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SCIENTISTS AND ARTISTS: MOTIVATIONS, ASPIRATIONS, APPROACHES AND ACCOMPLISHMENTS*

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I. INTRODUCTION

Since modern science began in the 17th century and particularly since the arrival of 'Big Science' about 40 years ago, comparisons of science and art have received more and more attention. There is a broad spectrum of conflicting views on this subject. At one extreme is the contention that science and art are diametrically opposite, that they are separated by the gulfs between the objective and the subjective, the intellectual and the emotional, the materialistic and the idealistic. On the other hand, there are those who claim that the apparent differences between scientists and artists are simply due to the somewhat different directions in which their creativity happens to function. Readers will find discussions of these views by numerous authors in past issues of *Leonardo*.

My personal contributions to these views are those of a professional scientist with a major interest and amateur involvement in the arts. My purpose is not to present a synthesis of previous views but instead to account for *some* of the elements I have noted in the motivations, aspirations, methods and accomplishments of scientists and artists. I shall try to point to both similarities and differences in these elements on the basis of certain assumptions I have made, particularly as regards the arts. I hope that my analysis will contribute to better understanding and communication between scientists and artists.

With this aim in mind, I believe it is advisable to approach the analysis in terms of my interpretation of what artists and scientists think they are and do, rather than what some 'objective' study would conclude they are and do. Also, in order to pinpoint the various elements with greater clarity, I must make a simplification of a number of complex matters. In particular, situations with many shades of different possibilities will sometimes be replaced by the much cruder but simpler image of two opposing arguments.

II. MOTIVATIONS

There are several very important motivations that scientists and artists share. Perhaps the uppermost of these is the one that they share with those working in other fields, namely, creativity. Fortunately for mankind, a considerable number of individuals are born with an urge to make something of their talents and capabilities, to create something new.

It is common these days in America to belittle people with a strong creative urge by accusing them of being 'accomplishment oriented'. According to this view, a striving for the exercise of creativity is a neurotic trend due to a tendency for self-glorification and those who yield to this drive do so at the cost of their 'human' qualities. I very much disagree with this, since I believe that the basic assumption of the view is false, namely, I do not find that the fundamental motivation for accomplishment orientation is a selfish one. I believe that creativity is basically neither selfish nor altruistic but is rather an unpremeditated activity of most human beings that, incidentally, has been of immense benefit to humanity.

A second motivation shared by scientists and artists is somewhat related to the first one and is of an aesthetic nature. Beauty is enjoyed by many people, though the definition of what is beautiful might vary greatly from person to person. To a scientist, the laws of nature, that is, the regularities in the working of the universe, are extremely beautiful, just as artists find beauty in certain

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combinations of forms, colors, sounds and words. It is perhaps much less known to the layman that scientists often use criteria of beauty (for example, simplicity) in their formulation of scientific hypotheses. Thus not only do scientists get satisfaction out of the beauty of the regularities of nature but their feelings of beauty play a role in their practice of science.

A third common motivation is the desire to make a positive contribution to the welfare of humanity. The artistic heritage of different societies is being made known to those interested in any part of the world. In the sciences, results obtained have a universal character and international cooperation between scientists is broadly practiced. Thus both scientists and artists can feel that their creations become a part of an effort to enrich humanity.

This enrichment provided by the sciences consists of a compendium of knowledge that is at the base of the huge structure of technology. Technology has greatly transformed human life by reducing the time required to obtain food and shelter, so that people can devote themselves also to other, more interesting and, in some sense, 'higher' activities. Science and art are examples of such higher activities and through their broadening effect contribute to the mental and spiritual health of humanity. Thus scientists and I believe also artists contribute crucially to the well-being of the human race.

There are, on the other hand, some motivations of scientists and artists that differ. The paradox between the finiteness of human life and a craving for immortality troubles many people. There are channels through which this craving can be partly realized, for example, by having children. Scientists and artists also gain a sense of immortality through their achievements but in two importantly different ways.

