

# ART AND SCIENCE <sup>1</sup>

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THE thesis which I wish to recommend to you is that science is a form of art though not of fine art: that like art, it is a human invention, not less real for that, and having value, or being valuable, partly if not mainly because of that. I mean to indicate by this statement that for me at least a better insight can be got into the nature of science by considering it as a form of art, and asking how it differs from and how it resembles fine art.

The differences are the more obvious, and I begin with them. But at the outset I am faced with the question what art is or what the beautiful is. The question is notoriously difficult to answer, and I have no answer to give which satisfies completely even myself. I would rather be understood to be proceeding tentatively and offering some suggestions towards a study of value in general. If I seem to my hearers rambling and desultory, I hope I shall be forgiven for not pretending to be surer and more systematic than I really am, for not "calling," as they say in the game of Bridge, "above my cards." By the beautiful or object of art I premise that I mean the æsthetically beautiful, which may include what to the unæsthetic sense is ugly. What is displeasing and repels us like an ugly face may become highly beautiful in the æsthetic treatment; and similarly "facile" beauty may not necessarily be artistically beautiful.

We may define or describe art from different points of view according to the particular side of art that we have in mind, or to the particular interest we take in it. Some are inclined to dwell upon the uniqueness of the values of truth, beauty, and goodness, and especially of art, and to declare beauty to be indefinable. Beauty and good are to be taken for what they are, and all we can do is to say what kinds of things have these qualities, or by what means, for instance virtuous acts, they can be attained. I have grave doubts about this proposition, which by the way has rarely been extended to include truth. Before coming, however, to the point of real importance in this view, a word of protest is needed, I think, against a certain abuse of it which is becoming very common among philosophical theologians. The writers whom I mean regard religion as a value along with truth, goodness, and beauty, and

<sup>1</sup> Read before the Bedford College Philosophical Society on November 25, 1925.

insisting on the uniqueness of value, they seek in this way not merely to remove it from the purview of science, but even to claim for it superior validity to science; and all this without any inquiry even into the conditions underlying the values (I mean the kind of circumstances under which we pronounce judgments of value), or considering what has been attempted at an analysis of the idea of value. This procedure is a confusion of issues. There is no doubt of the supreme importance for life of the values and of religion. But there is equally no doubt of the importance for life of physical bodies, of energy, or of weight. Practical importance does not, however, exempt the values from an attempt to understand them, from a science of them. The values are practically unique; but their uniqueness does not exempt them from investigation by the science which is proper to them. If we are seeking to understand religion, we are not to exempt it from understanding by the consideration, irrelevant for understanding, of its preciousness. Such methods weaken the defence of something which really needs no defence, but only understandingly (that is philosophically) to have its place assigned to it in a scheme of things.

I am, however, not so much concerned with this aberration as with the view that beauty is a quality of things, indefinable like colour or smell, one of what are consequently called the tertiary qualities of things. Now it seems to me doubtful if we can compare beauty with redness. I doubt if beauty is a quality in the strict sense at all. Quality is the surd in our account of things, it is incommensurable with the measurable properties which we can analyse or deduce; and has to be accepted as given, when certain measurable conditions occur. It has "ingress" into nature as the *Timæus* of Plato and Mr. Whitehead say. Redness is irreducible to the light of a certain wave-length which is its underlying physical structure. Not even when we are told that red light excites the red substance in the retina, or, upon another theory, breaks down the red-green substance, do we come any nearer to an insight into why we should see red or any colour at all. Now it is true that there is a uniqueness about beauty or good. Hume said in a profound passage: "We do not infer a character to be virtuous because it pleases. But in feeling that it pleases after such a particular manner, we in effect feel that it is virtuous. The case is the same as in our judgments concerning all kinds of beauty and tastes and sensations. Our approbation is imply'd in the immediate pleasure they convey to us." So much in the view we are considering is correct. But the difference between red and beauty is this: red is incommensurate with its conditions; but the conditions of the æsthetic character are not incommensurate with it. If we choose to treat the secondary qualities as mental, then

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a certain disposition of colours in a picture looks beautiful, and gives us æsthetic pleasure. If we regard the secondary qualities as qualities of things, a certain disposition of them possesses the additional character of beauty. I cannot say why vibrations of a certain length look red simply because they appeal to certain characters of the optic nerves. But it does not seem ridiculous to say that a landscape or a bust looks beautiful because it appeals to certain mental dispositions in me which it satisfies. We may in fact be able to say that beauty is that which gives a peculiar mode of pleasure because it gratifies a specific tendency or want.

