

# THE DEVELOPMENT OF SPECIALTIES IN INDUSTRIALISED SCIENCE

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Modern developments in the sociology of scientific knowledge, reflected by the collections of papers presented at recent conferences,<sup>1, 2</sup> can be viewed as a reaction to the Mertonian tradition of research.<sup>3</sup> Whereas the latter concentrates on the development and operation of social institutions within science, the former seeks to unite this within an analysis of the cognitive structures produced by them. Thus cognitive developments within science are no longer viewed as being generated by an inevitable process of cumulative discovery guided by the application of 'the scientific method', but are seen as linked to social processes of conflict and consensus amongst working scientists. Conversely, the internal organisation of science and the behaviour of scientists are no longer to be explained simply in terms of the operation of social factors. Cognitive structures, be they 'paradigms'<sup>4</sup> or 'research programmes'<sup>5</sup> must be viewed as sources of authority<sup>6</sup> which influence both the evaluation and control of what is to be accepted as scientific knowledge and the internal organisation of science in terms of the growth and decay of areas of research.

It is apparent that most of the research in the early stages of what might be termed the 'neo-Kuhnian' sociology of science has sought to explain processes of scientific change in terms of interrelated social and cognitive processes internal to the scientific enterprise.

By contrast, work in related areas of the 'science and society' field has frequently emphasised the inadmissibility of considering science as an autonomous sub-culture within society. The Marxist tradition in the history of science, exhibited in its most radical form in Hessen's work on Newton's *Principia*,<sup>7</sup> has consistently rejected the separation of scientific culture from the 'material basis' of society. From a historical viewpoint it has been argued that the low degree of articulation of 'scientific' cognitive structures in the early era of modern science renders meaningless attempts to differentiate between scientific and non-scientific culture.

In a modern context various authors have emphasised, from differing viewpoints, the interrelationship between science and other social systems. Ravetz has described the interpenetration of science and industry in the process of 'industrialisation' of scientific research.<sup>8</sup> In a slightly different vein, authors such as Sklair,<sup>9</sup> Cotgrove and Box,<sup>10</sup> Ellis<sup>11</sup> and Blume<sup>12</sup> have attacked the Mertonian research programme on the grounds that it deals only with academic scientists, who comprise a relatively small and atypically independent fragment of the total scientific community. In various ways these authors dismiss the notion of an autonomous 'ethos of science' which can be applied to scientists situated in industrial or governmental situations.<sup>13</sup> In addition, the considerable amount of work concerned with the impact of science and scientists on government policy and with the formulation of 'policy for science', testifies to widespread interest in the interrelationship of the scientific and political systems. Many authors have suggested that the scientific community is undergoing a process of politicisation, either within the 'advisory establishment' which transmits scientific opinion to government or within more radical groups of scientists dedicated to action in the arena of 'outsider politics'.<sup>14</sup> Likewise, the problems involved in the funding, planning or direction of scientific research by governments in order to generate industrially, medically, socially or militarily 'relevant' research has generated a burgeoning 'science policy' literature.<sup>15</sup>

We are therefore confronted with two areas of research which have remained essentially distinct. On the one hand, there exists a generalised literature concerned with various aspects of 'science and society', or the 'social, political and industrial relations of science' and, on the other hand, a specialised sociological literature, initially concerned with the behaviour and internal organisation of scientists, and latterly, in the 'neo-Kuhnian' school, with the interrelationships between such behaviour and organisation and internally generated cognitive structures.

This is clearly an artificial and unproductive separation. The concepts and modes of analysis used in the 'science and society' literature are themselves called into question by theoretical developments within neo-Kuhnian sociology of science, while the latter is concentrating on an increasingly idealised, non-existent science. Whitley's<sup>16</sup> challenge to sociologists to concern themselves with the problems of the relationship of scientific production to other systems of production in society,

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both material and cultural, has still to be answered. The work of Young<sup>17</sup> and Freeman<sup>18</sup> represents a useful start in the historical domain. Preliminary analyses by Mulkey<sup>19</sup> and Robbins and Johnston<sup>20</sup> give an indication of the potential fruitfulness of uniting these two approaches.

This paper represents an attempt to combine our interest in both these areas. Through an analysis of professionalisation and occupational control it suggests the beginnings of a general form of conceptual analysis by which we may better understand the way in which external factors have operated to influence the structure of the modern scientific community. Its focus is upon the process of differentiation within science and examines the way in which various influences affect this process and the consequences for the cognitive and normative structures of science.

