Editorial

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This issue is unusual, as it contains a collection of opinion papers, in which electrochemists contemplate the present state and future of their science. The development of scientific disciplines is, globally seen, an unorganised process. New scientific results, experimental and theoretical, may come from three sources: (i) the curiosity of scientists, (ii) the attempts of scientists to meet objective demands (e.g. from industry, medicine, defence), and (iii) accidental findings (also by laymen). With the establishment of scientific organisations (universities, academies) and scientific journals [1] in the seventeenth and eighteenth centuries, attempts started to direct and steer research activities, e.g., by issuing prize questions and advertising awards for solving scientific problems. Later, some scientists, like the mathematician David Hilbert, published lists of unsolved problems, as to direct the thinking of his fellow scientists to those problems which they have identified. In 1900, on the International Congress of Mathematicians in Paris, Hilbert phrased it as follows [2] “WHO of us would not be glad to lift the veil behind which the future lies hidden; to cast a glance at the next advances of our science and at the secrets of its development during future centuries? What particular goals will there be toward which the leading mathematical spirits of coming generations will strive? What new methods and new facts in the wide and rich field of mathematical thought will the new centuries disclose? History teaches the continuity of the development of science. We know that every age has its own problems, which the following age either solves or casts aside as profitless and replaces by new ones. If we would obtain an idea of the probable development of mathematical knowledge in the immediate future, we must let the unsettled questions pass before our minds and look over the problems which the

science of today sets and whose solution we expect from the future. To such a review of problems the present day, lying at the meeting of the centuries, seems to me well adapted. For the close of a great epoch not only invites us to look back into the past but also directs our thoughts to the unknown future.”

Referring to the great progress of science, in the time he could personally survey, George Sarton (Gent, Belgium, Aug. 31, 1884–Cambridge, USA, March 22, 1956) wrote [3]: “The immense success of science is due largely to the selection of problems, one at a time, the simplest and easiest first, and so on. Genius in science as well as in art is essentially the ability to select properly.” Indeed, it is the proper selection of the problems to work on, which decides about the future success and significance of research. This proper selection needs a profound knowledge of the present state of a science discipline and of its history; however, it also involves intuition, if you like, that divine spark, which we marvel at when learning about the great and sometimes also small discoveries. Without phantasy, scientists are lost. That phantasy can only grow on the basis of very wide knowledge, as it is often “nothing more” than transferring ideas from one place to another; the more distant these places are, the more we admire the involved phantasy.

At the end of twentieth century and beginning of twenty-first century, the above mentioned three sources of new knowledge are still operative, and they will be in future; however, the balance between them has tremendously shifted, and politics and global economy became major players. Whether that is for the benefit of science is not always clear to me. There are certainly many positive examples, but also—in my opinion—negative examples, e.g., when political decisions impede the research in nuclear power generation. Behind political decisions is not always objective scientific insight (if so, the better), but often the interest of companies or considerations how to please voters. Hence, the interference of politics in science is manifold and only occasionally positive. Political systems also decide about the social boundary conditions, which may stimulate or obstruct scientific or technological progress [4, 5].

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Now we have to ask the question, what is science for, what do we expect from science? There are only two answers to this question: *First*, we expect that science is for the benefit of people, which clearly includes all our surroundings, i.e. our animate and inanimate environment. *Second*, science is a cultural achievement, which provides people with the *intellectual pleasure* to understand nature. The beauty of theories and experiments is as much rewarding as the beauty of works of art. We should never forget this, lest we will become a completely benefit-oriented community of technique-oriented (pseudo)scientists. The question, whether (i) research directed on practical goals, or (ii) research that is completely driven by curiosity, provides more benefits, is still not clearly answered. I believe that it cannot be answered in this or that way, as we need both. We also need both, because nature has equipped people, scientists, with different skills and affinities, making some of them more successful in applied, others in fundamental research.

When we could look into the brains of contemporary scientists to understand why they are in research, we could probably identify the following, ethically fully acceptable motives: real curiosity, the wish to solve a current practical or theoretical problem, or the wish to establish a career in order to safeguard a decent living. There is no doubt that we would also find selfishness. There are also uninspired scientists, who by accident entered science. Let us now shine light on the question, how scientists define their research goals: Also here we see a great diversity: some define their goals by striving for a deeper understanding. Others, perhaps the majority, will look for advertised funds. Of course, the scientific goals are almost completely defined by group leaders, professors, etc. Only rarely a PhD student brings forward his own ideas (luckily, there are still such students). The hunt for funds has positive and negative sides. While the positive aspects, stimulation of new research, is clear, the drawbacks are also obvious: on a tour through a country which is a major player in the world, I noticed that in each university, the scientists worked toward the same goals, because they all participated in a centrally advertised scientific program. Asked, why they do not follow their own and individual goals, they told me that there are no possibilities to apply for funds outside the centrally announced ones. In most countries, the situation is less rigid, but I see also in the European Union, that the balance between individual applications and centrally directed applications, more and more shifts toward the latter. I believe that this is a clear indication that the responsible politicians do not understand properly how science develops. New ideas are born in the brains of individuals, and these individuals need proper outside conditions, i.e. first, they should be free of any serious worries for sustaining a decent life. Second, they should work in a creative environment providing intellectual exchange and excitement. Third, they should have excess to funds for realising their ideas. In short, I would say: choose the right

