WELTANSCHAUUNG, SCIENCE, TECHNOLOGY, AND ART

by

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At the date of publication of the present collection, the editorial staff of the REVUE MUSICALE had not yet received from Mr. Carl Lesche the written text of his presentation at the Stockholm Meeting. It was therefore decided — with the permission of Mr. Lesche himself, UNESCO and the Fylkingen Association in Stockholm — to publish a text written by Mr. Lesche and already published in No. 1, *Volume* 1 *of the FYLKINGEN INTERNATIONAL BULLETIN (Winter* 1967).
This text closely resembles the actual paper delivered by Mr. Lesche at the Stockholm Meeting.

The purpose of this is to introduce two frames of reference that could be considered when discussing the relationships between Weltanschauung, science, technology, and art. The first frame of reference is concerned with the justification of technological prescriptions, the other frame takes up the question of certain relations between the four areas mentioned with special attention paid to the justification of technological prescriptions.

What follows will take the form of a philosophical analysis; specialized knowledge within these different fields will not be presented. After the introduction of the frames of reference, a pair of applications follow.

The justification of technological prescriptions

By analysing certain aspects of technological texts or discourses, we shall demonstrate a general pattern for the justification of technological prescrip-

tions. Technological prescriptions are those prescriptions or rules that tell us how to attain given ends proceeding from specified initial conditions and using specified means. We naturally find such technological prescriptions in textbooks on technology (technology in the engineering sense), but similar prescriptions appear also in discourses on the techniques of different forms of art. If we examine publications on the theory of music we find that they have a very mixed content. The « theory » of music is not built up in the same way as a theory in physics, for example, Newton's theory of gravitation. The predominant function of discourses on the theory of music is to give technological prescriptions for composition, i.e., they are doctrines of composition. Of course, a doctrine on composition is not written as a collection of prescriptions or rules in the imperative or « ought »-form, but as rules given in the indicative. However, there are pedagogical expositions where the rules are in the imperative.

We are not going to analyse any concrete technical or artistic prescription but study a completely fictitious case. This is done to set up a general pattern of justification. It is also advantageous to analyse a « neutral » case, in order to avoid possible disagreements as concerns prescriptions, means, aims, adequacy of scientific descriptions, acceptableness of value judgements, etc. The pattern for justification one develops when making this analysis is useful generally in technical matters : be it boat or bridge building or in electrotechnology or medical treatment or in the technology of different art forms.

Suppose then that we examine two technological handbooks : one for vegetable-growing, the other for flower-growing (Fig. 1). In the vegetable book we find the sentence « Plant A is to be watered in the mornings », and in the flower book the sentence « Plant A is to be watered in the evenings ». What do these two sentences mean in the given discourses ?

In technological discourses these two sentences are not meant to be descriptions of reality, but as prescriptions. Their function as prescriptions would be more clearly seen if they were to be transformed to imperatives : « Water plant A in the mornings ! » and « Water plant A in the evenings ! »

We can now ask ourselves why we should follow one or the other of these rules, or any of them. The technological prescriptions therefore demand justification.

First of all it may be said that as technological prescriptions these reconstructions are incomplete. They must be completed by adding the reason for or purpose of watering. Somewhere in the two handbooks explicit information concerning these purposes may perhaps be found or these purposes made apparent by examining the context of the discourse, or could be found in other botanical texts. Suppose we succeeded in completing the rules in the following way : « Water flower A in the mornings in order to get plants with small flowers ! » and « Water plant A in the evenings in order to get plants with big flowers ! ».

The rules have though, not yet been fully reconstructed. We ought to indicate the population to which the rules apply, as well as the group that demands the realization of the rules. We shall, however, not concern ourselves with this aspect in this case.