### *The Process of Differentiation within Science*

The modern scientific community can be regarded only in the very loosest sense as a homogeneous or integrated entity; in the course of its development a variety of forces have acted to induce fragmentation. The interest of sociologists has been on differentiation via cognitive specialisation, that is, the process associated with the emergence of increasing numbers of distinct areas of research. The claim that 'it has become clear that an understanding of how new research areas come into being is central to the sociological study of scientific development'<sup>21</sup> has been reflected in the number of recent studies of the emergence of scientific specialties.<sup>22</sup>

The parallel between this 'division of labour' in science, a system of intellectual production, and Durkheim's<sup>23</sup> description of the division of labour in Western industrial societies' systems of material production has been noted.<sup>24</sup> However, the process of specialisation has been explained predominantly in terms of social processes unique to science. Hagstrom, following the Mertonian tradition, has argued in functional terms that segmentation alleviates organisational strains by restoring the social control; this control operates primarily through informal colleague relations and hence is only effective if groups remain relatively small. It is the competition for social rewards, recognition and resources in general which provides a motor for this specialisation process. 'Those who discover important problems upon which few others are engaged are less likely to be anticipated and

more likely to be rewarded with recognition.<sup>25</sup> Differentiation is thus seen as a purely social process, deriving from community competition. Mullins has drawn on these notions of goal conflict and the availability of trained personnel anxious to exploit potentially rewarding areas in exchange for recognition to explain the emergence of 'the phage group'.<sup>26</sup> Mulkey views this process of differentiation by cognitive specialisation as a general mode (what he calls a 'branching model') of scientific development which accounts for the fact that concepts and techniques are displaced from one 'research network' to the next.<sup>27</sup> The explanation of specialisation still, however, rests on the exchange and reward model:

'Research undertaken within a precise and firmly established cognitive framework cannot continue indefinitely. For as research proceeds, the problems raised become less and less significant and the professional recognition awarded those who provide correct solutions becomes less and less adequate.'<sup>28</sup>

The law of diminishing returns apparently induces scientists to seek new fields where rewards may be higher.

Whitley<sup>29</sup> has criticised these functional explanations of differentiation through competition for recognition, because they imply a non-problematic nature of scientific knowledge; that is, they are rooted in a pre-Kuhnian positivistic conception of scientific knowledge. He offers a theoretical model which incorporates characteristics of the cognitive framework to determine why certain actions and decisions appear 'natural' to scientists in the light of their social and cognitive situation.

Rather less attention has been directed to differentiation of the scientific community by means other than cognitive specialisation. Studies of scientists employed in industry<sup>30</sup> have suggested that occupational rôle is a significant cause of differentiation within the larger scientific community. The growth of 'big science' has led to the emergence of teamwork,<sup>31</sup> necessitating in some fields a functional division of labour into theoretical and experimental scientists.<sup>32</sup> However we wish to suggest that external forces are responsible not only for this form of social division of labour but have had a direct influence on the differentiation through cognitive specialisation.

It seems obvious that the emergence of specialties such as chemical engineering, agricultural chemistry, textile science and colour chemistry must be explained, at least partly, in terms of the theoretical and manpower requirements of the chemical, agricultural, textile and dye-

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stuffs industries, respectively. Any description of such differentiation through cognitive specialisation solely in terms of the emergence and institutionalisation of academic peer groups is necessarily incomplete. The selection of these examples to illustrate the argument does not preclude the possibility of significant influences on the less immediately industrially-related sciences, such as physics and biology. Our general argument is that external influences play a rôle in all cognitive specialisation, but their effect may be much more readily apparent in one field than another. Indeed, there is a sense in which the whole scientific knowledge system can be said to reflect certain social interests in control and manipulation of the environment. Marcuse, for example, argues that the cognitive structure of science in its entirety is a technological artefact that has developed in concert with the technological domination of man by man within capitalism.<sup>33</sup>

In order to examine the rôle of external factors on differentiation within science we wish to introduce the notion of science as a profession and in particular, professionalism as a form of occupational control. Ben-David has argued that the growth of modern science can be traced to the developing professionalism associated with general social acceptance of the rôle of the scientist.<sup>34</sup> Storer<sup>35</sup> has also regarded science as a profession in developing his model of the social system of science. By adopting this perspective we can draw useful analogies from an examination of differentiation within occupational professions in general.<sup>36</sup>