The first of these differences has to do with the respective structures of science and art. Science on the whole is a tightly knit structure, in which almost every contribution of an individual scientist becomes a building block in the overall edifice that we call scientific knowledge. Thus a scientist, even of modest ability can generally take comfort in the fact that his accomplishments have in fact contributed to this edifice and therefore have earned him immortality in this sense.

In contrast, art is not generally considered to be a single process of development with an arrow pointing unambiguously toward progress. Art is, instead, taken to be more like a large variety of different approaches to obtaining a solution of the same fundamental problems and the criteria of right or wrong, so well established within the framework of scientific methods, do not exist, although there are aestheticians who believe that they will be found also for art. Thus, accomplishments of artists tend to be remembered for what they are and not for what they lead to or contribute to and fame, and hence 'immortality', is determined by the tastes and conventions in a culture at a given period of time rather than by a 'superhuman' set of laws of nature that rule science.

As a consequence, it seems to me that a mediocre artist has much less of a justification for considering his work in terms of immortality than a mediocre scientist has. Such an artist will feel much more 'alone' that the mediocre scientist, for the latter knows he is a positively contributing member of a scientific community that is spread out not only over the whole world but also over centuries of time. It may be, however, that actors and performing musicians also look upon themselves as part of an ageless team that maintains the heritage of bringing great examples of the performing arts previously created to succeeding generations.

The second of the differences between the motivations of scientists and artists, on the other hand, favors artists. It has to do with the sense of uniqueness of individual contributions. Exactly because of the closely knit scientific community and the 'objective' subject matter of science, it is difficult for a scientist to believe that his contribution is really a unique one. If he had never lived, it is very plausible to assume that somebody else would have made the same contribution to scientific knowledge, perhaps a few years later. This belief is greatly buttressed by the constantly growing number of cases of simultaneous scientific discoveries. Especially recently, with the exponential rise in the size of the worldwide scientific community, a large number of scientific discoveries has been made independently, practically at the same time, by several scientists or groups of scientists. Discoveries seem to be reaped by one or another worker in the scientific community only when they are ripe. Thus though immortality is gained, it is, in some sense, not a personal one but one of the scientific community as a whole.

In sharp contrast, the few known examples of kinds or of styles or art that were developed at about the same time in widely separated cultures lead artists to believe that if they had not lived the art work they made would never be made. This belief is strengthened by the fact that a vast number of variations of the subject of a work can be executed within a specific basic style, depending on the personal characteristics and life experience of an individual artist and that these individual variations are taken to be the essence of art, whereas the analogous differences in styles and forms of scientific papers announcing new discoveries are immaterial to science.

The sciences are oriented toward the objective

exploration of the worlds of nature and of man, whereas artists express their subjective reactions to aspects of these worlds, which vary from individual to individual. Thus, to summarize the status with respect to immortality, scientists can feel that they have a piece of it, however small it may be, but this piece is really community property, while artists can be much less sure of the immortal character of what they have to offer but they can feel more easily that their work is their own in a personal sense.

To conclude this discussion of motivations, I want to mention one more aspect in which scientists and artists are different. Both groups engage in their activities in order to communicate, to express themselves. But the nature of what they communicate is quite different. As I said above, artists make works with subjective and highly personal overtones, which they wish to share with others. In contrast, a scientist discovers something that exists in nature, though before unknown to human beings. What is communicated, therefore, is of a different character. In science one can share in the recognition of the beauty and importance of something eternal in nature, something much larger than oneself, and the tacit faith is that it will appear the same to everyone. The artist, on the other hand, has to face the much more difficult task of communicating something very personal, something that might not really 'exist' in an 'objective' sense, even though his personal creation might be inspired by something 'objective' and universal. Thus the success of communication by an artist depends not only on the intrinsic communicability of his message but also on his mode or code of expression being understood.

III. ASPIRATIONS

Scientists and artists share the aspiration to find or do something new for mankind. Creative artists are not satisfied with simply copying old masterworks and scientists in repeating analyses of problems already solved. The specific ways of bringing this about points, however, to some differences between them. The work of both involves problem solving. For an artist the problem may be how to depict a subject on a piece of canvas or how to carry out a musical conception with the sounds of musical instruments. For a scientist the problem may be how to measure and explain the average temperature of the Pacific Ocean at a depth of 3000 feet or to develop the theory of the nuclear process of supernova stars.