A very usual and useful way of describing beauty in its distinction from truth and goodness is to consider the state of mind from which it proceeds in the artist, or to which it makes appeal in the appreciating spectator. Beauty then is regarded as being in some special manner related to the feelings. "The æsthetic," says F. H. Bradley, "is the self-existent emotional." "Beauty is the self-existent pleasant." It is, however, fairly clear that any such description needs to be qualified if it is to be true. Take the famous saying of Wordsworth, "Poetry is emotion recollected in tranquillity." It will not, I trust, be thought inconsistent with honouring Wordsworth on this side idolatry, if I say pedantically in the first place that poetry is not strictly emotion at all, but is primarily words rhythmically ordered, which may indeed express or be charged with emotion or other significance. I should not urge this pedantic demur (of course not wanted in respect of Wordsworth himself), were it not grown so much a habit of the day to treat the artistic material as unimportant, as the mere technical expression of a state of mind. Whereas primarily a work of art is not imaginations or emotions, but sounds or pigments or words or stone, fashioned by the artist.

In the next place, it does not seem to be true that emotion is the dominant feature of the beautiful. Not all poetry is emotion. Lyrical poetry is. But who shall say that emotion is what is signified by our poet's own words about the poet: "He murmurs by the running brooks a music sweeter than their own," or in the great dialogue of Claudio and Isabella: "Death is a fearful thing." "And shamed life a hateful"? There is æsthetic delight in both passages, but it cannot be said that either of them is primarily emotional in its meaning; the first rather expressing reflection, and the second character. Whatever Greek statuary of the great time may have meant to the Greeks themselves, into whose feelings it is hard for us to transport ourselves, it is not emotion, but character which they represent to us, who also find them beautiful. The truth is that what is important in Wordsworth's saying is not the word "emotion," but the words "recollected in tranquillity."

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Not even these are vitally true. Goethe found relief from the urgent passion for Lili by his lyrics upon her, which made his passion an object of contemplation, and purged it of its personal character. Yet it is true that the tranquillity of memory is favourable to art just because it removes the feeling of the artist from the practical opportunity which makes or may make passion selfish. For what Kant said of art is eminently true, that in appealing to feeling it appeals to disinterested feeling, not to the personal feelings which we have in the practical enjoyment of an object we consume. Æsthetic feeling leaves its object unaffected, and a practical feeling (like the mere pride of the owner in the possession of a picture) is not æsthetic. Perhaps this truth may be better expressed by noting that art, like truth, is always contemplation and never mere practice; though of course the artist's practice of his art is not itself æsthetic but practical.

Yet once more we have to qualify. Truth and goodness furnish equally a disinterested pleasure, so that after all there would appear to be a peculiar and specific relation of art to the feelings of the artist or spectator: there must be something in art additional to the formal feeling of æsthetic pleasure. This I submit is to be found in the presence in the work of art of the personality of the artist, one side of which may be emotional, but which manifests itself in thought or imagination as well, and may on occasion contain little emotional tone. What we seem to learn from the consideration of Wordsworth's unqualified dictum is that the artist imports his personality, in whatever form, into his creation, while in the search for truth personality dare not colour the object investigated, under pain of failure. The artist's personality actually supplies part of the contents of the work of art. And yet even so it is not his individual personality which is thus imported. It must be stripped of that practical urgency which belongs to emotion, except it is remembered in tranquillity, must be impersonalized. Science, on the other hand, while it calls for the most strenuous exercise of personality on the part of the inquirer, obliterates his traces in the product. We shall presently ask why. Enough for the moment to note that in art the person of the creator enters impersonally into the product, in science it is depersonalized altogether.

