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The Formation of the Identity as a Scientist

This article sets out to explore the social worlds in which students are involved as they learn to participate in contemporary scientific enterprise. My primary focus is on the way that this social experience turns scientific knowledge and the means of grasping and utilising it into a personal reality for the individual scientist, a reality which is otherwise removed from personal intelligibility by social barriers of expertise, both for those about to enter research training and for those who never have the opportunity.

The power which sustains continuing contribution to the scientific enterprise resides in the fact that scientific knowledge is a personal reality within which the scientist comes to identify his action as scientist with both what he wants to do, and with the socially reinforced support of who he is. I am thus concerned with negotiation between the subjective meanings of action for individuals, and the objective meanings (or those which are shared and perceived as external to individual intention) within scientific enterprise. What becomes 'scientific knowledge' is ultimately the product of individual action and

constructions of meaning, so to understand the social premises of, and parameters to this knowledge, we must start with an analysis of the way in which this negotiation defines and sustains a particular definition of reality, and, therefore, the way in which it also closes off alternative formulations of what reality is seen to be.

The personal identity of the scientist develops in interaction with other scientists; it is they that form the corpus of other 'professionals' that legitimate the validity of one's own research products, therefore of one's own action – and through this, of oneself. At the same time, it is through this interaction that the meaning of science as a body of legitimated knowledge is formed.

As a knowledge system, science consists of a collection of symbolic constructions that refer to 'reality' or inferred structures and laws within it; it is supported by legitimated techniques for testing whether these symbolic constructions work. What enters scientific dialogue is a product of what scientists experience within the laboratory – even abstract conceptualisations have a reference point in an experienceable reality; but the

form of what is taken as valid experience is narrowly circumscribed by what the scientist has learnt through his socialisation into science; and what ends up in the literature is mediated by mores that govern what can be presented.

What is legitimated by other scientists as knowledge thus depends on what ground-rules and assumptions they share about how reality should be defined and tested: these are the 'objective' meanings of science – consensually shared but with a life of their own, independent of the individual contributor's own subjectivity. My purpose is to try and grasp, through an examination of socialisation into science, the way in which this objective level of meaning constrains action as individual scientist, and in turn is sustained by this action. This hopefully will help to make a little more transparent the connections between the reified appearance of 'scientific' knowledge and its base in social action, cultural meaning and ideology.

The analysis thus attempts to demonstrate the social dynamic that sustains in our culture a belief in what Habermas (1972: 4) calls 'scientism', i.e. 'the convictions that we can no longer understand science as one form of possible knowledge but rather must identify knowledge with science'. Scientific knowledge does assume a reified certainty in our contemporary world, particularly to acting scientists. This reification is fundamentally a product of the closing off of realms of experience and self-reflection in the education of people who become scientists: it is they who sustain in their own actions the meaning and products of contemporary scientific enterprise.

My approach attempts to be 'interpretive', a perspective introduced into sociology of science by Law (1974) and Law and French (1974). It moves from an individual to an institutional level of analysis by examining the interactions between the two. Table 1 presents in schematic form the stages of primary socialisation in childhood and of secondary socialisation into science in which the following discussion is based.

The Social Derivation of Meaning – a General View of Primary Socialisation

Meaning and social action

My starting point is a general view of socialisation as the internalisation of meaning through action. Basic to the present perspective is a recognition derived from Mannheim (1952) that within any social action a variety of levels of meaning may be expressed, as the action is viewed, for example, from the standpoint of participant, immediate observer or retrospective observer. Purposive action, perception of potential reaction, and reaction itself are set within the interplay of all levels of meaning residing in the phenomena. Mannheim highlights interplay between three levels of meaning in action: 1) expressive meaning, which directly involves the intention of the social actor; 2) objective meaning, which can be grasped without any knowledge of the intentions of individuals taking part in the social process, because objective meaning lies in 'structural laws of the object itself'; 3) evidential or documentary meaning, in which, either as actor or investigator, the overall meaning of a unique social action is grasped by its relationship to other elements of one's experience, allowing its intelligibility as 'evidence' of a wider generalisation or construction of the world. Evidential meaning thus requires a synthesis between one's own attachment of personal or expressive meaning to action, and the objective meaning of that action perceived to be shared by others.

A symbolic interaction view of socialisation

Before going on to demonstrate the social derivation of the specialised meanings of science for scientist actors, I will attempt to trace from a symbolic interaction theory perspective, how the individual learns to construct the meaning of his socially mediated world, and specifically the objective meanings of his experience within it. Each of the concepts developed here will be used to analyse the process of socialisation science

Table 1. Key factors in primary and secondary socialisation into science.