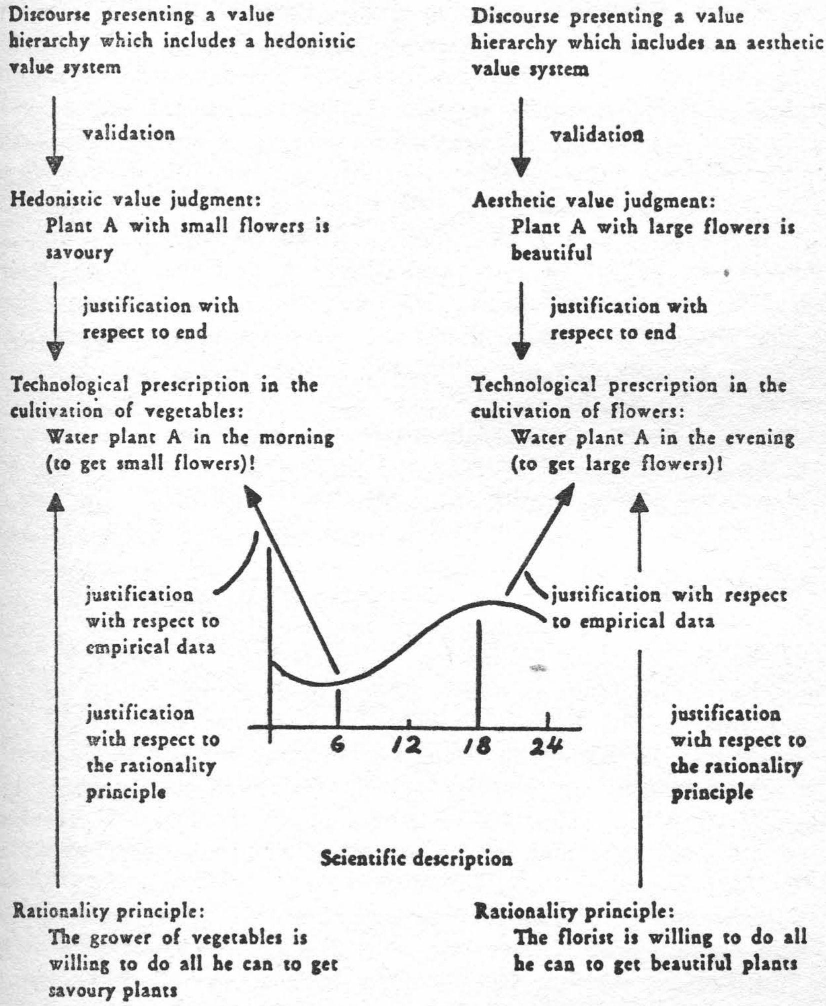

Fig. 1

The justification of the technological prescription must be made by taking several different aspects into consideration.

(1) Consider scientific descriptions : We may find, in our handbooks or in some botanical treatise, descriptions of flower size as a function of the time of watering, perhaps in the form of a diagram. This diagram may show that by watering the A plants in the morning you actually get the smallest flowers, and by watering them in the evening you get the largest flowers. You achieve the

goal or purpose therefore, if you follow the prescriptions; conversely, you follow the prescriptions, if you want to achieve the given goals. If, on the contrary, the description had been such, that by watering in the mornings you get the largest flowers, and by watering in the evenings you get the smallest flowers, then the scientific description would not have justified the technological prescriptions, and one would not be obligated to follow them. We notice that the same scientific descriptive discourse can justify different technological prescriptions which pertain to different desired ends.

(2) No prescription can follow directly from a scientific description. In addition we require a value-judgement of the goals or desired ends. Consider, then, value-judgements of the ends : Suppose that there are passages in our fictitious handbooks that treat of values, in which passages plants A with the small flowers are judged as tasty and plants A with the large flowers as beautiful. (The idea is that plants with small flowers have large, tasty roots or something similar.) It may be that these value-judgements do not occur in the handbooks, because they are considered so evidently a part of our system of values or norms. If the flower-grower shares the value-judgement of the desired end, and if the scientific description is adequate, then he has cause to follow the prescription. If instead he judged the ends in such a way that he considered the plants A with large flowers as ugly, then the rule about watering in the evenings is not justified, and he need not follow the prescription.

(3) Justification of a technological prescription is, on the other hand, not yet completely concluded. Consider also the so-called rationality principle : « The vegetable-grower is willing to do everything in order to get tasty plants » while « The flower-grower is willing to do everything in order to get beautiful plants ». The line of thought is, of course, that if the scientific description is adequate and the flower-grower shares the value-judgement of the end, and accepts the rationality principle as well, the prescription then becomes a binding imperative for him : he ought to follow it. It would be considered an « oddity » that, under the given circumstances, he should not follow the prescription.

Justification of a technological prescription can be complicated by the difficulty in finding propositions that would be both necessary and sufficient for the justification, without having them lead to prescriptions that would conflict with each other.

To illustrate this, we shall extend the fictitious case. Suppose we apply the following description : « If plant A is watered in the evenings, while it is growing in a flowerpot, then the roots will rot and the flower die. » This description would not justify the earlier prescriptions, but would perhaps give rise to a new prescription, viz. « Do not water plant A in the evenings ! » The situation is then that two descriptions, that do not contradict each other, lead to a justification of two conflicting technological prescriptions. Justification in this case could be outlined as follows :

Scientific descriptive discourse on the watering of plant A in general.
Scientific descriptive discourse on the watering of plant A in a flowerpot.
Aesthetic value-judgement about plant A.
« Vital » (biological or health-giving) value-judgement about plant A.
Rationality principle 1 :
The gardener is willing to do everything in order to get beautiful flowers.
Rationality principle 2 :
The gardener is willing to do everything to prevent the plant from dying.
If plant A is in a flowerpot do not water in the evenings !

The values in this case form a so-called hierarchy of values with respect to their dominance in the justification scheme :

Vital values,
Aesthetic values.