### *Professionalism and Occupational Control*

Johnson<sup>37</sup> has characterised the sociological analysis of professions into two broad types, namely 'trait' and 'functionalist' models. The former is based on the identification of the core elements of professionalism. However, as identification of these attributes has in general been carried out in a completely atheoretical manner by drawing on the characteristics of what are presently accepted as professions, the inadequacies of such a model for explaining either the emergence of a 'profession' or the particular form they take, are obvious. A second, more refined version of 'trait' theory regards professionalisation as a process whereby 'an occupation passes through predictable stages of organisational change, the end-state of which is professionalism'.<sup>38</sup> However the patterns used to support this claim can be shown to be historically specific and culture bound; there is

no reason to assume that there exists a uniform or linear process of professionalisation of universal applicability.

The second 'functionalist' approach regards the professions as 'service or community-oriented occupations applying a systematic body of knowledge to problems which are highly relevant to central values of the society'.<sup>39</sup> The usual critique of functionalist theories applies, however, in that they do not allow for the possibility of alternatives, in this case to the form of institutionalised control they refer to as professionalism.

Johnson sets out to develop a framework which will account for the variety of institutionalised forms of occupational control by focusing attention on the practitioner-client relationship. This leads him to look to changes in the distribution of power in society as a major factor transforming the nature of the clientele and, therefore, the institutions of control. 'In order to determine the variations which are possible in forms of institutionalised control of occupational activities . . . it is necessary to take account of the wider resources of power which are available to an occupational group.'<sup>40</sup> Professionalism arises only where the tensions inherent in the producer-consumer relationship are controlled by means of an institutional framework based upon occupational authority. A trichotomy of types of occupational control is constructed, consisting of (i) *collegiate* control, in which the producer defines the needs of the consumer and the manner in which these needs are catered for; (ii) *patronage* control, in which the consumer defines his own needs and the manner in which they are to be met; (iii) *mediative* control, in which a third party mediates in the relationship between producer and consumer, defining both the needs and the manner in which the needs are met.<sup>41</sup>

We will now apply Johnson's framework to science with the aim of establishing the form of occupational control operating within the scientific community and to examine the consequences for differentiation.

### *Occupational Control and Differentiation within Science*

Close examination of the scientific enterprise reveals that scientists have never possessed sufficient power and consequent autonomy to define and organise their professional activities in the way that medical and legal practitioners have been able to do. The scientist has been employed, not primarily as a generator of scientific knowledge but for

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other related purposes: as an educator, as a provider of weapons of war for state patrons, or as a provider of money-making innovations for corporate patrons. This lack of autonomy may be explained primarily in terms of the importance of systems of patronage in the development of science. Professionalism, in the classic Nineteenth-century sense, can only emerge when there exists an effective demand for occupational skills from a large and heterogeneous consumer group. In this situation, consumers are unorganised, dependent and exploitable and the collegiate authority of the profession becomes the most important factor in professional-client relationships.

Only in situations where scientists have acted as educators have such conditions been consistently approached. The pupil, by definition, is not in a position to exert a great deal of control over what he is taught or the manner of its teaching. It is interesting to note that the university teacher emerged with claims to professional status in the medieval university long before the scientist.<sup>42</sup> Even in this occupational segment, the professional autonomy and collegiate authority of scientists have been increasingly limited by mediative control, that is, by the intervention of the state between educator and pupil in order to define the needs of the latter and the ways in which they should be met. In effect, the state, via its mediation, 'attempts to remove from the producer or consumer the authority to determine the content and subjects of practice'.<sup>43</sup> The extent of such mediation has varied according to the sector of education involved. In secondary education it has been considerable, resulting in the removal of aspects of occupational control from the professional community, with the resulting definition of a new occupational sub-grouping amongst scientists. Only in higher education where mediation has been limited by the traditional autonomy of the university and the greater importance of scientists' activities as generators of certified knowledge, has a relatively high degree of professional autonomy been maintained.<sup>44</sup> Elsewhere scientists have traditionally worked under rather limiting conditions of patronage. In its formative stages, that is the Sixteenth and Seventeenth centuries, most scientists were supported by powerful aristocratic patrons in the expectation that they would produce innovations capable of giving their patrons advantages in the spheres of culture, war or commerce.<sup>45</sup>

The conditions for professionalism, in the sense of collegiate authority, developed in Britain in the second half of the Nineteenth century

in association with the rise to power of an urban middle class which provided an expanding market for various services based largely on individual needs, whether private or entrepreneurial. At the very time that the traditional 'professions' of medicine, law and architecture were establishing themselves, the scientists, particularly in the well established fields of physics and mathematics, and to some extent chemistry, managed to establish a degree of collegiate control. In particular, within the German universities, a new model of scientific education and practice emerged which transformed science into a status approaching that of a professional career and into a bureaucratic, organised activity.<sup>46</sup> It is interesting to note that it is in this period that the ethos of science as an independent pursuit of truth became generally accepted.

