by their own increases of theoretical knowledge and its practical applications. How could these processes, and how could globalization therefore, not challenge the sciences?

But how does it do so, and what is it that in first instance that poses the greatest challenge? Let the biologist in me start by considering what animal this is, *Homo sapiens*, the human being, the knowledgeable animal; you might even say the animal that knows; or even more precisely the animal that is self-aware of its knowledge. There can be little doubt that humans are different from all other animals, that they are unique. However, they are not only different from all other living organisms and unique in the sense that the lion or the mouse, the daisy or the primrose are each unique too. Human beings are truly exceptional in an entirely new sense. Above all, they differ profoundly from each other also as individuals. Their individuality is not only accidental, deriving from random genetic variation among them as is the case in almost all other animals. Individuality is the most fundamental characteristic of human nature. Their genes may hold humans together as a natural species with a common gene pool, as is also true of other species. But these genes can only provide the stage for the particular unfolding of human individual development, especially of the individual brains of humans, their individual thinking, and their individual behaviour, which some 20,000 to 30,000 genes can never fully control. This is deeply influenced and really formed by their unique personal experiences, which make every grown-up human being a unique instance of *Homo sapiens*, since none of them equals any other, not even identical clones. Humans may all be different, yet they still are all of equal value, regardless of race, gender, age, culture, or creed. They may not all be the same in their potential, and differ in their behaviour. Indeed, they vary a lot in their capabilities and appearances. But nobody can be qualified as of higher or lower value before he or she has developed his or her individual faculties, and has demonstrated these to him- or herself, and to others. Above and beyond, they are equal in being unique individuals of the human species, and have an unalienable value in themselves.

Still, all human beings are held together as members of a single, a singular, species. It is their common gene pool, their assembly of genomes, which at the

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same time sets them apart from all others and unifies them. They are also subdivided into races and even more so into cultures, each with its own distinctive common mores, common fate and history, common language, common laws and common governance, common habits of eating, drinking, marrying or reproducing. Although all this makes peoples and nations quite distinct, there is a commonality to all members of a nation beyond their individuality thus bundled, and even more so to the whole species, the genetic or natural species of humankind.

Owing to rapid globalization, the demarcation lines between cultures are ever-faster disappearing, with human beings becoming more intensely aware both of their individual uniqueness and of their basic normative equality as members of one genetic humankind, globally the same wherever they may have settled and in their peculiar cultural adaptations, different as they may be as individuals and due to their cultural diversity. Travel and migration between populations and nations grows, transcends all borders of nation states and continents, and leads to a mostly fruitful (and occasionally also dreadful) intermingling of cultures and races. In such an amalgamation of humans from all over the world, indicated with the term 'globalization', very soon nothing counts – beyond the most immediate personal ties – but individual differences of capability, ambition, and personal achievement. People now are held together not only in the most basis sense of common ancestry and by their nature, i.e. by their genetic endowment, but by the more and more acutely felt need for common rules of conduct based in a common ethics, and by laws that are valid for all, without exception, precisely because they are all members of the human species. These laws have to take notice of individual differences between humans, but at the same time also provide an equitable framework of norms, which all individuals have to respect, and which above all has to guarantee freedom and common human rights to all. Although globalization is not really new for humankind, in the sense that various waves of globalization have washed over the world, even in the past, the speed the phenomenon assumes at present to some resembles a tsunami rather than simply a new 'wave'.

Science is just one of the areas of human endeavour affected by this rapid globalization, but it is affected in a very specific way. Science (with a capital S) and Research, leading to scientific knowledge, are – next to the arts – probably the most readily and fully globalized human activities, and certainly they are indispensable to the survival of the 6, 8 or soon 10 billion people that populate planet earth. Science results from the activity of the human brain, that is to say, the organ that makes us all different and individualized to begin with. Yet, the sciences altogether might be called the common human brain, or rather the outcome of the activity of billions of brains, dead or alive, and memorized forever – or at least as long the human species will survive – in the knowledge of the living people and in the books or other endurable means of storage of human thought in libraries of every kind.