Another protest may be allowed me in passing against a view sometimes entertained that the very object of art is to appeal to emotion, or even that art exists to give pleasure. If art does not please it is not art; but everything turns on the particular fashion in which it gives pleasure, and this point, which is the vital one, is evaded by the doctrine in question. The purpose of art is to create beauty, which is pleasant, and beauty is not a mere means

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of pleasure but of satisfying the artistic hunger ; in the same way as the purpose of food is not to provide the pleasure of eating, but to satisfy material hunger. There is a strange half-truth which arises out of this error, that there is no disputing about tastes. No proposition is so trivial where it applies, or so false in itself. If you dislike mutton and like Martin Tupper, you have a perfect right to your tastes, which are incontrovertible facts, but no right to claim them to be unquestionable. It is thought that while in science only the wise can claim knowledge, art is purely a matter of taste. There is really in fact no distinction between art and science in this respect. Taste may be educated as well as opinion. Even morals are in the end matters of taste, enforced by the majority which prefers goodness upon the reluctant minority which prefers vice. The use of artists is to show us what is really beautiful and what is not, and it is they and those who learn from them who settle the standard of taste. The inartistic remain like the ignorant. Only unfortunately we do not put the same pressure on them as we do upon the vicious by better education.

Thus feeling or emotion fails as the distinguishing feature of art, needing so many qualifications to fence it round that it becomes nearly useless for the purpose. Moreover, feeling and emotions play equally a part in practice, where also to become good they have to be impersonalized, so that another person in the same place might do the same action and win approval from his fellows. In fact, the neat distinction of truth and beauty and goodness by reference to knowing, feeling and willing, is the product of the too sharp distinction of those aspects of the mind's action, a discrimination traditional since Kant. Later psychology has come to dwell upon behaviour, and to look mainly to the tendencies or dispositions or impulses or instincts, call them what you will, from which our activities proceed. We shall do best then, inspired by the precedent of the psychologists, to fall back upon a more ancient distinction. First of all we may separate practical action, of which the standard or norm is found in morals, from contemplative action which issues in science and art. The works of morality are consumed in their performance, however much regulated they are to meet the demands of impersonality. The works of science and art are not consumed in contemplation, but abide. They abide in themselves, and do not merely acquire a posthumous permanence in their effects upon future action.

Secondly, we may distinguish science and art from one another as being, the first the satisfaction of intellectual curiosity, the second the satisfaction of the creative impulse. The distinction is of course as old as Aristotle. To call art creative must not be taken to deny creativeness to science in the sense of invention.

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“Creation” is used for want of a better word, and in order to avoid the partial error we should commit if we called the tendency which issues in art that of self-expression. For though art is self-expression, it is something more. It means the fashioning of existing material so as to be significant, through the importation of elements supplied from the personality of the artist, where under personality are included not merely emotions, nor even principally emotions, but thought and fancies, patent or latent—“whatever stirs this mortal frame.” This I have already said in my remarks upon Wordsworth’s famous phrase. Clearness on this point is so important that I will dwell on it a little longer. From one point of view the statement is obvious. The sculptor breathes life into the dead stone; the painter infuses character into a mere artful combination of colours; or rather I should say perhaps, by an artful selection and combination of pigments he makes them significant of character. So much truth there is in the notion of “empathy” or *Einfuehlung*. It is more important, however, not to overstate the truth. The sculptor feels his own life, it is said, into the block. Such a statement is really untrue. He imports into that block not his own life but life; but he supplies the life from himself. All kinds of fancies and feelings may go on in the poet’s or the painter’s mind; but he does not make his art expressive of these as such. He is the medium only by which these meanings are imported into the work, or, if I may use the word, are “imputed” to it, by himself and the spectator after him. Only in this limited sense is the work expressive of the artist. It is of course in addition expressive of him in the sense that it satisfies his impulse to creation or creative representation.

Hence when art is said to be expressive the word must be understood with care, and the current doctrine of empathy tends to obscure its meaning. Art is expressive in the proper sense of the subject which the artist is representing. The horses of Phidias are alive, and alive through the life imputed to them by Phidias. But what they express or are expressive of is horses in certain significant attitudes. This statement is obviously true of dramatic poetry. We do not think that Lear is an expression of the emotions of Shakespeare, though the poet may for all we know have thrilled with the passion he imputed to Lear.<sup>1</sup> We do mean that Lear is expressive of a certain character, and that the words he speaks

<sup>1</sup> Cf. Browning’s

“With this same key  
Shakespeare unlocked his heart.” Once more!  
Did Shakespeare? If so, the less Shakespeare he.



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are selected and arranged to have that significance, have that meaning imputed to them, or are charged with it. That is how I understand the somewhat vague dictum of Mr. Clive Bell and others that art portrays significant form<sup>1</sup>—a dictum laid down for the visual arts, but capable of extension to the other arts, as it ought to be unless we maintain poetry to be an impure art.