In this way a hierarchy of values can arise when different value-judgements conflict with each other. One may have to take into consideration different sorts of values : knowledge values, vital values, hedonistic, aesthetic, ethical, religious values, values of justice, legal values, social, economical values and so on. For different persons and different circumstances different personal hierarchies of values apply. For different persons in the same situation the hierarchy of values can differ both as regards elements and the arrangement of these elements. The hierarchy of values for one and the same person changes with time and circumstance.

This is the general scheme for the justification of technological prescriptions. This scheme can be used for different sorts of technological prescriptions, even for those from the fields of different art forms.

From the theory of composition in music the following situations may arise. There are technical prescriptions about how certain given goals are reached proceeding from certain initial conditions. At this point, however, several problems spring up. For example, what are the goals considered to be, that is to say to what do the prescriptions apply ? In the conventional theory of composition (viz. the theory of harmony), the goals seem to be notes, groups of musical signs on a staff. The idea is that if these notes are played, then certain physical conditions of vibration arise in the concert hall, and these in turn give rise to certain psychical phenomena experienced by the audience. The initial conditions can in the same way run parallel to these three different stages. If the goal is to create physical conditions of vibration, then the prescriptions are principally justified by applying scientific descriptions from the field of physical acoustics. If the goal is to call forth psychical phenomena, then we need, in addition, psychological descriptions of tones and music. The interesting thing is to observe how the justification, in different times and under the influence of various musical tendencies, is dominated either by metaphysical philosophy, physical or psychological descriptions.

Finally one more remark regarding justification of technological prescriptions. We have shown above how an isolated technological prescription is justified. Often, however, the goal is a complicated process in time (a longer piece of music for example), and then the question of a system of prescriptions has to be investigated. Justification of prescriptions for different parts, for combinations of parts and finally for the whole may be demanded.

Connections between Weltanschauung, science, technology, and art

The following figure (Figure 2) symbolizes areas for world view, science, technology, and art, as well as their different subdivisions. In the course of this discussion these areas will be characterized and certain relations between them suggested, with the purpose of showing how intimately integrated they are with each other.

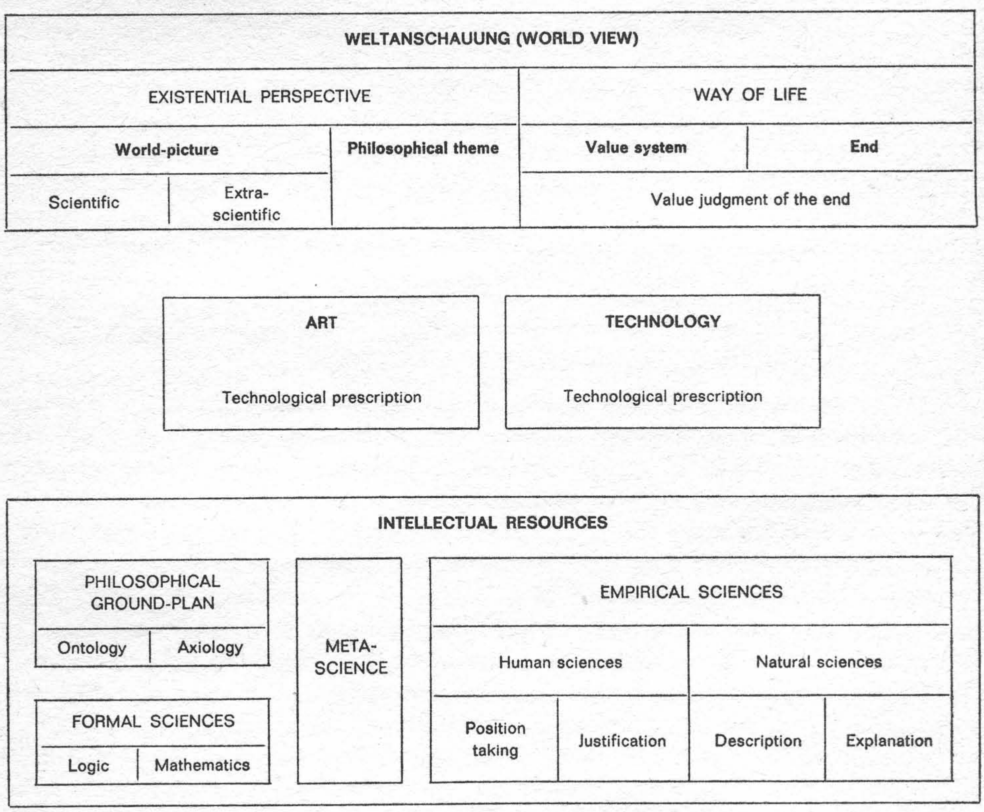

Fig. 2

The Weltanschauung is a personal, total insight of the world. This Weltanschauung consists of two parts, a theoretical part, which we shall call

existential perspective, and a practical part, the way of life. The existential perspective can be further divided into a world-picture and philosophical themes. The world-picture is a comprehensive way of looking at things, which consists of very general hypotheses about the world and our existence. There are scientific world-pictures and extra-scientific world-pictures. A scientific world-picture is based on the sum of scientific knowledge at a given time. Hypotheses about world-pictures are meant to be cognitive, but they do not comply with those criteria of adequacy that we are in the habit of imposing on scientific sentences. Among these hypotheses are some that science can not or has not yet been able to test to provide an answer for.