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Science is, in addition, the most relentlessly growing human activity – by less than 1% annually in some nations to more than 7% in others – to which all its practitioners contribute, whatever their race, gender, cultural origin, personal creed or religion. Mind you, all these may try to influence what science has to tell us. But the rules according to which scientific knowledge is tested and proven are such that scientists struggle to fight free of all these efforts to influence them, at least in the long run. Science strives to attain true and reliable knowledge about this world, and only that knowledge will survive that can stand up to every effort to put it to trial. Therefore, reliable scientific knowledge can be contributed to by all human beings – even though probably not by all alike, nor is it equally available to all in view of national differences, cultural proclivities (or prejudices), or personal profit. Science is also useful for every human being alive, and at the exclusive service of no single individual, group, nation, company or trust (unless by patent laws we let them make use of some of this intellectual property for a limited time in order to recoup the expenditure of gaining the knowledge in question in the first place).

This human uniqueness to be capable of fully globalized science and of its knowledge has the following consequences:

- in principle, every human being can contribute by his or her own efforts or by communal scientific research;
- again in principle, no law – one might jokingly say, with the exception of the three laws of thermodynamics! – can restrict or force the pursuit of scientific knowledge, even though we know only too well that human laws, and ethical norms, may sometimes hinder or even try to forbid it. It follows from this that,
- what is scientifically knowable will eventually be known, at least by some people, and maybe with some delay; and what is knowable cannot be made unknown again in the long run, whatever forces are applied, because the truth will out sooner or later – or at least we hope so.

Scientific knowledge is therefore not something that may be invented, or mimicked like some particular musical or pictorial style, or neglected. As long as there are human beings alive, with human brains, i.e. with minds actively seeking knowledge – and in consequence with human hands and technology deriving from them – scientific knowledge will prevail, because it conforms to reality (and if it does not, it should have never been regarded as 'science' in the first place).

Sometimes, this insight may seem quite menacing, especially as science not only cures diseases or tries to rescue the needy from predicaments of all kind, but as it is also scientific knowledge that enables the development of means of destruction that may well jeopardize the future survival of mankind. As much as ethics and laws may try to curtail this in order to rule out the unthinkable, it is at

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the same time true that such knowledge, and the potential to put it to use, will forever be part and parcel of the human endowment; some might call it the human predicament. All that we know of our natural heritage and of our cultural achievements makes clear – as does historical experience – that this thinking ape, the human primate, will need to make every effort possible to rein in those awesome powers that science provides, and only insight into our human nature can curb the dangers involved. It is as if we live, and have to live, on the fertile slopes of a volcano ready to erupt if, for as much as one second, we fail to keep up our efforts to keep it safe – and it may erupt notwithstanding!

But let me first say a few more words about globalization. Many people think that this is not only a new buzzword, but also a new phenomenon. It is not. It is one of the oldest characteristics of this ever-restless primate species to which we belong. In addition, it is a process that has gone through many stages of development in prehistory and history. You might see it as a slow but relentless migration, without boundaries – except too wide a sea, too high mountains, or too broad a desert – for the first sparse populations out of Africa hundreds of thousands of years ago, and again and again for our forebears in search of food and space. It is a migration that finally filled the entire habitable earth and, as this is a globe, that boundless migration eventually ended where it began, with for instance the Bantu Africans, the Dutch and the British converging on South Africa a couple of hundred years ago. Yet that was only the first wave of globalization.

At all times, globalization has mostly been a matter of the migration of people across boundaries, and this continues to this very day, when once again we see people trickling out of Africa and elsewhere. Man is a migrating species *par excellence* – Man the Migrator, *Homo migrans*. No matter the mightiest walls or the highest fences – there is always, maybe not a human, but in the end a humane, way across or around them.

Nowadays, globalization seems like an ongoing migration beyond all bounds: instantaneous, worldwide and covered on-line by the media. Formerly, it was mostly only people – but already along with them ideas, cultures, technologies – that migrated in search of a better future elsewhere. In our economically determined times, and with ever-increasing access to the internet (well over 200 million users now in both the United States and China), it is increasingly capital that travels all over the globe. This is a migration not in kilometres per years but in virtual money per millisecond in the computer networks and recesses (some call them the cess-pools) of the financial markets. The real economy of production, transportation, and consumption, often accompanied by the phenomenon of indentured itinerant working people, now as in the past, forced to migrate in pursuit of food and jobs, follows somewhat more slowly. Thus, globalization occurred in successive waves: first, the hunters and gatherers out of Africa, maybe a million – certainly hundreds and tens of thousands – of years ago,

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spilling all over into Asia, Australia, and Europe, and finally also into the Americas. Next, there was the Neolithic agricultural revolution, bringing with it domesticated plants and animals from several centres in the old and new worlds, but most importantly from the Near East to Europe, and from Indian and Chinese centres of cultivation to large regions of Asia.