PRIMARY SOCIALISATION OF THE CHILD INTO THE LAY CULTURE		→	SECONDARY SOCIALISATION INTO THE PROFESSION OF SCIENCE	
CHARACTER OF SOCIALISATION	The establishment of a largely passive synthesis about the object world			A re-opening of former passive synthesis about the object world
STAGE IN DEVELOPMENT	FUNCTION FOR MEANING		STAGE IN DEVELOPMENT	FUNCTION FOR MEANING
IMITATIVE	Unexamined entry of cultural values about the object world into what subsequently remains a passive synthesis		IMITATIVE - undergraduate training	<u>Undergraduate training as an imitative stage:</u> Learning through imitation of the symbolic content of science about the object world and appropriate method for examining this world. Anticipatory socialisation towards the profession of science.
PLAY OR DISCRETE ROLE-PLAYING	Evidential construction of cultural meaning, drawn from immediate experience of the appearances of discrete others.		PLAY OR DISCRETE ROLE-PLAYING - interaction with the supervisor as local role model	<u>Local role-model of supervisor:</u> Learning intersubjectively the role-model of scientist: the supervisor stands <u>for</u> the profession. Contact with other immediate present role-models is very limited.
GAME-PLAYING OR COMPLEX ROLE-PLAYING	Evidential construction which abstracts from the separate appearances of a <u>variety</u> of others - entry of ideal typical construction of anonymous others.		GAME-PLAYING OR COMPLEX ROLE-PLAYING - balancing 'professional' expectation against the immediately available model of the supervisor	<u>Interaction with the wider profession:</u> The basis for ideal-typical models of action-as-scientist. Learning expectations of the anonymous others who form the body of the 'profession: these expectations must be met in day-by-day behaviour, as anonymous representatives of the profession will examine the thesis at the end of training.
INTENTION AND ACTION	Direct experience of the object world through the pragmatic motive. During the child's development, action in the world is on-going; the pragmatic motive welds meanings derived from socialisation into action.		INTENTION AND ACTION	Direct experiences of physical reality within the constrained world of experience <u>as scientist.</u> Active synthesis by the student scientist is required in his experimental work. As manipulation of this constrained reality works, meanings of the profession are brought in to action within the object world of science.

studies experience as they move into the specialised sub-world of science.

Mead's theory: The learning of social meaning is fundamentally a product of the

development of an individual's conception of himself. An individual's self-conception is a product of social interaction. The child sees himself in the 'looking glass' which is held

up most intimately by his family, and at a somewhat greater distance by peer groups of other children and by wider groups in society. (Mead, 1934; Cooley, 1909; Laing, 1965) Interaction between the child and others acts, then, as the means by which he can come to an understanding of self. In Mead's view, interaction depends on the sharing of symbols. For example, verbal communication or the 'significant symbolism' of 'Open the window!' requires as Meltzer (1972) points out, that 'the pattern of action symbolised by these words must be in the mind of the speaker as well as the listener. Each must respond to the words in the same way. The child learns this symbolism through social mediation his experience, though this experience may be sensate experience of his physical world.

The child's experience of the physical world is mediated by the social interpretation of those around him. They add interpretations to the physical meaning. The experience of the physical world has a social interpretation component. Consequently we have Mead's hypothesis of the mind which views the mental emerging out of the organic life of man through communication. It is through this communication that self-concept emerges. Accordingly, an individual may act socially towards himself, just as towards others. To act towards himself requires that the individual sees himself as object and hence in a relationship to others as objects. The understanding of the relationship is achieved by taking the roles of others, and seeing himself as others would see him through the filters of social meaning they share. In internalising their definitions of objects and events, the child learns their definitions of his own conduct.

Mead observes the child's development to flow through three basic stages of rope-taking of 1) meaningless imitation, when the child copies specific behaviours with but a primitive understanding of their significance; 2) the play stage, when the child plays a discrete role modelled on a discrete 'other', and when the child comes to perceive himself as object, and starts to direct activity

toward himself; and 3) the game stage, when the child starts to form a unitary conception of self abstracted from the particular concrete roles of the others with whom he is interacting: here the child must respond to the intentions and expectations of several people at the same time. From association with others, in which consistency of self is expected and reinforced, the child builds up a 'generalised other' or reflection of self within the normative framework of an abstract conception of a group and its likely response.

To relate a symbolic interaction view of child development to evolution in the child's construction of meaning, it is possible to see interaction between levels of meaning, and the welding of expressive with objective meanings through increasingly abstract evidential meaning construction, occurring in the following way:

- 1) In the imitative stage consensual meanings of the culture are written into child's framework for viewing the world and himself within it into his expressive meaning. The child emulates the culturally determined 'objectivations' (Berger & Luckmann, 1971), the outward forms of which communicate the inter-subjective reality of other in relation to self, but without reflection on cultural alternatives.
- 2) In the play or discrete role playing stage the child acts out roles of single discrete others, requiring a synthesis based on his construction of the evidential meaning of the otherwise unique appearances of their individual actions. The transition from the simple copying of specific actions to forming a purposive synthesis in social action depends on his increasing abstraction from that which is immediately perceived, to relate this to comparable or contextual experience in memory, or even more deeply in experiential frameworks that lie beyond conscious reflection.