Throughout the twentieth century there has been a steady decline in the collegiate control of the scientific community. The increase in state patronage<sup>47</sup> was at first welcomed by scientists as it brought with it a vast increase in the financial support for research. It is only in recent times, with the decrease in funds, that there has been a realisation by some scientists that collegiate control has been eroded.<sup>48</sup> Simultaneously, industrial patronage has been of increasing importance. The utilisation of considerable numbers of qualified chemists by the rising German dyestuffs industry in the late Nineteenth century, and its influence over research carried on in the universities, provided a precedent that was widely emulated.<sup>49</sup> While precise data on the present situation are difficult to obtain,<sup>50</sup> industry is by far the largest single employer of scientists and performs over sixty per cent. of the national research and development, in terms of cost, in the U.K.

The consequences of this type of patronage in terms of the differentiation of the scientific community have been spelt out by Johnson :

'Patronage is associated with a fragmented, hierarchical, locally oriented occupational group. The "housed" practitioner defers and refers to his patrons and identifies with the court or corporation, not primarily with the professional community. In short, the evaluation of rôle performance is to a large extent in the hands of the patron.'<sup>51</sup>

With regard to the social norms of professional groups :

'Fragmentation arises in response to local needs of patrons . . . local reputation becomes an important basis of prestige and may depend more on conformity with local customs and beliefs concerning non-professional matters than conforming with professionally defined norms . . . occupationally defined norms have less significance than corporately defined



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expectations . . . Finally, the homogeneous community which is characteristic of professionalism is displaced by hierarchical forms of occupational practice and organisation.<sup>52</sup>

In the particular case of science, it was precisely this type of local variation of social normative structure that was discovered by the studies of Ellis,<sup>53</sup> and Cotgrove and Box.<sup>54</sup> What then is the relationship of social localism to cognitive localism? Johnson suggests a close relationship:

'Patronage systems are characterised by practising contexts in which the practitioner must *know* and *do* what is expected of him . . . The pursuit of basic knowledge is stressed less than the pursuit of knowledge specifically related to the needs of the patron. The body of theory applied by practitioners may also be affected by the demands of patronage. A major criterion will be its applicability to patron needs . . . knowledge tends to be particularistic in content and local in orientation.'<sup>55</sup>

It is clear that this process of fragmentation via occupational patronage has been at work throughout the growth of the 'scientific community'. It is worth noting that patronage has a second-order effect in inducing increased differentiation within the academic sector of the community. When patrons are sufficiently powerful, for example the state or large corporations, they may initiate and support the emergence of new specialties in academic science. These specialties arise specifically to create knowledge and manpower to fulfil needs defined by such patrons. Thus, university departments based on industrial technologies arise which have strong links with parent industries and strong normative or cognitive orientation towards them. There will, therefore, be considerable differences of outlook between academic scientists attached to such departments and scientists attached to departments based on scientific disciplines of a less vocationally-oriented type which established their area of interest in an era of collegiate control—a point we will return to in the next section.

A further form of occupational control, that of state mediation, must also be considered. The results of such mediation have already been mentioned in terms of professional fragmentation in scientific education. State mediation may be distinguished from state patronage in that the state intervenes between professional and client to ensure the flow of services deemed to be 'in the public good'. Under state mediation, occupations are increasingly incorporated within the organisational framework of government agencies. As a result of this development of varied specialist and hierarchical organisational forms, divergent interests and orientations are created within an occupational

community. The proliferation of organisational contexts is an important feature of the form of control which produces differentiation in the organisation and practice of occupations. As for patronage, 'variations in the structural and organisational location of practitioners will not only lead to differences in attitudes regarding the occupational community, but also to differences in the types of knowledge and ideologies espoused'.<sup>56</sup>

