of itself tends to immobility, but as a moment within the larger process of developing science, it is limited to consolidating past achievement and facilitating the discovery of present defects. This position, of course, is just the opposite to Hegel's, who did not place logic within movement but invented a new logic that contained movement. But the more relevant contrast would seem to be with Aristotle, who not only was the father of logic but also drew heavily on logic to construct an ideal of science at a time when science was just beginning to exist.

For Aristotle, then, science was a matter of knowing the cause, knowing that it was the cause, and knowing that the effect could not be other than it was.[1] In brief, the object of science was causal, necessary, and immutable. Opinion, in contrast, was true knowledge of matters of fact where, however, the fact was not necessary or, if it were, then its necessity was not apprehended.[2]

The vehicle of Aristotelian science was, naturally enough, the syllogism. Syllogisms express knowledge of causes inasmuch as the middle term names the end, the agent, the matter, or the form.[3] They express necessary knowledge inasmuch as the premisses are <u>per se</u> predications in which essential attributes are assigned to commensurate subjects.[4] Finally, besides the premisses that may be derived syllogistically, there are those that are true, first, underived, better known than their implications, and related to them as cause to effect.[5] Obviously, the existence of Aristotelian science depends on the existence of these basic premisses in each field. Unfortunately, while Aristotle does describe how our knowledge of principles does arise,[6] while his description fits quite accurately the manner in which scientific discoveries are made, still such discoveries do not yield the knowledge of necessary causes and immutable effects demanded by the Posterior Analytics.

What the scientist discovers is not a truth but a hypothesis, not a necessity but a possibility. For instance, a free fall is a constant acceleration. The matter has stood the ~~set~~ test of centuries. But it has done so, not because bodies must fall that way, not because the free fall cannot be other than it is, but simply because out of many hypothetical possibilities the simplest verifiable formula is the constant acceleration.

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1) Aristotle, Posterior Analytics, I, 2, 71b 10 ff.

2) Ibid., I, 33, 88b 32 ff.

3) Ibid., II, 11, 94a 20 ff.

4) Ibid., I, 6, 74b 5 ff. The necessary and essential also is eternal. How, then, is science relevant to this world? Aristotle remarked that the attributes of perishable things either cannot be demonstrated or else the relevant syllogism will be 'mixed' with one premiss necessary and the other contingent (Ibid., I, 8, 75b 21 ff.). Aquinas appealed to the immutability of the abstract: Rationes autem universales rerum omnes sunt immobiles, et ideo quantum ad hoc omnis scientia de necessariis est. Sed rerum, quarum sunt illawe rationes, quaedam sunt necessariae et immobiles, quaedam contingentes et mobiles, et quantum ad hoc de rebus contingentibus et mobilibus dicuntur esse scientiae. In Boethium de Trinitate, q. 5, a. 2 ad 4m. On the more intricate problem of scientific prediction, see W. D. Ross, Aristotle's Prior and Posterior Analytics, Oxford 1949, pp. 649-652.

5) Post. Anal., I, 2, 71b 19 ff.

6) Ibid., II, 19.

Moreover, what holds for the free fall, holds for all other natural laws and, no less, for the theories and systems that relate them to one another. All such laws, theories, systems are subject to revision; they have a claim on our assent, not because of any intrinsic necessity, but only because they happen to be verified; and the moment further data begin to tell against them, they become questionable.[7]

We have been touching on the crucial difference between the Aristotelian and the modern notion of science. On the Aristotelian notion science is concerned with the necessary and immutab.e. On the modern notion necessity and immutability have no more than a marginal signf significance. Science is concerned with the intelligibility, not that must be, but that can be. Of itself, such intelligibility is hypothetical; essentially, it stands in need of the complement of verification; and any verification yields no more than a probable confirmation.

From this crucial difference other differences follow.

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7) In the nineteenth and early twentieth centuries it was still common to speak of the necessary and immutable laws of nature and even of the iron laws of economics. This trend has been reversed by the refutation of the uniqueness of Euclidean geometry, by the successful use in physics of non-Euclidean geometry, by the alternative probabilities predicted by quantum theory, and the limitations placed on deductive systems by theorems of the Gödelian type. On these, see J. Ladrière, Les limitations internes des formalismes, Louvain 1957. On mathematical principles, see M. Polanyi, Personal Knowledge, London 1958 and 1962, pp. 187-193; B Lonergan, Insight, London and New York 1957, pp. 304 ff.

Logic might suffice to expr ess necessary and immutable knowledge. But when possible hypotheses are legion and only cumulative verifications are significant, one has to move beyond logical operations and make room for inquiry, observation, discoverym, experimentation, and verification within an on-going process.