In association with this stage, the learning of language, which symbolically represents and communicates experience of

others, provides the mediation between the child's expressive intention and the 'objective' or consensual symbolic world in which he is growing up. The language which provides the material for a developing mind's symbolic rehearsal of action, focuses attention on what is culturally observed, defined and evaluated; it shifts out attention those elements of sensate experience which are not part of a culturally shared 'reality'. Thus cultural meanings become constituted within expressive meanings as external and real, for they provide the ultimate framework within which a concept of self, and one's own reality and meaning, can be constructed. For the child, the culturally assumed and prescribed meanings are personalised during this cognitive stage, and are directly observable in the significant others with whom the child comes into immediate contact and on whom the child must rely for continued physical and social survival.

- 3) In the game-playing stage of complex role-taking evidential meaning construction is more abstracted form that which is immediately perceived: instead of providing synthesis between the separate behavioural appearances of single others, it requires synthesis between the separate appearances of variety of others. Underlying, but not immediately intelligible in his perceptions of others, are the frameworks of meaning that they share. Ultimately within their culture these lie below the surface of any dialogue.

In addition, as Schutz (1972: 163–214) suggests, the less immediate and concrete is the other to whom one is responding, the more one must construct as an ideal type their projected response to oneself.

As the child learns through evidential synthesis what 'one' does in society, and responds to this construction of a 'generalised other', he is increasingly responding to an essence or normative structure underlying the separate behaviours of the particular others with whom he comes into contact.

The development of a concepts of self involves awareness of this selfhood within consensual definitions of reality and of meaningful action that relates one to this reality. The most powerful consensus circumscribes the child's whole conception of what is real, for consensual definitions of reality are built into his earliest framework of cognition on the basis of which he learns to experience the world, and even to reflect upon it and its meaning. Consequently, the cultural consensus he experiences becomes his own, a basic construct in his personal identity. Those elements of cultural consensus which are further back in the child's experience are likely to remain the least examined, precisely because they are so basic to the construction of self-identity.

Cognitive synthesis and abbreviation

This view of the interplay between subjective, objective and evidential meaning constructions reinforces the conception of cognitive synthesis by the ego presented by Husserl (1960). He distinguishes between 'passive' and 'active' syntheses with respect to the entrance of ego's intentionality into synthesis: in passive synthesis the object constitutes itself in consciousness, not consciously but anonymously; in active synthesis, the object is productively constituted, though on the basis of objects already given. Therefore, active synthesis involves the construction of evidential meaning, where intention is required to focus consciousness through the stages of abstraction required to do this. Passive synthesis on the other hand, assumes prior construction of evidential meaning, which is most deeply anchored in earlier direct sensual experience, the objective meaning of which is sedimented into subsequent experience of the world. Passive synthesis, though originally an active synthesis at a primitive level of abstraction, thus sets the basic frameworks and categories within which the individual perceives the world as an adult. The social roots of physical object perception consequently are buried under subsequent social experience both

at the micro-level for the individual, and at the macro-level for the culture as a whole.

The re-opening of passive synthesis: socialisation into science profession

The most interesting point of transition now emerges between my preliminary discussion of socialisation and the social construction of objective meaning: the socialisation of people into the 'profession' of science.¹ For what the process of research training does is to re-open the cognitive synthesis of objective reality for the student, to create, through action on the world of physical objects, an active synthesis about objects which formerly were perceived anonymously rather than with reflexive intention. In the student's research experience, action as scientist requires active synthesis with respect to phenomena which are drawn from his passive experiential world. Thus, the active synthesis involved in action as scientist is built on an already established passive synthesis that has formed the base of experiencing the social and physical world. It assumes the thinghood of the objective reality that is consensually shared.

This active synthesis reinforces rather than questions the culturally prescribed limits to the meaning of knowledge and of its objectivity. To show how this conservatism is built into action as scientist and thus into the scientific enterprise as a whole, I will now present an analysis of socialisation in to the science profession, and the way in which this is parallel to but fundamentally predicated on primary socialisation and acquisition of meaning.

Secondary Socialisation in to Science²

The relationship between primary and secondary socialisation

There are two obvious differences between the secondary socialisation of students onto science, and the general process of primary socialisation and derivation of social mean-

ing I have discussed above. The first is that students are already adults by the time they commence training to become scientists: research training embodies secondary socialisation or the 'internalisation of institutional or institutional-based sub-worlds', internalisation of a partial reality set within the 'base world' view that is the product of their earlier primary socialisation (Berger & Luckmann, 1971: 158). Therefore, they have already built into their self-concept the culturally prescribed meanings attached to social action, reality, and even the role of scientists within their society. The second is that whereas the child's behaviour is guided by the unformed question, 'how do I become a person in society', the research trainee is guided by the more precisely formulated question, 'how do I become a scientist', a specific role within society. Both questions involve a quest for identity, but the second is predicated on the first.