Hence art is expressive of what it intends to express. It is only where it intends to express feelings, as in lyrical poetry and possibly in music (for I have not thought enough of music to judge), that it expresses the artist, and even then he expresses himself impersonally, as we have seen and as I need not repeat.

Thus art is creative so far as creation is possible for finite creatures. It takes a foreign material, and fashions it to express imputations derived from the creative artist. It achieves a blending of a material, stone or musical sounds or words or pigments, with a human mind by virtue of qualities which it has not in itself, but only through the imputation of elements which have their origin in the artist's or the spectator's mind. For I repeat that the stone itself is dead, and only lives through the presence of the mind to it in one intimate fusion. Even if it were merely copied from a model, it would indeed suggest to us a human form, being already a work of art or handicraft so far; but it would only be really alive and have character through the added skill of the artist. "The finest model ever found upon the earth," says G. F. Watts, "if set up in the position, for instance, of Theseus, would not look like him. The Greeks understood where to accentuate the lines, and so to use them as to express what they wanted to express."<sup>2</sup> The artist by his work transports us into a new world which is a blending of material with mind. This world is real, so long as neither party to it is absent. But its reality is not the same as that of the material world. For the stone has life and beauty only to the artist or the spectator, and they in turn have the experience of beauty only as it is embodied in physical material. The stone belongs in itself to the physical world; it belongs to the world of beauty only as blended with elements supplied from the mind. And the same thing is true with proper modifications of beauty in nature herself, for in herself she is physical and not beautiful; only I must not linger on the topic.

It is clear, too, from this that, compared with physical reality, the work of art contains illusion. For in itself it does not possess the qualities, say of life or character, which it possesses in the

<sup>1</sup> *Art*. Clive Bell (new edition) London, 1924. If only for lack of space I am unable to discuss this phrase, or in general the question of what a work of art contains, its contents.

<sup>2</sup> *George Frederick Watts*. By M. S. Watts. Vol. iii. p. 12, London, 1912.

reality of art through imputation. Such imputation is not deception, for it is the essence of art. An imputation may deceive us in perception, when we mistake the cry of a bird for a cry of distress. That is error. The imputation used in art gives us not error, but beauty—makes us free of the new reality of human creation. Every reader of Mr. Berenson's books on the painters of the Italian Renaissance remembers how constantly he urges that the painted forms in great art have tactile value: being two dimensional they seem solid; and how Giotto's figures not merely are in contact with the ground, but press upon it with their weight, which the figures, he says, of Duccio in the great altar-piece at Siena, for all their liveliness and charm, fail to do.

We are already within sight of one difference of art from science. For knowledge, perceptions must be faithful; there, too, we see the coloured surface only of a solid body, but we perceive a solid body, and our imputations are correct; the body whose surface we see really is solid. The painted figure has not in physical reality the solidity which we impute, and for that reason when it blends with our mind it is art.

Which leads us on to the vital difference of art and science, that science being the satisfaction of curiosity, is controlled entirely from the real world it desires to understand. Imputations from the inquirer are only valid if they are veridical, if they work. His personality is but a means to the attainment of truth. What he supplies dare not alter the contents of what he investigates. His imagination may be called upon to the highest degree to supply the thoughts which interpret the world he finds. But he does not like the artist build his imputations into the material and create something which is not there in the world of nature. If he did he would falsify. How in spite of this cardinal distinction his science still resembles art we have presently to see.

Another difference, often dwelt upon, arises from the fundamental fact of the control of science from without. Not that art is not guided by its material, limited and stimulated in all manner of ways. Yet the artist is free to impute to his material all that it can bear. Now since the artist is thus creative, his creations are singular or individual. He does not create thoughts, but individual forms, forms which do not exist in the real world of nature, or if they do, exist there by happy chance. Science, on the other hand, is concerned with universals, with laws. Hardly anything can be said on the subject without qualification; and it is not true that science is concerned with nothing but laws. It begins with singulars, and its laws are tested by singulars for their validity. It arises and ends with history. Nor on the other hand is art confined to mere singulars. It does not portray laws as such,



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but in so far as it creates significance in its singulars,<sup>1</sup> it connects together many singulars on a vital thread. But the broad distinction still remains. Some art like the drama may even represent in the singular case the operation of great universal forces of human nature in their conflict, as in Hegel's favourite instance of the *Antigone*; and therefore it was that Aristotle said that poetry was more philosophical than history, though he was clearly neglecting the higher fetches of history which are highly philosophical.