The growth of state mediation is reflected in the increasing magnitude of 'in-house' research, such that in the U.K. it now constitutes 24 per cent. in terms of national R. & D. expenditure.<sup>57</sup> Initially this was concentrated in defence. Since 1945, however, this has grown to include civil nuclear power programmes and more recently support of a wide range of activities, including environmental protection and technological development. State sponsorship of this form of scientific work in universities provides a further source of occupational pluralism within science. Scientists within government service agencies subscribe to ideologies, in the sense of systems of integrated normative and cognitive belief, that differ significantly from those of their academic and industrial counterparts. Such ideologies will tend on the one hand, to stress public service and, on the other, to be influenced by the bureaucratic and hierarchical organisational forms appropriate to the civil service.

State mediation may occur in a wide variety of areas, with consequent growth of large numbers of government agencies, embodying a wide range of roles and a variety of organisational structures. The tangle of scientific agencies associated with the state and federal government in the U.S.A. are examples of this. Professional fragmentation will, therefore, be further augmented by the emergence of divergent missions and orientations within the occupational subset of science created by state mediation. The clash between scientists of the Atomic Energy Commission and the Environmental Protection Agency in America over the adequacy of maximum permissible levels of radiation exposure is an example of a conflict generated by the divergent missions of two scientific groups within the mediative sector of science.<sup>58</sup>

### *Implications for the Scientific Enterprise*

The foregoing discussion seeks only to outline a potentially fruitful approach to the conceptualisation of the rôle of different forms of

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occupational control in differentiation of the contemporary scientific community. While it is in need of elaboration, a number of significant implications are already apparent.

Firstly, for the purposes of analysis, we can distinguish two extreme forms of the process of differentiation in science. At one extreme is 'specialisation', a division of labour determined by the operation of sources of power and authority internal to the scientific community through the development of collegiate control and interwoven cognitive structures. The external environment may exert a peripheral effect, for example the level of research funding may speed or retard development, but the differentiation is primarily a consequence of social and cognitive factors internal to science. Specialisation is thus characteristic of the most autonomous segment of the scientific enterprise, that is, academic, 'pure' science, and it is this occupational sub-set that has been most studied by sociologists. At the other extreme is 'fragmentation', a division of scientific labour determined by factors external to science, in the form of the needs of patrons.<sup>59</sup>

What then are the cognitive and social implications of these two ideal differentiation processes? The Durkheimian notion of solidarity<sup>60</sup> may be useful in this examination for if, as argued in this paper, patron and societal needs exert, in varying degrees, an influence on the division of labour in science, then this will affect the nature of the solidarity both within and between the segments of the scientific community created by that division.

Analysis of the division of labour in science has been made at a variety of levels. At the most general level, Downey<sup>61</sup> has rejected what he describes as 'the organic trend in the sociology of science' rooted in the Mertonian conception of science, and argued that the scientific community operates on the basis of mechanical solidarity. Law has criticised the simple Kuhnian view of science as a collection of paradigm-bounded specialties, implying an internal mechanical solidarity, and argued that specialties may have either a mechanical basis of solidarity where the 'development and maintenance of relationships . . . depend on shared standards and exemplars, and hence on a relatively high degree of consensus about theory and method' or an organic basis, when 'scientists come into relationship with one another because one performs services which the other cannot easily carry out for himself'.<sup>62</sup> At the laboratory level, Gaston has applied a straightforward sociological functionalism to the division of labour in

a physics laboratory.<sup>63</sup> In contrast Bitz *et al.*, describing the organisation of work in a clinical research unit as resembling 'craftsmen of quite different training and background working in a common location on a class of objects' have stressed that the traditional notions of organic and mechanical solidarity are inadequate to describe this situation.<sup>64</sup>

Failure to specify the social unit of analysis, whether imputed or assumed, has led to considerable confusion in attempts to discuss solidarity in science. However, bearing this in mind it should be possible to use the concept of solidarity to examine the impact of different processes of differentiation. Combining this with the analysis of the previous section, we are able to compare the consequences of the operation of different forms of occupational control on the type of knowledge produced, the structure of science as a whole, and the structure of the individual specialties (see Figure 1).