Channelling: Moving into science is not a sudden shift out of the world of common reality into separate institution-based sub-world. Rather, it grows out of a seed of commitment to intellectual life planted well back in the experience of growing up in a wider society. Immersion in the sub-world of science is product of a sequence of socialising agencies – the school, undergraduate science education, research education – which extracts the child from his 'home' in common knowledge, and with scant regard to his social development outside a specific intellectual domain channels him into a reality increasingly dominated by science definitions both of the world and oneself acting within it. The journey toward this sub-world appears to start at least well back in school and appears to be based on its attractiveness as a world in which one is measured solely by intellectual achievement, and where one is free to be an individualist in this intellectual sphere, untrammelled by the social regimentation of others. Of course, this attractiveness is based on a superficial ideal of the real world of science. But, as with a child's idealised understanding of reality, for the trainee scientist little but ideality is likely to

surface above the mystifications that help hold together the reality of scientific enterprise and safeguard it from impingement by the lay culture.

The institutionally prescribed path that the student moves along in his transfer from his base world of common reality into the sub-world of science, increasingly refines the limits of action and reality definition towards the highly specialised reality of science. Whilst students may well experience a sense of alienation in their educational experience – and a consequent questioning of why am I here? why should I learn this particular content? – most ‘hang on’ if they can keep passing. In this way they are promised getting the degree that appears to promise better life chances than if they fail. Outside side-bets and institutional commitments bind the student to remaining at the university. Those for whom the conflict is too great are likely to drop out. Those who continue into higher degrees are those who have accepted the commitment and who have already decided that ‘science should be my career’. For them, by virtue of their demonstrated success and therefore potential, the outward bounds of personal identity as scientist have been formed and remain as a passive synthesis. The legitimisation of these boundaries is assumed within a culture which accords to science an ultimate jurisdiction over the significance of common knowledge.

We can discern the way in which the partiality of the symbolic meaning of science becomes sedimented into this evolving identity by examining the way in which wider meanings of knowledge are closed off by the structural boundaries to experience contained in the institutionalisation students confront in their secondary socialisation into science. Although set in a largely finalised product of primary socialisation, the experience of the sub-world of science appears to follow a parallel sequence to that outlined for the individual’s earlier experience of society as a child. Construction of meaning follows a parallel path of increasing abstraction.

Undergraduate science education – the imitative stage

Imitative learning: Within undergraduate training the structure of courses and expectations of performance require students to become scientifically literate, to grasp the symbolic content of science and demonstrate they have learnt it. Students are generally examined, however, on their ability to reproduce this symbolic content as it is presented to them, particularly in the one way communication of lectures, and in the established symbolic content of texts, which, as Kuhn (1963) points out, are often the work of eminent scientists whose commitment to science ‘as it is’ is the more complete by virtue of their personal status commitments to the enterprise. Science thus presented is exterior to the student’s own active intervention in the world, and is logically prior to it. The language and conceptual frameworks of legitimate knowledge are given, and must be internalised as such for one to act as a scientist.

The student’s direct contact with action as scientist is through practical experimental work, but this usually involves the imitation of standardised procedures laid down in detail in practical work notes. As is the case for the child is his earliest learning of social rules, the base for the undergraduate’s perception of the meaning of action within the scientific sub-world is predicated on imitation of the outward form or objectivation of the symbolic content that lies within scientist action. The imitation has a developed social meaning (in contrast to the child), but this is likely to primarily derived from his relationship of these outward objectivations to prior learning of the wider social significance and location of scientific action, rather than on their intrinsic meaning within the science sub-world. Thus the assumption of meaning for the scientist actor is predicated on wider cultural assumptions about science which have been removed from the reality of the internal world of science by institutionalised barriers of specialised expertise and mystification

that separate the institution of science from its cultural context.

Local role models: In making these intrinsic meanings intelligible, the student has available to him a number of local role models of practising scientists who stand for and in front of the profession as a whole. The student's contact with these role models tend however to be distant, singularly task-oriented, and mediated by the knowledge that the person he is attempting to intersubjectively grasp as a scientist is also the one responsible for evaluating whether he has picked up the scientific role and concepts correctly. One can only make intelligible such a role model by learning the symbolic representation of scientific reality as presented, remaining at a distance, and projecting one's own frameworks of established meaning onto the other.

Anticipatory socialisation: The structure of assessment and reward ensures that those who perform well in reproducing the given exterior symbolism of science are likely to come into more direct and relaxed contact with these role models, and have a higher chance of becoming scientists themselves. Thus by effective imitation greater intelligibility is promised. By virtue of the autonomy institutionally accorded to scientists, it is through these local role models that the profession of science assumes an attractive future potential for oneself. In this sense, undergraduate training represents 'anticipatory socialisation' for what one later can become.

Consequently the structure of undergraduate training in science encourages evidential synthesis between an 'out-there' cultural meaning of what science is in society and in 'in-here' meaning derived from imitating what scientists have done. Copying without understanding of the intrinsic symbolic meanings ensures that if an intelligibility of one's own action-as-scientist follows, it is deeply set within the assumed meanings both cultural and professional, that are 'objectively' attributed to scientist action. The base of scientific knowledge thus remains opaque, subsumed into a largely passive synthesis that furnishes the foundation on which sub-

sequent experience of action-as-scientist is predicated.