The big difference I claim is that the problems in science change constantly whereas in art they remain basically the same. Another way to say this is to assert that problems in science are solved and then the solutions are used in the applied sciences, while problems in the arts are virtually perpetually the same and what one witnesses is a myriad of approaches to obtaining solutions of them.

I do not mean to imply that science is 'successful' and that art is 'impotent'. The difference arises rather from my assumed difference in the basic nature of the problems. I assume that problems in art are formulated in such a way that they are *intended* eternally to be without final solution and the whole point of art is to explore more and more 'solutions' of them, many of which are on an equal footing as far as 'goodness' or 'completeness' is concerned. In science, on the contrary, problems are *assumed* to have only one most concise answer and once that answer is obtained, one can go on to another problem. It is exactly this characteristic of problems of nature that gives science its progressive character of hierarchical cumulation, which I discussed earlier.

This assumed difference in aspirations places something of a burden on an artist, partly because for him the novelty is only in the approach and not in the problem and partly because it is difficult to decide whether his approach represents a 'good' solution of a problem that has been posed as eternal. And yet, here also we encounter an element of individuality that favors an artist. It is possible for him to formulate highly individualistic solutions whereas a scientist is 'only' after *the* solution, the 'cold', 'impersonal' and universally valid solution that pre existed him and that (for all we know) is already known to a much more advanced civilization on some distant planet.

IV. APPROACHES

Popular ideas of the so-called scientific methods notwithstanding, scientists and artists very closely share the element of intuition. Of course, intuition can only function when the brain has stored in it some information relevant to the problem being considered. That art is intuitive rather than deductive has been generally accepted and in fact, artists who try to do something by 'logic', for example by using a computer, are often frowned upon by those bound by artistic traditions. On the other hand, a widespread view about scientists is that they 'deduce' laws from experiments, simply by cranking a superhuman machine called 'The Scientific Method'.

The truth is quite different, however. Much has been written about the crucial importance of the intuitive element in scientific discoveries and about the little understood nature of scientific creativity. Scientists know that their best scientific ideas arise in quite 'mysterious' ways, not unlike melodies are born in the head of a composer or verses in the

mind of a poet. We do not know whether creativity requires, for example, conscious experience to be submerged temporarily in the subconscious before a synthesis leading to a solution can emerge at an unexpected time. Some scientists believe that this may be a principal mode of creativity. Training in the gathering of information and in the use of scientific methods, in this light, is not different from training in any complex field of human activity.

Assuming that the creative process is common to scientists and artists, I shall turn to some of the differences in approach that I have noticed. A very striking difference arises from the different ways art and science have been pursued. As I already mentioned in a different context, science has a highly collective aspect. Scientists use and acknowledge the use of each other's results. It is difficult to imagine a scientist working in isolation on an island, even if he had the necessary equipment. This is one of the reasons why modern science did not come into being until only a few hundred years ago. Flourishing science needs a scientific community provided with good channels of communication, even though scientists are highly individualistic and most scientists do not work on teams to solve problems.

In contrast, traditionally artists have imagined themselves to be truly individualistic. It is of course not true that one artist has no influence on another. But many artists choose to work in isolation and a worldwide network of frequently communicating artists has not developed, although new technology now appears to be forcing the establishment of such a network. Thus the sociology of the community of scientists and that of the artists has been a very different one during the past three centuries, with far-reaching political, economic and psychological consequences for them.

Another basic difference that may exist between science and art is the large discrepancy between the creative ages of the practitioners. In the sciences, it is well known that the most creative contributions are made very early in life, in the 20's or early 30's. In contrast, most artists have been assumed to continue to grow in stature and maturity and correspondingly in the weight and importance of their creations, well into old age.