persons and give them the money they need, then the results will come. Here, the most serious problem is the choice of the right people! Using bibliometric measures is for sure the wrong way [6, 7].

This journal issue is an attempt to remember that science needs people who identify the innate questions of their discipline. Publication of these questions concerning electrochemistry will perhaps not significantly change the development of our discipline, but it may show the readers where we are and what directions are important and interesting to advance electrochemistry. All contributions will together widen our views. If the contributions in this issue will stimulate young and elder colleagues to think about what we need and what we may gain, then the aim of this publication is reached.

This collection of opinion letters is also meant to serve a higher purpose, i.e. the contemplation on the interrelation between *science*, *society*, and *humanities* (*human sciences*, in the German tradition, *Geisteswissenschaften* = sciences of mind, in opposition (better, in differentiation) to *Naturwissenschaften* = natural sciences). Not only in education, although especially there, but also in their research, scientists should widen their views by understanding the historic and philosophic backgrounds of the development of sciences and humanities, and equally strive for a profound knowledge of the major languages of science [8], as many ideas can only be fully understood when read in the original language. Here, I have to refer again to George Sarton, who has given us an excellent lecture on the interplay of human sciences and natural sciences, when he wrote [9]: “There is a technique, a “grammar” to every subject; there is a grammar of anatomy, a grammar of chemistry, and so on, and scientists who have remained on the technical stage cannot be humanists. On the other hand every subject and not only the philological ones has its higher level, which is properly the humanistic level. We know what we mean when we speak of English humanism, or classical humanism, or Sanskrit humanism, but there is also in the same spirit something which might be called medical humanism, chemical humanism, and so on.

A chemical humanist (for example) is a man who knows not only chemical facts and theories (and he could not know them too well); he also knows their genesis and evolution; he is familiar with the great men of all ages and countries to whom we owe the chemical discoveries, he has read or examined the famous books and memoirs wherein those discoveries were first explained; in short he knows not only the present of chemistry but its past - all the vicissitudes, the humanities, the glories of our chemical experience. I should add that the chemical humanist does not only know our chemical past; it would be more correct to say that he is familiar with the past of mankind with special reference to chemistry. He is able to integrate chemistry with the rest of our culture; to explain chemical history in terms of human history in general, and on the other hand to enrich our culture with the incorporation into it of our chemical wisdom.

Many grammarians and philologists, many historians even, do not deserve the fair name of “humanist” because they have never been able to lift themselves above the dead level of grammar. There is in the world today a superfluity of scientists and learned men – some of them very distinguished – who have become virtuosi in a certain field, but are nothing more. They may make occasionally important discoveries, but they are not humanists. I often feel that the mastery of a difficult technique is but too often a cloak for intellectual mediocrity in the same sense that dogmas and rites are often convenient substitutes for religion.

On the other hand, think of such men as the chemists MARCELIN BERTHELOT and WILHELM OSTWALD, as the biologist THOMAS HENRY HUXLEY, as the mathematician HENRI POINCARÉ – were these not full-fledged humanists and did many of the other humanists ever soar as high as they did? These men were not only technicians, pioneers, discoverers, they enriched not only our knowledge, but our wisdom as well, they lifted our minds and hearts up to a higher level, they enlarged our humanity. What does it matter after all whether the poet or the wise man found his inspiration in the eyes of a girl or in the stars of heaven, in the solution of physiological mysteries or in the transcendental subtleties of geometrical patterns and rhythms?

What does it matter whether noble ideas were expressed in Greek or in French, in Arabic or in Chinese? It is the ideas that matter above everything else – immortal ideas of justice, beauty and truth, – humanism, not grammar.

All the classifications by subjects or languages may be necessary for practical purposes but from a higher point of view they are singularly irrelevant. No division is more stupid than the vertical division between science on the left and the humanities on the right; it must be replaced by the horizontal one between grammar or technique below and humanism above.”

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