Research training in science – the stage of active synthesis

In conducting research himself, the student moves within research training into an active synthesis between his own action-as-scientist and the objectifications of what action-as-scientist means within the sub-world of science. He becomes involved in the creation of knowledge rather than with the passive reproduction of what already has entered the content assumptions of scientific enterprise. Consequently, the research student is involved usually for the first time in social exchange with the profession of science that lies anonymously outside the laboratory walls of his own direct experience.

The shift from passive to active synthesis appears a natural and unquestioned one, a further stage along a continuum of experience. The student brings into this active synthesis the baggage of meanings already acquired through imitative modelling of the symbolic world of science, baggage which remains unopened, a passive synthesis deeply underscored by a wider cultural belief in the legitimacy of scientific enterprise and therefore of the institutionalised path one must follow to become part of it.

To demonstrate which realms of symbolic meaning are opened and which are closed or represented in a fiercely abbreviated and partial way during research training, I will examine the apparent consequences of the structural features surrounding three aspects of research education. These are: specialisation; role models available to students; and conditions of interaction with the wider professional science. Within these structures we can see how the professional meanings of science come to ground in the student's direct experience of conducting research.

Specialisation: Students are generally required to conduct Ph.D. research in a highly specialised cell on man's total wisdom, and not to relate their work to other disciplines or broader human wisdom. In addition, stu-

dents appear to enter their particular specialty without direct consideration of why the specialty is significant or even whether they will be employed in it once they graduate. Rather, they have been channelled into this position by past opportunities and performance.

On entering Ph.D. training the student usually has a very limited choice about what he researches. Most commonly students stay with the supervisor with whom they did an Honours Degree, a relationship originally established more on the grounds of departmental expediency than student choice; they are required to select a project from a limited portfolio of personal specialised interests offered by a narrow range of available supervisors within the department.

The structural position of academic supervisors gives them a vested interest in maintaining an unquestioned specialisation by students. Supervisors are usually themselves specialists and have been working within that specialty for the whole of their academic lifetime. For them to move outside their specialty threatens both their competence and their academic security. There is also available research money to be used to sustain their research output, so Ph.D. students who are available provide the necessary 'other pair of hands' that are needed to further one's career.³

Consequently, the structural conditions of science education prior to and within research training are likely to narrow the perceived meaning of students research down to what is open to him on the basis of his very limited experience within a virtually unquestioned and highly specialised segment of the total scientific enterprise. Whilst epistemological premises of his enterprise may be consensually assumed across other disciplines in science, their meaning for the researcher is centred in their highly particularised expression within his own immediate and limited experience. The student is channelled into a particular line of research, and even a questioning of why he should be conducting research on this rather than a range of other questions, is likely to remain unex-

amined. The existence of these boundary conditions to meaning within the student's action-as-scientist are thus to a large extent independent of his intentions. Given the way that specialisation rarely permits contact with philosophic, sociological or even economic questions of one's intention in research action, these boundary conditions to the meaning of research behaviour would be expected to remain part of a virtual passive synthesis.⁴

Role models available to students:

1) Interaction with supervisors: The most immediate role model that the research student has of what it means to be a scientist is his supervisor. Within their relationship the student has directly available to him an intersubjective experience of the meaning of science-in-action through the objectivations embodied in the supervisor's actions. That the supervisor becomes a 'significant other' for the student is institutionalised in the apprentice-ship relationship that Ph.D. training involves. Within a specified and narrowly constrained contest of meanings, the student depends on his supervisor for selection of the specific question to research and the general research approach to use in resolving it; for legitimation of the day-to-day manipulations of the symbolic world of scientific meaning by students; and even for selection of the examiners who represent the most appropriate professional audience to whom the student must respond and to whom he must present the finished product of his labour – his thesis. A child learns to do, how to act, and to whom he should respond.

Interaction between student and supervisor tend to reinforce the closure of this interaction from the experiential world in which this sub-world is set. According to Hill, Fensham and Howden (1974), interaction though frequent, tended to focus just on the research project: 70 percent of students stated that they rarely or never talked about anything else. At the same time, interaction, apart from communication about research, consisted of brief passing contacts. As such, the detail

of the student's action-as-scientist is the only thing 'we' can interact about. The objectivations of social meaning which student and supervisor shared were thus severely circumscribed.

2) Contact with alternate professional role models: The student had very little contact with other professional scientists who worked outside his university department. (16% rarely or ever attended professional meetings; 47% said they never talked with scientists outside their department.) Contact with other professional scientists within the department was infrequent and tended to occur in passing social relationships. The students reported finding an occasional source of ideas in these contacts, but considered other staff to be almost completely valueless in their actual provision of direction or evaluation of the student's own action-as-scientist. In general, students remained insulated from the staff of their departments, though they maintained continuing contact with each other.

3) Interaction with other students: Students talked to each other about their research, although on average they spent only half an hour a week doing so. The circle of other student colleagues tended to be quite small. Although a relatively high value was placed on interaction with other students as a source of ideas, such contact was seen as being little value for either direction or evaluation of the action-as-scientist in which the student was engaged. For the individual, other students were seen as at much same level of professional development as himself: such colleagues may give ideas, but have little authority in feedback or evaluation.