This difference might be explained in the following way. In the sciences, experience does not rank as high in the qualifications of a successful researcher as it does in the background of a productive artist. Somehow more of scientific creativity stems from innate talent, ability and imagination. Incidentally, I believe the importance of experience over 'logic' also plays an important role in the social sciences, where problems are primarily approached from an empirical point of view because of their great complexity and number of variables. It is this difference that often compels natural scientists to feel qualified to attack social problems with exaggerated expectations and distorted illusions about their preparedness. Interestingly enough, natural scientists are much less likely to commit the same mistake with respect to the arts. In other words, a scientist might very well claim to have easy 'solutions' to social problems but he is much less likely to make claims as to the excellence of his artistic contributions, even though many scientists take an amateur interest in some form of art.

Another interesting difference in approach stems from the fundamentally different nature of the problems that I already discussed. I mentioned that scientists attack a given problem, solve it and then go on to the next one. Thus one of the virtues in natural science is the ability to isolate a problem, that is, the ability to simplify the real world of complex interactions and replace it, for the purposes of experiment or of a theoretical model, by a much smaller world containing only one single phenomenon.

In art, I believe the virtue goes often in the opposite direction. Insight in art (as in many of the social sciences) comes often through the realization of the complexity of the problems and works of art become often more relevant in terms of personal identification if they pertain to a large segment of life. To be sure, the techniques used in the creation of the works of art might often be dominated by one or several 'tricks'. But the essence of Rembrandt for me is not his 'trick' of chiaroscuro but rather his insight into human beings and his ability to communicate that insight to me on a few square feet of canvas.

This difference is connected with what appears to me to be another profound disparity between science and art. In the former, to a large extent scientists define the problems they are to study. Scientific experiments are arranged to pertain to a particular problem selected by the researcher and this gives him a certain feeling of control over his activities. In contrast, art seems to me to be to a much larger extent a passive human reaction (even if a very personal one) to the external world. This leads to the paradox that science, which essentially deals with 'objective' reality, involves a series of actions to a large extent subjectively controlled by scientists, while the arts, which are fundamentally much more subjective, nevertheless appear much more constrained by 'objective' human reality.

V. ACCOMPLISHMENTS

Throughout the ages both science and art have been successful activities in their own ways. But all is not well. Both science and art can be used also for evil practical purposes, that is, to achieve certain specific goals that are contrary to the

welfare of humanity. Thus both scientists and artists have run into questions of their social responsibility. Though much stronger in the sciences because of the more conspicuous practical byproducts, the basic questions in both cases are identical. They pertain to age-old problems humanity has struggled with, for example, the individual vs. society, the absolute or relative criteria for good or bad and the inseparability of the good and bad effects of human creations. It is evident, therefore, that scientists and artists have much common material for an intense dialogue between them when they ponder over these complicated issues.

Finally, let me mention another difference between science and art, somewhat related to their respective accomplishments. This pertains to their respective accessibility by the public as a whole.

On the face of it, art seems to be in a much more favorable position. Art is assumed to be much more easily understood than science. It is much easier to attain amateur level in the traditional arts than in the sciences, where knowledge is much more structured and formal technical expertise has been much more crucial. Thus science, on the whole, remains a closed activity of its high priests, while art has spilled out more widely and covered, even though thinly, a quite large fraction of the human race. Though this difference will probably remain with us to some extent, it is not unlikely that as science becomes older it will also gain greater affinity with an increasingly large segment of the population, which in turn will have increasingly greater leisure time to devote to such non-utilitarian matters.

In fact, the methods of science already have had some influence on populations as a whole. They suggest that by systematic methods it is possible to solve complex problems and through the knowledge acquired in this process man can change the 'natural' course of events in a desirable way. In this sense science has a certain 'rational' influence on people. Art also can influence many people but through 'emotional' means.

When talking about accomplishments, it is also intriguing to speculate about the indispensibilities of science and art, respectively. Looking back in history one would think that art is more permanent, because it has existed in all previous civilizations in one form or another, while science in any substantial form is very new and primarily limited to industrialized countries. On the other hand, when viewing the contemporary scene, one has the immediate reaction that since science is practically 'useful', it is indispensible, while art may slowly disappear since it seems to have become only a frosting on the cake of life. I believe, however, that art will continue to provide one of those 'higher' activities that contribute to the mental and spiritual health of people who will be freed more and more from devoting time to obtaining the minimum necessities of life.