Later, during the Little Ice Age, Europe, starving and suffering from over-population, spills out. Preceded by explorers that carried the banners of Christianity, but that were mostly driven by an insatiable quest for profit, from gold and precious stones to spices and tropical goods, but also, as ever, for food and space, Europeans kill or subdue the weaker indigenous populations discovered and scientifically described in 'Neo-Europe' – the Americas, Australia, New Zealand, and South Africa. Probably more than 50 million people altogether left Europe. If this was not globalization – the second wave of it – even if at the time it was called 'colonization', I do not know what globalization really means.

This was followed by the mixed blessing of the Industrial Revolution and the economic upheavals of global markets, carried by ships and railroads, and finally by aeroplanes in an ever-faster race for added values; going along with the expansion of the ideas of governance and social organization, which try to safeguard the underlying entangled web of economical and financial markets, and of always new ideas – innovation is the buzzword – driven by them together with the sciences, entangled as ever on a global ecosphere could have been by millions of natural species.

There can be no doubt: all this expanding, migrating and networking, this third tsunami-like wave of globalization, finding its congenial expression in the ever-growing fusion of nation-states, free-market zones, governments and economic trusts, would never have been possible, and neither would the spectacular population growth of the human species, now already close to seven billion, without the reliable knowledge provided by science and research. Research here means nothing more than 'science in progress,' a never-ending quest for new frontiers, for better, more reliable knowledge about the world in which we exist, and the never-ending efforts to solve the problems, mostly produced by the always limited scientific and practical knowledge of our predecessors, in order to mitigate the consequences of the incredible success, in the eyes of some even the unbearable success, of the human species – that thoughtful, if not so considerate, ape!

Without doubt there are consequences to these processes of globalization, driven by ever-increasing scientific knowledge and research by millions of busybodies – actually above all busy minds! – profound ones, unexpected ones, irrepressible and perpetual ones and mostly irreversible and even profligate ones. You may name these consequences 'challenges' all right, comprising both chances for progress (of which kind, however?) and risks endangering even this successful species and with it the biosphere of the whole globalized globe.

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Therefore, when addressing these challenges we have at the same time to ask how we can limit what no one can want – even if it may sometimes seem inevitable or as even further serving science and research.

What are these consequences, what are these challenges, the chances and the dangers of the final globalization of science and research? Because this much should be clear: the knowledge provided by science is here to remain as long as human beings are here, but its consequences may endure even if humans were no longer to be on this earth.

The first of these consequences is therefore that the globalization of science has consequences for all of mankind, as there is no way of stopping or ending scientific knowledge and future science-based technology. Maybe it is possible that one or other nation will try to stop them, by swearing to abstain from the spirit of science and by returning to the hardship and poverty of post ages, but this is only a local disturbance in a stream relentlessly pushing forward into the future. If it is the firmest conviction of true science that truth must always prevail, there can be no way around it in the long run, and those who by all means try to work against it at some given moment, do so at their own peril and detriment and will eventually fail. This does not mean that some methods of exploration, though possible in principle, such as forced experiments on humans, cannot and should not be forbidden and completely suppressed: I will come to that later. Of course, it is up to the democratic lawmaker and to the judges, from the lowest to the highest, to decide on what are admissible ways to gain knowledge and apply it. But the victory of scientific rational thinking – as opposed to magical or mythological practices to explain occurrences in the physical world – is inevitable and inescapable, even though not all humans may be willing or able to grasp this. Mythological knowledge has to be believed, scientific knowledge can be proven. More importantly, it can be empirically disproved. Mythological faith can only be renounced. Scientific statements and arguments can be refuted.