Philosophical themes are for contemplation ; sometimes, perhaps, they can not even be put into linguistic form. For instance : life and death, the freedom of the will, determinism and indeterminism, numbers. These themes give rise to specific philosophical and scientific problems, which are later treated in philosophy and the sciences.

The way of life, the practical philosophical side, consists of general maxims that answer the questions « How am I to live ? » We refer to these maxims ultimately when we want to justify the system of values. The system of values and the ends are included under the way of life. The rationality principles we named earlier are also included hereunder. Further there are value-judgements of the ends. These value-judgements can be justified by using the system of values.

The intellectual resources consist of the accepted knowledge and instruments at any given time. Most of the headings in these figures are clear and need not be commented upon. We can add philosophical anthropology under the heading philosophical ground-plan. Under the heading empirical sciences we can name alongside (natural) sciences, the human sciences.

Art and technology have been placed between Weltanschauung and intellectual resources. The technological prescriptions could well have been counted among the intellectual resources, but for the sake of clarity we have placed them in the figure under the headings art and technology.

We shall now look at certain relations between these areas. Actually we ought to differentiate very carefully between relations that exist between different phenomena and relations that exist between discourses on these phenomena. The historical interdependence of science and technology is, we notice, an entirely different relation from the one which relates the justification of technological prescriptive discourses to scientific discourses. As far as this is concerned, however, we shall be rather less precise about the relations and interconnections between the different areas in the figure.

Let us take the scientific world-picture as a point of departure. It directs scientific activity, especially the construction of theories in the sciences. On the other hand the scientific world-picture is also based on the empirical sciences, from which it is extrapolated or divined. The world picture is also reciprocally

related to the philosophical ground-plan, in particular to ontology. The world-picture is, further, reciprocally related to the way of life, both to the value systems and the ends. To the way of life one ought to admit even the ideal of science and the ideal of knowledge. These govern the empirical sciences. Two different ideals of science and knowledge underlie the sciences and the humanities.

The way of life gives rise to values and ends that one tries to attain by calling upon technology for help. Before the scientific revolution in the seventeenth century and the technical-industrial revolution in the eighteenth century, technology was also justified by magical, extra-scientific hypotheses on world-pictures. Art and technology were linked together ; they shared the same ends. Later the ideal of technology came to imply that prescriptions ought to be justified by scientific descriptions. Technology poses in its turn problems for science to solve. By using scientific theories the descriptions are explained and new descriptions, that can be used for the purpose of justification, are derived. Technology has developed at such a rate, that in certain areas the justifying science is lagging. Such is the case in medical technology, where the beneficient powers of several new methods and drugs have not as yet been explained nor justified. The tremendous progress made in technology has in turn influenced man's whole way of living and given rise to opposing value-judgements, both pessimistic and optimistic, on this very technology.

As far as the justification of technological prescriptions is concerned, the treatment for art and technology is identical. I am going to restrict this justification discussion to music. Attempts have been made, since the time of the ancient Greeks, to justify the rules governing the theory of musical composition by using scientific descriptions ; but these descriptions are inadequate as far as present scientific knowledge is concerned. Principally, however, the justification was supplied by extra-scientific world-picture hypotheses and the way of life. But since the scientific revolution in the seventeenth century, we have demanded that justification be supplied by descriptions from the empirical sciences. For art, however, even the humanities bear weight.

As we have indicated, there exist feed-back relations between practically all of the areas in Figure 2. The relationship between art and technology is not only that technology functions as an aid to art, but also that both of them share a common background with science in a given world view.

Some illustrations

Two conceptual frames of reference have been presented. It would therefore be appropriate to fill these frames and show how specific and concrete examples of different world views and intellectual resources, etc., would occupy these abstract structures. In this way we would be able to follow the historical development of art parallel to the evolution of world views and

scientific development. We shall draw a rough and short outline of only two relationships : the first between music and science, and the second between architecture and technology.

Music and science

In order to understand the intimate integration of music, world view, and science, we must go back to ancient times. Music has enjoyed a quite unique relationship with science. The Pythagorean world-picture was a representation of a cosmic system, where a correspondence existed between the microcosmos and the macrocosmos. Doctrines about the harmony of the spheres, the ethos theory and numerology were established. The harmony of numbers concerned cosmology as well as music. The Pythagoreans considered music to have a cathartic, a cleansing, effect. The ethical function of music became even more important to Plato. Aristotle developed a transition to the aesthetic function of music, even though the ethical function predominated.