FIGURE 1  
*Form of Occupational Control*<sup>65</sup>

	Collegiate Control	Patron Control
Type of Knowledge	Universalistic. Theoretically oriented. 'Imperialistic' and translatable concepts and techniques.	Particularistic. Atheoretical. Concepts and techniques only locally intelligible.
Structure of Science	Inter-related specialties. Differentiation with integration. Organic solidarity*	Isolated fragments. Differentiation without integration. Negative solidarity.
Structure of Specialties	Oriented to shared cognitive structures, norms and standards. Mechanical/organic solidarity.	Problem-oriented subject matter fragments. Relations based on external power.

\* This term is used in the 'later' Durkheimian sense not simply of functional interdependence but of dependence within a shared meaning system.

(i) *Form of Knowledge*

We have already noted that knowledge produced under conditions of collegiate control is, in general, theoretically oriented and universalistic, at least within the context of the accepted world view of the scientific community. In contrast both patronage and mediation lead,

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through direction of problem recognition and choice, and selection of conceptual and technical resources, to particularistic and empiricist knowledge which possesses only localised intelligibility.

The process of specialisation is closely bound up with the transfer of concepts and techniques from one scientific context to another and is, as argued by Mulkay,<sup>66</sup> a fundamental source of innovation and growth in science. Indeed, this process of growth has been characterised in a number of recent papers as a consequence of competition between specialties in which the goal is one of extending their scope, or explanatory hegemony, over increasing ranges of phenomena.<sup>67</sup> In other words, 'cognitive imperialism' is the common policy and the degree of 'colonisation' a measure of success. These processes of competition and transfer also provide a mechanism for the cognitive interaction between the different segments of the scientific community which account for the fact that though problem selection and resolution takes place within distinct specialties concerned with disparate subject matter, the overall body of knowledge is, by and large, coherent and self-consistent.

However, differentiation in the form of fragmentation would inhibit such transfer both by making the migration of trained personnel more difficult and by creating cognitive structures of a 'closed' type which are relatively impermeable to external cognitive elements. Further, in cases where cognitive transfer has taken place the subsequent deployment and development of the transferred concept, model or technique will tend to take place in a strictly local context and it will not contribute to enriching, or 'fertilisation' of, the parent concept. Thus, differentiation which results from patronage or mediation will tend to reduce social cohesion within the scientific community and, in concert, to reduce cognitive intelligibility between different areas of 'science'. Differentiation of this type could lead to the destruction of both the unified professional identity of 'the scientist' and the related concept of science as a unified body of knowledge, a point we will take up in the next section.

### *(ii) Implications for the Structure of Science*

All differentiation poses a potential threat to the stability of the scientific community. Thus, Johnson argues that the homogeneity of outlook and interests in a profession are threatened when 'the norm of general practice has given way to a proliferation of highly specialised

sub-groupings'.<sup>68</sup> Under these conditions, the community identity of the profession is threatened by divergent orientations and missions. However under conditions of collegiate control, the tendency to break-up resulting from cognitive specialisation can be successfully contained because of the existence of a mechanical basis for solidarity based on a shared meaning system. For example, academic scientists from 'pure' specialties share many beliefs, values and interests, and this communality allows them to act in some degree of unison within broadly based professional institutions such as the British Association or the Royal Society. This unity will be most marked in moments of crisis, the response by academics to the Rothschild proposals being a case in point.<sup>69</sup>

The fragmentation resulting from patronage may produce a social structure rather less amenable to the maintenance of shared values across science as a whole. At first sight this form of division of labour may appear to have a basis of organic solidarity. However Bitz *et al.*<sup>70</sup> have argued that the concept entails two elements; firstly a form of differentiation and secondly, an element of integration that binds the differentiated parts to a connected whole. The process of fragmentation via patronage does not exhibit, in its idealised forms, this element of integration and cannot, therefore, be described as a source of organic solidarity in science. Rather it produces, in Durkheim's terms, 'negative solidarity', that is, differentiation without integration.

Under these conditions, scientists are unlikely to continue to share a common set of values and meaning system. One consequence of this is a profound division within the scientific community that is rarely containable by forms of the all embracing professional organisation. The controversies over various public issues, such as the setting of safety and environmental standards, provide good illustrations of the conflict arising from this form of differentiation.<sup>71</sup> It is of interest to speculate on the extent to which the current public discontent with science both in its manifestation in technology and in the form of higher education is a consequence of the loss of social legitimation Hill has shown to result from the breakdown of mechanical solidarity.<sup>72</sup>

### (iii) *Implications for the Structure of Specialties*

In Figure 1 we have described the internal structure of specialties under collegiate control operating through the authority of accepted