There is a corollary to the first consequence just mentioned. Science can and must be taught in every generation, patiently and sometimes even painstakingly, because all healthy human minds not indoctrinated against it can at least understand the gist of it, the basic points of its arguments. Those nations that at present make the most sincere efforts to provide the means for such teaching – China, India, Israel – will develop more successfully and solve their problems more efficiently than those that disdain scientific instruction and therefore neglect it. Listening carefully to the plans of some politicians for reforming the educational system with the object of making school easier and more amusing to the majority of pupils and students, I sometimes fear that my own country, Germany, may go down the latter road.

Learning by example and by practical experience is good. But it will never go very far without a tested and quantitative scientific theory behind it. As Immanuel

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Kant is said to have remarked: 'A reliable theory is the most practical thing in the world!' To approach the world casuistically and from one's own experience only is not a scientific way of understanding things more deeply. Unless our children are taught probability distributions and the properties of whole populations of phenomena, or the differences between correlation and causal relationship, or how models and predictions, quantitative and reliable as they may seem, crucially depend on the parameters and the numerical values given to them, they will not be able to approach this world rationally by experimentation and logical argument, and they will stay stuck forever in the preconceptions of their personal or communal (cultural) beliefs, instead of being able to transcend them and achieve true and reliable knowledge. Not only are the results of such scientific understanding of the world to be taught – after all they may be erroneous and soon superseded by more reliable facts and theories – but it is also the methods of scientific exploration and understanding, of testing and refuting hypotheses by incontrovertible evidence and logical argument, that have to be taught. Most important, science admits, or at least should always admit, when it does not have an answer. This is what makes science different from religion. Religion pretends to know all the answers; that after all is what it is for. Science should admit its doubts; when it does not have the answer to a question, that is what it should teach.

We call the application of such experimental and logical techniques 'research', and just as true scientific knowledge will never disappear, research will go on as long as there are inquisitive human minds confronted with problems to be solved. Not only is such continuation of research inevitable – we call it 'scientific progress', never to be confounded with moral progress; it is also necessary as long as problems arise in the world around us, and amongst us, even if more often than not it is we ourselves that are at the root of such problems, for instance by our productive and consumer habits. The major consequence of the sciences is therefore more science, the major challenges of and for science arise from research that aims to overcome the problems caused by science itself.

It is indeed a most consequential challenge of globalization for science and technology and for further research adding to knowledge, that their methods and results are available to every intelligent human being that cares to use them. That means also that they are available to every nation on earth, since, as again Immanuel Kant – and Descartes before him – remarked, intelligent judgement is a capacity most equitably distributed over all human beings. Nor should the process involved take much time – rather, dissemination should happen almost instantaneously, through the World Wide Web and the Internet. Patent laws, covering all kinds of technical inventions, put law and order into this use of science and research. They may curtail the free exploitation of inventions, by making applicants pay for their usage, but at the same time they make all these inventions open – patent – to everyone interested in them.

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There is no privileged or secret scientific knowledge, because in the long run everyone in this world can find it out. Whatever can be discovered by humans will be discovered, sooner or later, by oneself or by a competitor. It is true that only rich nations can afford satellites, multi-meter telescopes, or accelerators that measure kilometres around or along; but what is found out by them will be publicly available to everyone interested in almost no time, through cooperative sharing, espionage, or (free) internet. In other words: it will be globalized knowledge in a very short time indeed. The biggest challenge for every nation on earth is therefore that its own science and research will keep up with this steadily rising water-level of knowledge, because those who try to resist will soon learn the hard way that going under leaves terribly little time or space for breathing!

This in itself forms a major challenge for the human efforts to make life liveable in a sustainable biosphere, that is, it is a major challenge for those ethical rules and legal norms that try to put order into our lives and at the same time guarantee freedom. Here may even be the greatest challenge of and for globalized science and research: to find ways to mitigate unexpected and unwanted consequences, while deriving much-needed help and much wanted profit from innovative results.