There must be some limit set to musing on the differences of art and science. These differences always are on the edge of disappearance. Science is patently discovery and art creation. Yet it may be urged that science is in the highest degree creative. What is creation if Relativity is not? And art in its turn I have myself been recently urging is discovery<sup>2</sup>: discovers David in the vast marble block, of which poor Bandinelli could make nothing, but in which Michelangelo divined his statue; discovers *Hamlet* in the English language, where it lurked unseen till Shakespeare made it plainly audible. Yet scientific discovery is only the reading off from reality of what is there independently of all discoverers; the artist's discovery still depends on the participation of man in the experience. Gravity abides, and our Newtons and Einsteins do but approximate to reading it accurately. The David is David only for the appreciating mind. If it were to topple from its base, a dog which passed would see in the event not the impending destruction of a great creation, but danger from a falling block.

It is time to turn from the fundamental difference that science is controlled from the external reality, and art is a dual control from an external reality and a creative or appreciative mind, to my thesis, which threatens under this cloud of subtleties (not, I observe, of my own making, but made by the far subtler nature of the case) to be obscured, has at any rate been too "long delayed in that obscure sojourn." Art helps us to understand science, because in art so palpably the mind enters into the result. Now science, whose subject-matter is in general truth, is like art in being a human invention; though unlike art the ideas which the scientist supplies are already in the reality he investigates. Truth and reality are not identical conceptions. Truth is reality as possessed by mind, and this it is which makes science not fine art, but like art. Truth is a human invention controlled entirely from the

<sup>1</sup> Cf. in Wordsworth's poem on the poet:

In common things that round us lie  
Some random truths he can impart.

<sup>2</sup> *Art and the Material*. Manchester University Press. 1925.

object. The contents of truth are reality or are found in it. What distinguishes truth from reality is the presence in truth of the possessing mind, though that presence does not colour the object, though the mind which enters into truth as an ingredient is not merely impersonalized as in art (or morals), but depersonalized, so that no element of subjectivity contaminates the object.

This is the plain answer which seems to be required to the question of the relation of truth to reality. Sometimes they have been identified, in which case one or other of the terms is otiose. Sometimes truth has been said (like fraud or guile in the old saying) to be contained in universals. According to Locke, scientific truth was concerned wholly with abstract ideas. Yet we must admit a historic fact to be a truth if rightly described, as well as a reality, and science never cuts the threads which bind it to singular facts. Sometimes the relation has been described as one of correspondence ; and then the difficulty has always been how we shall discover the sensible reality except through cognition. The doctrine of the so-called critical realists has the singular merit of maintaining that the testing of truth by reality lies outside cognition itself, in practical adaptation, or the failure of it, to a real world which imposes itself upon us in that experience. The answer for all its merit is unsatisfying, if once we have learned to regard all cognition as a form of conduct, and cognized objects as revealed to us, directly or indirectly, in the practical effort to adjust ourselves to them which they compel us to make. The practical test to which the theory appeals itself supplies objects of cognition ; and unless truth lies wholly in universal propositions, it must consequently be regarded as linking into a coherent unity the subject, singular and universal, with which it deals, and as one therefore with reality itself, except that as has been said above, truth is what the mind makes of reality, is reality itself in its relation to the mind. To possess truth is to have peace of mind in regard of reality, and that condition is a product not indeed of fine art, but of art. Reality cannot be otherwise possessed. Only reality possesses reality in the literal sense, and is its own reality, and is closed to every other reality, though its influence upon other realities extends to the limits of things.

This statement that truth is an artistic product of the operation of the mind upon reality, that truth is a human invention in a profounder sense than a lie is, helps us to understand many familiar features of science. In the first place, since science as an art implies selection and arrangement, we understand how, in spite of the pervasive interconnection of things, the subject-matters of truth—the various sciences—are closed circles, a group of data enlightened by principles and forming in virtue of those principles