4) Significance of the student-supervisor relationship: In summary the research student tends to be isolated from external and internal contacts. The focus of interaction is with the supervisor, and here it is specifically about the student's research tasks. Whilst other students may provide something of a social refuge, they do not constitute significant professional others.

These patterns of interaction, the professional isolation arising out of them, and the value students placed on their supervisor

above all other role models, correlate closely with an influence one might expect from particular institutional features of Ph.D. education. These are: a) students must complete an uncertain but extensive task in a limited time period; there is great pressure to focus only on solving the assigned research question rather than doing anything else; b) the form of teaching involves specifically a supervisor-student apprenticeship, whilst contact with other professional scientist is not encouraged; c) the didactic character of science education, required to some extent by the form of presented 'exterior' knowledge, encourages social distance between staff and students.

As an evidence of the significant-other role model we found *inter alia* that even in the absence of much interaction about anything except the student's research. Most of students saw their supervisor as a 'great chap'. Identity presented primarily in connection with the objectivations of symbolic meaning within a narrowly circumscribed area of science tended to be received intersubjectively as a total identity.

Consequently, through evidential meaning construction the student can see in his supervisor the objectivations which as a member of the profession he presumably shares with others. The student is forced by the institutional constraints on research trainees to confront these objectivations quite directly, with immediate feedback on whether his action is in accord with 'accepted' scientific practice or not. The relationship between student and supervisor is exclusively concerned with the student's action-as-scientist, but because of the commitment the student has already made to becoming a scientist himself this highly constrained action is being played out on the centre stage of the student's developing conception of who he is and what is his place in the world. So the significance of this narrow band of total experience within a very specialised sub-world is generalised to the limits of one's total identity. This is reinforced by the intersubjective experience of the significant other's whole identity through

his action-as-scientist. The result of this institutional patterning of interaction is that the meaning of one's action-as-scientist is likely to be increasingly separated from the meaning of action-not-as-scientist, a reification of the 'in-here/out-there' world of science that Roszak (1971: 217–32) observes, where 'in-here' is order and rational thought, and 'out-there' is chaos and emotionality. The ground conditions are set of the symbolic meanings of science to shape the personal identity of the trainee. Meanwhile, questions of the validity of this role, or of the limitedness of a 'scientific' grasp on reality, remain unexamined in a relatively passive synthesis.

Conditions of interaction with the wider profession of science

1) Student relationship to 'professional' evaluation: Although the student must depend on his supervisor for immediate experience of the meaning of his own scientific activity, the supervisor is not the ultimate arbiter of the student's fate, so emulating the supervisor and meeting his expectations is not enough to be finally accredited as a professional. The structure of Ph.D. training requires that two representatives of the profession outside the 'local' institutions evaluate the student's research at the end of his commitment to it. Although these professional representatives may well be former colleagues of the supervisor, or at least personally known to him, they commonly remain faceless and even nameless to the student, who is not supposed to be involved in their selection. The examiners effectively represent social control by the 'profession' rather than by particular known, and therefore intelligible, individuals. By virtue of 'anonymity' of the student's relationship to his examiners, he must respond to an ideal-type he constructs concerning what is expected to him. He must balance his intersubjective experience of the supervisor against his projections of what the 'profession' of science means as well.

In the relationship of the student to the wider and 'anonymous' profession we see a parallel to the child's third stage of development: complex role and 'game' playing. The influence of the 'profession' so constructed has a fundamental effect on the shaping of the student's identity as a scientist, and thus on his action-as-scientist.

2) Continuing contact with the 'profession' of science: First, the student is in contact with 'the profession of science' through the reading of scientific publications. Through reading the literature, the student comes into contact with the consensually shared meanings of professional action as they are manifest in the action of other scientists, or at least in their presentation of it. The institutional fact of the refereeing of scientific publications means that what the student reads has already been subject to preliminary professional scrutiny, so questions of scientific validity to a large extent remain a priori to the student's evaluation of such professional communication. By keeping abreast of the current literature the student can assume that both the 'objective' and evidential meanings contained within scientist's reports will be scrutinised by other professionals, and he will be told if anything is amiss. Consideration of social or philosophic premises of this knowledge, of its social consequences, and even of its connection to other areas of scientific enquiry, are rarely (if ever) presented or evaluated. Thus in the literature the research student finds a 'givenness' of scientific knowledge and the specific area of man's total knowledge of which it is legitimate to be aware.

Research students need to use what they read in the literature however. In our study students rated the literature as being almost as valuable as their supervisor in providing a source of ideas. Also, although the supervisor was by far the most valued source of direction for what to do, the literature came second – before other students, staff, and particularly outside professionals. Consequently, the givenness of specialised scientific findings and explanations is brought into the student's own research action, and pro-

vides an orientation of what to do, and what questions to ask. But what is communicated to the student are highly formalised codifications or abbreviations of the action-as-scientist of the author: the student has highly specialised procedures made available to him, but no other contact with the author's world or subjective experiences in conducting the research. The anonymity embodied in this formalisation requires that the student constructs an ideal typical model of what professional action means and incorporates this within the expressive meaning of his own intention.