The moral and legal sciences, in spite of having half a dozen Max-Planck Institutes devoted to them, are different from the natural sciences. It is not that they are less scholarly or learned; their logic and argumentation, as are those of Mathematics (which again is different from the natural sciences) are no less intricate and forceful than are those of any chemical or physics investigation. Indeed, they impress us, belonging to the most advanced products of human culture. In the final analysis, however, they remain man-made social institutions. Therefore, the arguments and norms invoked in ethics and by the legal profession can never be decided or refuted by referring to the state of affairs, the 'is', of natural reality. The world of reality in which the 'laws of nature' as discovered by humans are tested, proven or refuted may be mentally constructed, but cannot be changed *ad libitum* by us humans. To think otherwise is one of the gravest errors of extreme cultural relativism. The bedrock of our knowledge about the existing world is that it may be explored by the scientific mind, but not 'invented' by it, or made to conform to different cultural styles of thinking (or if this is so, this will soon be found out, precisely by the tools of science). Ethics and law are fundamentally derived from some 'oughts', which – though some may root them in heavenly wisdom, others in evolutionary selection – are valid only insofar as they are believed in and accepted by the majority of human people in a society, and this is most certainly the case with the written laws of constitutionally controlled legal systems. Maybe some of the rulings of lawmakers and judges may be derived from fundamental norms and values through the process of what my former colleague Bernd Rüthers used to call (and at times castigate as) 'the right of unlimited interpretation' ('das Recht zur unbegrenzten Auslegung'). In any

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case, as long as the majority of a human community, as legally organized in a nation state (or in a supranational legitimate institution) continues to put its trust in this legal system and is willing to follow its rulings, these are valid as 'the laws of the land', and thus it is with them that rests the ultimate power to decide disputed matters. In the end, things may even come down to a 3:2 ruling. Such a decision will still count, even though it may lead to academic disputes without end. Regardless of the fact that a lot of thought may go into making the law free from contradictions, then, the point is that this is not a scientific decision, as proven by logic or experiment.

What does all this have to do with the challenges of globalized science and research, you may ask? Quite a lot, because, as I explained before, science labours under the irrepressible urge to find out the truth about 'everything'. Science can never step back and find within itself the moral or legal limits under which it may function in order to remain bearable for the people that after all pay for it. In other words, science cannot determine what makes it into a servant of human life and not its master. Science is, as it were, by itself blind and dumb with regard to human needs and fears, as it pursues only the goal of reliable knowledge. It cannot produce moral rules or legal norms; it can only conform to them, sometimes only grudgingly so. In some cases it may even revolt against them.

The challenge globalized science poses, then, is how its inherent 'limitlessness' can be checked in practice by those institutions that have the competence and power to do so. It is nonsense if these institutions buttress their arguments with reference to god-given, or natural, or evolutionary norms which we should have to follow. To begin with, gods tend to speak quite differently to their different followers. Second, nature (or rather 'Nature' with a capital) has no specific interest in human affairs. The only way that ethics and the law can meet the challenges of existing science and on-going research is by finding out which moral and legal arguments convince the majority of people. If science and research in the future become ever more globalized, the greatest challenge for the moral and legal experts is to come up with such rules and norms as are acceptable to a worldwide majority of the world's population, irrespective of race, gender, nationality, religion, culture or profession. This may seem like a tall order for these experts, habitually divided amongst themselves, but it will at least provide them with a continuing legitimation for what should be their peace-saving, social-engineering work.

The development of the natural sciences may suffer or be fostered by these efforts here or there, but in the long run they will have to follow the rules set by sovereign humanity, comprising all continents, nations and cultures. No doubt there will be many setbacks on the way to a truly globalized and unified world. Some even venture that the earth may get rid of its inhabitants long before these find common, sustainable solutions to their ongoing competitions and quarrels. Perhaps. But if not, then it will be only through these normative disciplines that

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science and research can contribute to the well-being of humanity, and of a living biosphere. The normative disciplines should not ask for help from the natural sciences to meet this difficult challenge, as the latter have already enough on their plate with keeping their own house in good order. We should never forget that the survival of humankind will crucially depend on all of them doing their job properly and correctly: to do more research to solve our mental and material problems, always within the limits of norms guiding these efforts. Therefore, the normative professions are well advised to let the natural sciences and their research flourish well enough for the latter to worry about the norms limiting them – and not the other way around. The 'normative sciences' are there, as it were, in order to lead the 'natural sciences' from reliable knowledge, which only they can provide, to true wisdom, in order to make of them truly 'humane' sciences. In other words, the normative sciences have to lead the natural sciences 'beyond nature'. In the final analysis, both kinds of science are there not to serve 'natural laws' or 'legal paragraphs', but to serve sovereign mankind, which will forever depend on them both.

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