spectra which were explained by Bohr's atomic theory and from the 'facts' about the planetary model he elaborated. Of course the conclusions reached are logically different in the sense that while those derived from the facts are themselves facts and need no 'processing', those derived from the model must be transformed by rules such as that connecting energy differences between orbits (a concept of the model) and the wave-length of the emitted light (a fact). Bearing this difference in mind we can say that the possibilities of deductive elaboration are strengthened by the existence of the explanatory part of the theory by which it differs from description. The conclusions from both description and model are, when suitably treated, useful predictions.

The informal modes of elaboration, deployment and development, described above are possible only in a theory, for they depend upon the use of models and analogies. However, they too issue in predictions though they are not in general quantitative. The move 'If light is a wave motion then there should be optical interference phenomena' is a prediction made by a deployment of the wave model in the style of (i) above. The predictions made on the basis of Fajan's theory were developments, for to the atomic model is added the notion of deformation, disturbance and reformation of the electron orbit. The hazardousness of prediction based upon informal elaboration, illustrated by the failure of the attempts experimentally to investigate the 'luminiferous ether', is just that discussed above in considering the deployment of a model, for the extent of an analogy can be discovered only by experiment. Experiments are rarely conducted, so far as I know, to determine the boundaries of an analogy, but rather in working with the analogy certain lines of investigation prosper and others peter out. The attempt to treat heat as a fluid had some initial success, otherwise it would never have been adopted as a model, but the accumulation of negative evidence, if it can be called such, from the many false starts led to its being dropped. To say 'Heat is not a fluid' is in this case to say not only that there is no calorific fluid, but to say that the analogy between calorific and hydraulic phenomena is too restricted to be of great value. However, sometimes the analogy is retained in restricted form without there being any suggestion that it provides more than a model for certain phenomena. It is still useful for example to draw an analogy between electrical and hydraulic phenomena, for the

analogy goes a good deal further than it does for heat, and provides some useful models when for example electrical circuits and hydraulic networks are compared. This is an intermediate case for as I hope to show below some models are thought to be more than helpful parallels to overt phenomena.

Mach thought of science as primarily a condensation and codification of our scattered and unsystematic knowledge of facts. We have seen in the preceding chapters, how this conception though a valuable contribution to the understanding of scientific processes is too narrow, for there is a need to understand as well as a need to describe, however neatly. Of course there is a connection between condensed, codified knowledge and understanding, for only in some condensed form can we grasp the tremendous complexity of the world. Yet I believe the basic aim is understanding, and condensed descriptions are of value in so far as they subserve this aim. Condensation will be of no use unless there is a way of regenerating the information expressed in the abridgement. An ordinary generalization is a good paradigm for the machinery of abridgement and regeneration. The expressions 'all', 'every', etc. discussed in Chapter 1, can be used to say something of a range of things that is true of each thing individually. From 'All dogs are faithful' as much particular information can be regenerated as is required provided that individual members of the range 'all dogs' can be identified. The use of 'all', as well as linguistically representing the range, serves to convey the logical point that whatever member is selected from the range the predicate is true of it. The logical steps are clear:

(i) A codification procedure is followed (called in the jargon, an *induction*).

(ii) A recognition procedure is followed, by which a case of generalization is determined (based upon a *definition*).

(iii) A regeneration procedure must be employed to once more particularize the information condensed in the generalization (called an *instantiation*).*

It is important to see that the essentials of theory, schematism, model or mathematical formalism, can also be used for the abridgement, codification, and regeneration of particularized knowledge.

The abridgement and condensation of knowledge is partly a

* Since most generalizations simplify the data on which they are based regeneration will rarely be exact.