Students are also expected eventually to publish the products of their own research action. Apart from the motivation of supervisors noted earlier to get their research students to publish, the contemporary science Ph.D. student confronts a severely competitive job market on graduation, in which the most attractive employment opportunities (at universities) usually require a prior publication record. In publishing his own work, the student must 'translate' his own action into the codified and consensually agreed upon meanings of research activity, research products and explanation. Without an ideal-typical model of action-as-scientist the student cannot do this. The competitive pressure of publishing before others get there requires that the student follow specified procedure as efficiently as possible once the research idea is formulated. Consequently, to be able to participate in the institutional imperative of formalised interaction with the profession of science, the student is forced to internalise a model of what action-as-scientist means within his day-to-day experience. But, through contact with others via the literature, the student can only bring an ideal-typical construction of the profession's legitimated objective and evidential constructions of meaning into his own action. By acting as he believes other professionals do, the student's own expressive intention and subjective view of his sub-world reality are likely to be increasingly experienced as 'objective' expressions of reality, i.e. 'if I act as scientists do, then what I do, find out and explain

has objective meaning independent of my own subjectivity'.

3) Anonymity of evaluation: On top of this formalised interaction with the profession of science, the student is confronted by the inflexible reality of his own thesis being evaluated by representatives of 'the profession'. He cannot escape the need to bring his construction of professional meanings into his daily action. But members of the reference group from which those meanings are derived remain anonymous, whether they be predecessors or contemporaries. As Schutz (1972: 219) points out, 'the more anonymous my partner ... the more conceptualised must my dealings with him be. And the more I conceptualise my partner, the less I can regard him as a free agent'. So ideal-typical construction rigidifies the perceived freedom of other scientists to act outside the objective meanings assumed by the profession, and thus acts as a constraint on one's own action. However, although the ideal-type may be rigid and without freedom to change, a key component of its construction is the autonomy of oneself (and others) as scientists. Embodied freedom is, however, as rigid a construct as any other component of an ideal-type: this freedom is an illusion, for the limits to his role as a scientist are set by the professionalism he has internalised.

4) Balancing of the supervisor role model against the profession: The student's intersubjective experience of another 'professional' is primarily limited to that experience he has of his supervisor. This experience is constrained by the need to balance the profession's expectations against those attributed to the supervisor. Interaction with the supervisor usually is formal and task centred: it has purpose both for the supervisor and student in aligning the student's action with professional interests and requirements. So the student does not grasp the supervisor as 'a spontaneous and freely acting being' (as Schutz suggests), but is constrained to see him acting out the highly specialised meanings of 'professional' behaviour. The student may well grasp the supervisor's emotions, irrationality and social

attitudes, but these are all epiphenomena to the expressive meaning of being a scientist. Furthermore, it appears that scientists tend to hold others they work with at a personal distance, and project their own expressive meaning onto the action of the other. So even intersubjective experience of the supervisor is likely to be mediated by ideal-typical meanings attributed to the profession as a whole and this personal representation of it in particular.

The expressive meaning of the supervisor is not free, since it is bound into constraints of professionalism. But the supervisor is likely to be regarded as a free individual by the students. University employment is regarded as offering by far the greatest opportunity for self-fulfilment compared to any alternative job, for achievement in terms for which this Ph.D. training befits them and which they can pursue on their own terms and in their own time (Hill, Fensham & Howden, 1974). The student is not free and is fundamentally aware of this. The profession of science that the research student is reaching towards offers apparent autonomy for the institutionally accredited individual, but presupposes an effective socialisation into this sub-world. The individual is in fact acting according to the profession's 'objective' meaning of 'professional' action. Without this institutional imperative, the profession is likely to die and the social rewards of participation for its members will disappear.

The promise for the student of becoming a professional thus is clear: it allows escape from the present 'transient' phase of his experience in which autonomy is denied – even concerning what to do research on, or how to do it. Within his closest experience is a significant other who is free, as an accredited professional scientist, so the student can grasp intersubjectively the meaning of this freedom. However, what can be grasped is constrained by the ideal-typical constructions that form a context for viewing experience of the supervisor, and these are constructions of the 'objective' meanings of the profession.

By the time the student has become accredited, he is likely to have so internalised the meaning of scientist professionalism that freedom does mean acting as a professional, and acting within the specific section of the total scientific enterprise to which he now finds himself committed.

5) 'Direct' experience of physical reality: The ideal-typical constructions of meanings attributed to the profession and to the supervisor's action, as well as the balance between these indirect and direct experiences of professional others, all come to ground in the student using his own synthesis of professional meanings as a basis for his work action-as-scientist. In the direct experience of conducting research, the student brings a specified segment of the 'reality' of the world into his own hands. Attention to scientific 'rigour' really works, for within the constraints of experimental method, the student does manipulate reality and see it change. So the meanings he attributes to research and knowledge derived from it – though drawn from the profession – appear for him to exist in the phenomenon observed, for as long as the student perceives that he follows normative professional behaviour, reality responds as expected, or, at least the representations of this reality which have come to be accepted, change in the way that is expected. The meaning of the world as described by science thus becomes one's own meaning through action in relation to it.