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a coherent unity, which constitute like individual works of art distinct entities. I do not mean that one science disdains its sisters; the contrary is obviously true; but that till philosophy steps in to insist upon the family tie which binds them, they remain separate departments of the world of objects before the mind. Moreover, their artistic or, better, artificial, character explains the instability of truth compared with the stability of fine art. Greek sculpture is beautiful still, though it need not be supposed to have exhausted the possibilities of sculpture. Greek science is antiquated, and is no longer true. The reason is that knowledge of things has grown, and with it the range of human ideas invented to unify them and verified by the things themselves. The artifices of the man of science cease to be adequate to the material. If we could transport ourselves to the days before Lavoisier and forget what we have learned since we should doubtless re-invent the notion of phlogiston. The destruction which overtakes truths does not destroy the truth for their own time of limited knowledge, but only attests their insufficient skill of artifice. Even so, the outworn truths which in their day explained triumphantly a certain range of facts may still be preserved by discarding their transitory imperfect elements, and retaining what is still a useful tool in the handicraft; as at the present moment the once triumphant notion of æther is being recast so as to shed certain of its inadmissible features, while retaining certain others. Thus the artificial products which are art remain because they are material things transfused with mind, and since they are beautiful through their meaning, their beauty is recoverable for all who can penetrate their meaning. But the products of science are but reality as read by minds; as the reality reveals itself in changed characters or wider range, the reading changes too and old truth becomes history only, and not present truth. This does not of course apply to the simplest selections from reality, such as the laws of thought, e.g. that a thing cannot have contradictory qualities in the same relation, nor except in a minor degree to limited and defined artefacts like arithmetic.

The consanguinity of science with art explains next a much more puzzling feature of science, often remarked, its partial independence in its working of the constitution of reality. The mind goes its own way and suits its own convenience in seeking to understand reality. A notable instance is found in the contrast of the reasons or arguments used by science or thought with the causes which operate or are supposed to operate in physical reality. We may infer what turns out to be true for a hundred reasons which serve our purpose, but do not assign the cause. Every cause, says Bradley, is a because, but not every because a cause.

Two coins are like each other because each is like a third. But the cause of the likeness is that both were struck from the same die. The fall of the barometer from which we infer the storm is not the cause of the storm, but its effect and only its sign. The apparatus which science uses to attain its results has been compared (by Lotze) to the builder's scaffolding which enables him to build the house. The simile limps, for the builder pulls his scaffolding down, but the arbitrary procedures of the science are part of the scientific structure. It would be easy to account for the phenomenon if we supposed thought to possess some duality with things, to have objects of its own which do not as such belong to the common world of reality. I am, however, assuming that the objects of thought are directly or indirectly a part of the common world, at least in their elements ; and then the puzzle is how science can be faithful to its control by things, and yet manipulate things so as to relate them not as they palpably are related in nature, but in their relation to the thinker's convenience. The likeness of science to art resolves the puzzle. Provided he does not introduce himself into the contents of what he explains he may displace and connect his material as suits him, much as the maker of fine art uses conventions, like those of the opera or the soliloquy.<sup>1</sup> For truth is not reality itself, but the reality as the investigator possesses it. Those arbitrary means, it must, however, be observed, by which he takes reality upon occasion into his possession are themselves founded in the end on the nature of reality itself. For example, the use of signs is legitimate instead of causes, because for instance the fall of the barometer and the lowering of wind-pressure are reciprocal in actual things.

I have mentioned two ways at least in which science takes on the aspect of art, and does so because the mind is a partner in science, though a depersonalized one : first its selection of departments or departmental features of the world and creation of the separate entities which are the sciences ; and next in creating the body of its conclusions, not necessarily by experiment which follows the outlines of things, but by arguments of its own, governed by its own convenience, and following logical laws, though these in the end are only broad outlines in things and not pure human inventions. But there is a third and more striking way in which science betrays its affinity with art, most obvious in the abstractest science of mathematics—the science of number, and in the speculative reaches of physics. Generalization, as Mr. Whitehead shows in his *Introduction to Mathematics* in the Home University Library, is the life-blood of mathematics. Number is the most abstract of natural

<sup>1</sup> Hence, I may observe, the room left for individual (almost artistic) style in scientific exposition.