Pythagoras is said to have experimented with vibrating strings and established the relationships between the length of the vibrating string and the consonances produced. In accordance with the numerical symbolism of the world-picture, the only consonances accepted were those intervals that could be expressed by the numbers 1, 2 and 3 (4 also, which is equal to 2 times 2). Among the acceptable consonances were : the octave (2 : 1), the fifth (3 : 2), and the fourth (4 : 3). Pythagoras constructed his tonal system proceeding from juxtaposed fifths, which also determined the so-called Pythagorean temperament. In the Middle Ages the Pythagorean theory of music was further developed by Boëthius. His work laid the foundation for almost the whole of the theory of music in the Middle Ages.

In Classical Antiquity Aristoxenos started from another point of departure. He did not try to adapt the musical phenomena to a rational system, but proposed that the musical ear be the primary criterion. He abandoned the tuning by fifths and recommended an empirical tuning which approximates the equal temperament developed later. When music was to be justified, consideration was therefore taken of psychological descriptions. In Aristoxenos' system of values the aesthetical function of music was emphasized along with the ethical function ; though the latter was, however, considered the most important.

During the Middle Ages, up until the sixteenth century, music was a part of the quadrivium, along with arithmetic, geometry, and astronomy. The term music then actually meant theoretical music. Practical music, that is to say composition and apprenticeship, was considered as separate from theoretical music up until the end of the Middle Ages. The musicians developed their own technological prescriptions without establishing a connection with theoretical music. Inspired by the humanist conception of the unity of music

under the Greeks, an effort was made during the Renaissance to unite these two branches of music.

In medieval polyphony even consonances, not based on the intervals created by applying the mystical holy numbers of Pythagoras, were used. This is why the theorists endeavoured during the sixteenth and seventeenth centuries to justify the major and minor thirds, as well as the major and minor sixths.

The founder of the theory of harmony, Gioseffo Zarlino, abandoned the Pythagorean world-picture and embraced a neopythagorean, neoplatonic philosophy. He introduced a new numerology and expanded the area of consonances to include combinations which consisted of the first six numbers; these he called « senario ». By introducing senario Zarlino added to the consonances : the major third (5 : 4), the minor third (6 : 5), and the major sixth (5 : 3). The minor sixth (8 : 5) is not included in senario, but Zarlino incorporated this interval into his consonance system. Besides consonances there are the dissonances. Some of the latter could be used in a limited way in order to emphasize the effect of the consonances. Zarlino considered that the intervals he adopted were « natural », and that other intervals were « unnatural ».

Up until this time the Pythagorean temperament and the so-called Didymic temperament were used. They were originally meant for purely melodic music. If these temperaments are used in polyphonic music many difficulties arise, because the corresponding scales have whole intervals of different lengths and half intervals of different lengths. In addition certain harsh consonances can be heard. In the earliest times the instrument makers and tuners used to compensate for these deficiencies by tuning or tempering the consonances by ear. When the theoretical and practical sides of music were united during the Renaissance, it became necessary to solve this problem. At the end of the sixteenth century the positions taken by the neoplatonists (Zarlino) and the empiricists (Benedetti, Vincenzo Galilei) differed greatly. Zarlino's senario only allowed one tuning and this acceptable tuning was the Didymic temperament. He admitted, however, that it was necessary to temper keyboard instruments, but the voice and instruments without fixed tuning do not need to be tempered.

Zarlino dissolved the earlier connection between theology and music, and strengthened the position of music as an aesthetic art. Tones, intervals, and keys cause certain emotional effects, of which joy and sorrow were thought to be the most important.

In 1558 Zarlino published his « Le istitutioni harmoniche ». In it he developed the prescriptions for composition justified by his premises. In this publication he summarized the use of polyphony among his contemporaries and immediate precursors. His rules impeded experimentation on the forbidden intervals. During the following hundred years Zarlino's doctrine was buried by new scientific discoveries.

One of the first who attacked Zarlino's views was the mathematician and physicist Giovanni Battista Benedetti. He showed that Zarlino was mistaken, partly by experimental and partly by speculative means ; numerology proved inadequate. The distinction between consonance and dissonance is only relative. Benedetti showed also that the pure intervals could not be retained, and therefore suggested that equal whole and equal half steps be used, that is equal temperament.

One of Zarlino's most important critics was the musician Vincenzo Galilei, Galileo Galilei's father. He attacked Zarlino's world-picture, according to which certain intervals were to be « natural », because they exhibited simple numerical relationship and others were to be « unnatural ». Galilei held that the intervals outside of senario were just as natural as those within senario. Galilei emphazised the subjective side ; he considered the musical ear the most important criterion, and rejected intellectualizing. He embraced the then prevalent philosophical dichotomy into primary and secondary qualities.