Again, we mentioned above that Aristotle contrasted science and opinion. As science was of the necessary, so opinion regarded the contingent. But modern science is concerned with the contingent, with verified possibilities; and so we speak seek on each issue the best scientific opinion that is available. Science ando opinion no longer are opposed. Now is the time the contingent, with verified possibilities. Science, then, and opinion no longer are opposed. On the contrary, on each issue we seek the best available scientific opinion.

On similar grounds Aristotle contrasted theory and practice. Practice is concerned with the contingent, with things that can be other than they are. It follows that science cannot be practical, for science is concerned with the necessary, with what cannot be other than it is. Science accordingly must be simply contemplative and, in that sense, theoretical. Now in the modern context the term, theory, cannot be given such a connotation. Modern science deals with the contingent; it grounds endless practical connotations applications to make modern theory continuous with practice. So far from being opposed to one another, theory and practice now are two stages in man's deeal dealing with the same objects.

Further, to find necessity in a manifestly congtingent world, the medieval notion of science retreated to the universal and the abstract. In contrast, modern science aims at the complete explanation of all phenomena. Though it has to use abstract terms and unifversal propositions, still it regards them as limitations and strives to surmount them. Though it cannot master the concrete in its all but unlimited complexity, still it constantly endeavors to come as close as possible to such mastery, and it is extremely resourceful in inventing conceptual tools and imaginative models to advance ever further the understanding of concrete processes.

There follows an enormous difference in sheer bulk. An Aristotelian science is a habit tucked in the individual's mind and, as it purported to be certain knowledge, it was to be passed on from generation to generation. But the positive content of a modern science is only probable; it is continuously in process of development; its extent is so vast that it cannot be encompassed by any single mind; and its sustained development calls for the assembled resources and far-flung collatboration of the world's scientific communities.

Finally, on the modern conception science is defined by method. There is a science where there is employed a method yielding the sumulative advancement of knowledge. Methods differ from subject to subject, but each is directed to by its own proper method, and each is scientific by that fact and not by its more or less approzimate resm resemblance to something else. In contrast, the Aristotelian conception of necessary conclusions following rigorously from necessary principles was an ideal type;

it was thought to be realized in arithmetic and geometry;[8] elsewhere it was said to be approximated to a greater or lesser extent.

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8) See W. D. Ross, Aristotle's Prior and Posterior Analytics, Oxford 1949, p. 14.

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4. A Developing Ideal

I have been contrasting the Aristotelian and the modern ideal of science, and I wish now to say that the contrast does not define a choice but rather reveals a development.

It does not define a choice, for the Aristotelian ideal is now an anachronism. It is not entertained in natural science. It is not entertained in human science. It is not entertained in mathematics, where a minority (the intuitionist school) want, not necessity, but positive intelligibility, while the majority aim no higher than axioms that are not contradictory. In theology, finally, that ideal was never always more than an embarrassment. Were it realized, the result would be a rationalism or a semi-rationalism.

Still, it was an embarrassment that could not be avoided. Coming to terms with Greek and Arabic culture was the medieval problem of aggiornamento. If theology was to conceive itself as an academic discipline, it has had to do so in reference to some normative ideal, and the only one available was that provided by Aristotle. So it did so took over Aristotle and drew distinctions. Aquinas took advantage of the distinction between subalternativng and subalternated sciences, say, between arithmetic and harmonics, or between geometry and mechanics, to confine subalternating knowledge of God to the divine mind and to the minds of the blessed in heaven, and to allow us on earth no more than subalternated theological knowledge.[9] Again, as we have already seen,[10] Aquinas combined his Christian belief in the contingence of creatures with Aristotelian knowledge of necessity by confining scientific knowledge to the universal and abstract and holding that the abstract as abstract is immobile. Later Scholastics enumerated different kinds of necessity; besides absolute necessity in metaphysics, there is physical necessity, namely, the immutability of natural laws unless God wills to change them, and moral necessity, namely the necessity of events consequent to free choices when the choices are morally obligatory or commonly occur.

to confine subalternativng knowledge of God to the divine mind and the minds of the blessed, and to allow us on earth no more than subalternated knowledge of God theological knowledge.[9] As we have already seen,[10] Aquinas tried to reconcile his Christian belief in the contingence of creation with the Aristotelian doctrine of science as knowledge of the necessary, by appealing to the immobility of the abstract as abstract.[11] And Scholastics generally took advantage of the notion of hypothetical necessity[12][1] to go on to distinguish metaphysical, physical, and moral necessity.

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9) Aristotle, Post. Anal., I, 9, 76a 9 & 22 ff. Aquinas, Sum. Theol., I, q. 1, a. 2 c.

10) See above, p. 7, note 4.

11) A hypothetical necessity is any fact plus the principle of contradiction. If Socrates is seated, then as long as he is seated, it is necessary for him to be seated. If there are laws of nature, then as long as there are these laws of nature, there necessarily are these laws of nature.