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conceptions; and directly we loose number from its embodiment in groups of things, we find ourselves, in the history of mathematics, discovering new entities in this abstract world—not merely fractions or surds, but negative and imaginary numbers. These are not merely names or symbols which we manipulate at will, and they may have been suggested in the first instance by obvious facts like the difference between walking two miles east and walking two miles west; and the mathematician hastens, as Mr. Whitehead explains, to make these strange discoveries intelligible. Still, in one respect, the mathematician is the servant of the conceptions which he has abstracted or selected, as much as a novelist is the servant of the character he has postulated, which does and says things which the artist did not deliberately intend, but accepts when they are done and said. In the end, says the witch in *Faust*, we depend on the creatures which we ourselves made. *Am Ende haengen wir doch ab von Creaturen die wir machten*. Perhaps the most striking example is the construction of a manifold of any number of dimensions when once we have started with the familiar abstractions of order and dimension. At times, indeed, we seem in such cases to be transported not merely into the region of art, but almost into the region of fine art, and the impression left on our minds to be not so much that of truth and correctness as of beauty with its delight.

These close approaches to art proper might lead us to doubt the proposition I am maintaining that science is controlled by real things. What has the world to do with a 12-, or more-, dimensional geometry? Three dimensions were once enough it seemed, and now our world-geometry has four dimensions, and its geometry has become a department of physics. Even now it is sometimes suggested that our 4-dimensional world is curved within a 5-dimensional one. Is that more than a purely mathematical imagination? It is dangerous for a mere philosopher to talk about either science or art when he practises neither; but I must take my courage in my hands, and say that my proposition still remains true, that science is a transcript of the real world, and where it leaves or seems to leave that world for a seemingly arbitrary construction, it is still under service to the real world, which at one end is presented in sense. Indeed, in its abstractest efforts it is always bringing us back to sensible reality again. The most notable illustration of which is the use of the purely arithmetical theory of "tensors" to formulate anew the exacter law of gravitation. It is as if we made a locomotive and let it run away with us, and our locomotive had the wonderful property of laying down rails for itself as it goes, and possesses other strange properties as well. Yet it takes us into fresh places which we otherwise should not

have known, tells us more about the sensible world of which it began by being a part.

It need hardly be said that this is not identical with the proposition, glaringly untrue, that science is subservient to practice in the sense of having a practical end. The greatest triumphs of science have been won in disinterested pursuit of the subject-matter of the science. Science is an art in its own right. But its material is taken from the real world, and its highest flights bring us back to the real world again. In its greatest liberty of abstraction, and following out its own abstractions, it is unconsciously turning its eyes towards imprisonment in particulars again. It raises therefore an old problem to philosophy how the creations of mind can themselves belong to the world. That is the problem of Kant, how pure mathematics can be applicable to the world of objects; how applied mathematics is possible—though it cannot be solved as Kant solved it. Some persons are inclined to believe that as the world shows itself accessible to these pure constructive creations of the mind, the world must be itself spiritual in the end. Many even suppose that the theory of Relativity proves that each man's universe is the mere construction of his mind, and hold that it confirms the Kantian doctrine that Space and Time are but forms of the mind. It may be hoped that this reading of the new theory will not outlive among ourselves the exposition which is now within the reach of all of us in Mr. Russell's *A.B.C.*<sup>1</sup> The one aim, in fact, of the theory from the beginning has been to secure that the laws of physics should have the same form for all, however individual was the measurement of events from each individual's point of view. The validity of our quasi-artistic mathematical objects is not derived from the mind alone. There are no such things as pure mental creations; though thoughts abstracted from the world may be extended and generalized by science, and may breed fresh conceptions in the process. Ultimately the reason why mathematics is applicable to the world of things (so far as it can be so applied, which is only approximately) is that its subject is abstracted from that world, and never really loses its connection therewith. Strictly speaking, that answer is nearer to the real spirit of Kant than the naïve idea that the so-called forms of mind are instruments of the mind's own devising which it uses to understand things. But my purpose is not to defend Kant (a hopeless task) or to account for him. What I have been trying to suggest to you that it is in so far as science is an art that it raises this difficulty by its own procedure; and that it is really not art in the proper sense because even where it is most like fine art it is still, though perhaps at several removes, a transcript of the actual

<sup>1</sup> *A.B.C. of Relativity*. London, 1925.



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world ; that unlike fine art it does not introduce into the contents of its subject-matter anything foreign to that subject-matter derived from the mind itself ; while fine art for all its impersonality lives by reading into its material features which that material does not possess. Science for all its indirections is always bent on its office of penetrating into the real nature of a world it finds and does not make ; but being itself, like art, a new world in which nature is possessed by mind, it does also on occasion still further simulate art by wandering away in order better to observe.