Vincenzo Galilei rejected the numerological basis for the classification of consonances and dissonances and instead worked out a new order of precedence based on artistic experience and use, that is, he sought a psychological justification. According to the Pythagorean numerical symbolism, the « harmonic numbers », 4, 6, 8, 9, 12, 16, had been constructed, and it was assumed that these numbers produced the same intervals, whether they were measured lengths of strings or pipes, string tensions, hammer weights or bell and glass volumes. Galilei showed experimentally that these numbers are only valid for the relationship between the lengths of strings and pipes, if other factors, such as the thickness and tension of the string, are held constant. He showed further that consonances could be produced by intervals with numerical relationships not included among these harmonic numbers or senario, and even by using irrational numbers.

Galilei demonstrated that the Didymic temperament was inadequate : he considered Aristoxenos' temperament the most suitable. It is impossible to prove the superiority of one or other tuning system on mathematical grounds, but instead, Galilei held that the ear works subjectively and does not permit of quantitative measurement.

The physicist Galileo Galilei repeated his father's arguments against the numerical relations. But he stated, besides, that he had discovered the real basis for, or cause of, the constant numerical proportions for the tones that constitute consonances and all other intervals. These relationships are numerical proportions between the frequencies of the vibrating bodies. Thereby the Pythagorean ideas were reinstated, and a new phase of numerology began ; it still applies today.

Before the scientific revolution of the beginning of the seventeenth century, music had not yet been separated from science. The development of science influenced most, therefore, those areas of music which came nearest

the sciences in which the greatest progress had been made : that is, in astronomy and dynamics. In astronomy doubt was beginning to be raised about the concept of cosmic harmony. In dynamics the investigation of vibrations and acoustical phenomena upset earlier conceptions about numerical symbolism. Music, however, lagged behind ; so that discoveries in physics that could have justified the theory of musical composition were first applied a hundred years later.

When seventeenth century rationalism established reason as the criterion, it was not enough to experiment with music ; there was in addition an effort made to justify conceptions of musical theory by scientific descriptions. The scientific revolution encouraged composers and musicians to abandon old traditions and assume a positive attitude towards the improvements offered by science.

The concepts of resonance and overtones give a good illustration of the interdependence of music and science and underline the continual gap in time with which music lags behind. Aristotle himself touched upon both these concepts when he observed the octave phenomenon.

We had to wait until the sixteenth century for Girolamo Francastoro, the astronomer and physician, to investigate the phenomenon of sympathetic vibrations.

The universally learned Marin Mersenne applied Fracastoro's explanation of vibration to his own experiments. In the 1620's Mersenne observed the occurrence of several tones when a string vibrates. In his « Harmonie universelle », published in 1636-37, he enumerates five overtones, and in another connection even names a sixth.

Mersenne discussed these phenomena, as well as questions treating of the hierarchy of consonances, with the philosopher René Descartes and the physicist Isaak Beeckman. Beeckman explained to Descartes the relation between wave motion and consonance in a way which reminds us of Benedetti's theory, i.e., as the coincidence of vibrations. At first Mersenne accepted the explanation that the pleasing quality of consonances is caused by the coincidence of the vibrations. Descartes, however, remained sceptical to this explanation of the listener's subjective experience. He differentiated between a subjective and objective aspect, between the pleasing quality of an interval and the vibrations. He also said that it cannot be absolutely stated that one given consonance would be more pleasant then another, because the character of the experience also depended upon the musical context in which the intervals occur. Mersenne finally accepted Descartes' view.

In 1670 or there about, the English physicists, William Noble, Thomas Pigot, and John Wallis showed experimentally, by using paper-riders placed on strings, that the strings vibrate in sections, and that this is the cause of overtones. The French acoustician, Joseph Sauveur, arrived at the same result independently of the proceeding investigators. He stated that the « higher

harmonics » stand in a simple numerical relationship to the fundamental tone. The succesive harmonics coincide with the tones that are produced by succeeding sections of the vibrating string.

The composer and musical theorist Jean-Philippe Rameau used the scientific method of the eighteenth century to study the theory of harmony. He investigated his own compositions as well as those of his nearest precursors and contemporaries. Based on this material he classified the prescriptions for the movements of the chords above the movements of certain bass notes. As a follower of Descartes' rationalism, Rameau was not satisfied with his empirical system, but wanted to derive his laws within a rationally developed system. In principle, this system was to be derived from a sole self-evident principle. He established this principle by dividing the vibrating string into 2, 3, 4, 5, and 6 equal parts. He presented the results as a series : 1/2, 1/3, 1/4, 1/5, 1/6. Then he tried to manipulate this series in order to explain rationally the laws he had established empirically. He did not succed, however, in these attempts, but became involved in even greater difficulties. He published his doctrine in 1722, and called it « Traité de l'harmonie réduite à ses principes naturels ».

Rameau was later informed about Sauveur's publication of 1701. The overtones in strings and pipes coincide with tones from the first five sections of vibrating strings. The regularity of the occurrence of overtones gives a better justification of Rameau's theory of harmony than the partitioning of vibrating strings does. The overtones also showed that chords were generated by fundamental tones. These discoveries were used by Rameau in his « Nouveau système de musique théorique », which appeared in 1726. Rameau's theory of harmony was completely revolutionary in relation to the then existing theory of thorough-bass.

The mathematician Jean le Rond d'Alembert made a summary of Rameau's theory of harmony in 1752 for practical use, and found it suitable to reject Rameau's numerical speculations, retaining only the empirically established prescriptions.

It is interesting to note how the behavior of a vibrating string was treated by mathematicians. In the middle of the eighteenth century, Daniel Bernoulli presented the formula for the vibrating string using differential equations. He gave the solution in the form of a trigonometrical series, but did not succeed in proving that the series is convergent. Fourier's theory of trigonometrical series, published in 1822, came to be of the very greatest importance for acoustics. In 1747 d'Alembert formulated, and even integrated, the partial differential equation for wave motion. This equation was an important point of departure for the development of the theory of partial differential equations.

Hugo Riemann's further development of Rameau's theory of harmony illustrates the importance of justification. He based his views on minor chords, among other things, on the concept of « undertones », which were supposed

to lie under the fundamental tone as would a reverse overtone series. This view was criticized because the physical existence of undertones could not be shown. Riemann assumed, further, that his theory was valid in general, but this could not be justified ; at the outside it could be valid for the world view entertained during Viennese Classicism and the early Romantic movement.

Some exponents of different tendencies in the present musical avant-garde are again striving for an intimate co-operation between music, science, and technology with a view to their merger. Electronics and computer techniques, and the corresponding world-picture and way of life they call forth, inspire some composers to consider that perhaps the most adequate solution to the creative problem is offered by these same electronic instruments and media. When setting up and justifying the rules of composition for electronic or computer music we need, besides physical descriptions, psychological descriptions. This is because the ends are often formulated in psychological terms that apply to the perceptual or aesthetic objects of music. Not only does the situation demand co-operation between musicians and psychologists, but we need, as well, to encourage psychological experimentation, as the psychology of music is still a rather undeveloped science.

Art and technology

Some excellent illustrations of the close relationship between technology and art can be found in the history of architecture.

Technology is as old as Man. Its origin has been explained by referring to inherent organ and instinct deficiencies ; Man has no natural environment typical for his species, but is obliged to use his intelligence to transform any and all natural environments. Technology has therefore been developed in order to make up for these deficiencies.

Art was still allied to technology up until the end of the Baroque period. All large buildings were creations of art and technology in common ; no hard and fast boundary was drawn between them. Even in the mosaic arts, stained-glass work, enamel-painting, goldsmithery, the different graphic arts, etc., both art and technology were exploited. This long-standing union consisted of a mutal give and take.

Technology in the modern sense arose in the middle of the eighteenth century with James Watt's steam engine and the Industrial Revolution. The separation of art and technology dates from this time ; technology divorces art and marries at once science. Thereafter technology evolved at such a fantastic rate that not only the arts but society in general lag far behind. It has been said that man is an antique among ultramodern machines. Taste is so archaic that the art of our times is restricted to small circles.

The evolution of this condition can be clearly traced in the history of architecture.

In the nineteenth century architecture and technology drifted apart; something we notice if we regard the education given in these disciplines. In 1671 the « Académie d'Architecture » was founded in France and quickly became the highest seat of learning in architecture. Its door was open for advances in technology and the courses were based on rationalistic principles. The conception of art acquired rational features early.

More and more tasks were soon pressed upon the architects by an expanding state, and it became necessary to train technical specialists. This education could not, however, be provided by the academy, as its curriculum followed humanistic traditions. This led to the founding of the « Ecole des Ponts et Chaussées » in 1747 and the « Ecole des Ingénieurs de Mézières » the following year. All instruction in these schools had a strict scientific basis, on which heavy emphasis was placed. It was then that the difference between engineer and architect first arose. As a consequence the « Ecole Polytechnique » was created in 1794-95, with its curriculum built around mathematics and physics. At the end of the eighteenth century, nevertheless, engineers still occupy a secondary position. As science and technology advance, the engineer's field of endeavour expands, the field proper to the architect shrinks. As yet the break between art and technology, between the technique of building and architecture, has not occurred.

With the nineteenth century, and due to the continued development of technology, there comes a new object of beauty. Its forerunner was the iron bridge; the iron structures were later supplemented by glass surfaces. Paxton's Crystal Palace caused a sensation in the London of 1851 and represents the triumph of technology over traditional architecture. Alongside the naturally beautiful and the artistically beautiful now stands the *technically* beautiful.

Technology associated itself with the sciences; some of the arts did likewise, but the rest allied themselves to the new historical sciences. Historical styles and museums cropped up : the so-called cultural or « fine » arts. Painting and other art forms attached themselves to literature, history, and philosophy. The gap between this new cultural art and technology became wider than the gap between the classical academy and the engineers in the eighteenth century. The fine arts could no more be compared to the old concept of art, i.e., what was considered art up until the end of the Baroque period and all through the Classical age, than to the technologist's new art form.

In those art forms where it was the main intention to create « the beautiful », to produce « artistically beautiful » works as far as the fine arts are concerned, beauty was on the wane. Just the opposite was the case in building technology; technical perfection was sought and beauty came unsought as a matter of course. Because of this, architects, i.e., artists, in the twentieth century prefer the objectivity of building technology to the subjective principles of the fine arts.

From the middle of the nineteenth century architects and engineers have stood in a sort of opposition to each other as far as building construction was concerned. The engineering side of building claimed tasks which had earlier been performed by architects. The contractors and those who had commissioned the constructions, however, often still desired the engineering works to be enobled by the forms of fine arts : for example, the steam engine whose pistons move in a Doric column, or the factories that look like castles.

A new phase in the relationship between technology and art begins around 1910 — the revolution of the new art. Its goal was to abolish architecture and replace it with technological construction. Art, and then primarily architecture as art, was to be incorporated into technology. The artists of this movement demanded the abolishment of art. Art was considered redundant to the strictest proponents of functionalism. The organization of industry became the model for social order ; factories, offices, and showrooms became in turn models for the new construction.

Computer technology and computer music

Technology has been developed in three phases : (1) in the instrumental phase man produces the physical and mental energy necessary to perform work, (2) in the power machine or mechanical phase the physical energy is supplied by technical means, and (3) in the automatic phase an effort is made to carry out even the mental work by technical means.

Action is of fundamental importance to man ; he wants to transform the outer world. The « cycle of action » is typical for the human being ; his action is governed by a feed-back process involving trial and error, which eventually makes his actions automatic. The technical, cybernetic servo-mechanisms take the same form as the cycles of action. Man projects his inner being into an outer world and finds models in it which help him explain his inner being, his self. Cybernetic theories and models of nerve nets are some examples of this process.

« The Second Technical Revolution », involving automation, electronics, computers, and atomic energy, is radically transforming our civilization. Typical features in this new Weltanschauung are formalization and the abandonment of intuitiveness in both science and art. Another feature is experimental thinking. The search for new technological means to attain given goals in science, technology, and art is reduced, while the present means are varied and exhausted in order to study all the resultant possibilities.

Computer music is connected to this latter development of technology. The goals of this type of music are not predetermined in detail ; it is, on the contrary, the rules and the program that are composed. Computers operate on different initial conditions or values fed into it and calculate a host of possible solutions, from which the composer choses acceptable works according

to his own criterion of values. Attempts are being made to go even further along the lines of the projected automation, i.e. letting automata create music by simulating the psychical processes of musical composition.

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BIBLIOGRAPHY

Edel, A. : Science and the structure of ethics. (International Encyclopedia of United Science. Foundations of the Unity of Science. Volume II, Number 3.) Chicago : The University of Chicago Press 1961.

Gehlen, A. : Die Seele im technischen Zeitalter. Hamburg : Rowholt 1957.

Lesche, C. : A metascientific study of psychosomatic theories and their application in medicine. Copenhagen : Munksgaard, New York : Humanities Press 1962.

Lesche, C. : « Fackrutor om samband mellan musik, vetenskap och väridsaskadning » in Gerholm, T.R. & S. Magnusson : Idé och samhälle. Stockholm : SÖ-förlaget Skolöverstyrelsen 1966. Pp 84, 140-141, 190-191, 361.

Naess, A. : « The inquiring mind ». Inquiry 1961, 4 : 162-189.

Palisca, C.V. : « Scientific empiricism in musical thought » in Rhys, H.H. (Ed.) : Seventeenth century science and the arts. Princeton : University Press 1961. Pp. 91-137.

Seldmayr, H. : Die Revolution der modernen Kunst. Hamburg : Rowholt 1955.

Sequenz, H. (Ed.) : Der Geist der Technik. Wien-New York : Springer-Verlag 1966.

Siebel, E. (Ed.) : « Die Wandlung des Menschen durch die Technik. Die Vorträge der VDI-Sondertagung in Tübingen am 30. und 31. März 1953 ». Zeitschrift des Vereines Deutscher Ingenieure 1954, 96 : 113-159.

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At its inception in 1933, Fylkingen was intended as a forum for composers and performers of chamber music. The Association's present activities extend however well beyond the purely musical sphere, and the group includes many Swedish writers, technicians, sociologists, scientists and artists. Fylkingen has in fact become a forum for all sorts of experimental arts, and its objectives have been concentrated around the relationship between art, advanced technology and science.