6) Active vs. Passive synthesis: In doing research the student re-opens through direct experience an active synthesis of physical reality that otherwise is taken for granted in the earliest stages of the individual's passive synthesis of the nature of objecthood and reality. But the student's active synthesis is acted out in a severely focused field of attention: an underlying 'givenness' of reality that is a product of earlier socially mediated synthesis remains unchallenged; specialisation and an identification of one's 'self' in the specialised actions militates against social or philosophic questions threatening the boundaries of this reality principle. In this action-as-scientist the stu-

dent finds that the symbolic meanings consensually assumed within scientific circles enter into his own action, and research action guided by these meanings actually appears to work. Direct sensual contact with physical reality, or assumed indicators of property and change within this reality, reinforces the legitimacy of these meanings to oneself. As with the child's socialisation, it is with this direct contact with the physical world, and the mediation of this experience by (professional) others, that the trainee scientist learns to abstract and move into purposive (scientific) social behaviour, and to balance the meaning of this action against parallel ideal-type constructions of both the anonymous profession as a whole and the directly experienced supervisor in particular. Hence, through the entry of new specialised symbolic meanings, scientist intention actively intervenes in the finely reduced (and therefore, functionally manipulable) form of the objects.

Though this experience is fundamentally socially mediated by both wider cultural and professional socialisation of the individual, the student is faced by a powerful externality of the reality he manipulates. Consensual validation by other professionals of his constructions of objective and evidential meaning thus to be based on laws which are presented by physical reality and are not merely cognitive constructions that make this physical reality intelligible. The apparent directedness of entry of professional meanings into one's own action, together with institutionally proscribed questioning of the context of this action, ensures reification of professional definitions of reality above all other 'common knowledge'. One's identity as the scientific actor able to actively intervene in reality is also likely to be reified above alternative social roles.

With an increasing association of the symbolic meanings of science with personal action and identity, the research trainee is increasingly acting within a closed world of meaning in which the deeper issues which form its limits are treated as 'given'. Both the faculty of physical reality remain a passive

synthesis and the social context of knowledge is assumed as a passive synthesis not to be re-opened by action as a scientist. The student learns that the proper attention of science, and thus of oneself, is to preserve the 'quality' of knowledge as assessed in accordance with consensual criteria of the profession concerning what constitutes objective and evidential meaning.

Because the closedness of this world of meaning, metaphysical and epistemological certainty (and thus conservatism) are likely to be written into the scientist's world view and personal identity, and hardened by his acceptance of the ideal of 'organised skepticism', which tells the student that he can rely on the profession to question what he unreflectingly accepts. Within this closed world of meaning, the student is fundamentally alone in his active intervention in reality. He is assessed by the profession as an individual; his employment prospects depend on performance as an individual; his social world is limited to acting as an individual within a closed sub-world of his laboratory. Professional meanings thus have become the student's own if he is to succeed.

7) Student internalisation of professionalism: That students do internalise their ideal-typical constructions as their own view of science reality is demonstrated by the difference in attitudes between students entering Ph.D. training and those students nearing the completion of their degree. The most striking change between early vs. late students was the way in which the general value the student placed on being an autonomous individual became integrated into his overall structure of values – into his identity (Hill, Fensham & Howden, 1974). For students entering Ph.D. training, individualism was in conflict with a 'personal morality' dimension of values. By the end of training, individualism was in close harmony with personal morality; it had been internalised as a valid expression of self. In time 'individualism' became increasingly associated with drive, ambition, competitiveness and willingness to assume responsibility, and less with flexibility and pursuit of scientific curiosity.

The student had learnt that failure is his own responsibility.

This increasing acceptance of responsibility for oneself was also reflected in the student's perception of his relationship to the wider profession. Early students had a rather idealistic view of the profession, and though they were likely to have had virtually no contact with professionals outside their immediate department, they felt a part of the professional group and believed their rewards would come from cosmopolitan interaction. But during Ph.D. training this orientation moved from feeling a part of a group of professional colleagues to the feeling of being responsible for it.

The student appears to come into training with a stereotype of the profession to which he wants to belong. This, in time, appears to be transformed into identification with an overall acting out of the norms of the profession as they are perceived in the role model of one's supervisor and the ideal-typical models of behaviour conveyed in the literature. The orientating influence of the 'profession' also changes, coming to emphasise greater insularity from the world outside science. Students both at the start and the end of their training see scientists in general and themselves in particular as part of an elite group whose capability extends well beyond the limitation of their professional training.

Reification of personal identity in this elitism is demonstrated by the association with this factor of a belief that commitment to a scientist role takes precedence over commitment to personal life, even to life in the life in the family. But although elitism remains through training, for early students it is associated with an idea of the social applicability of science, while for later students it becomes increasingly associated with a stronger belief that scientists can stand above other peoples problems. In this the student is internalising the boundaries of science into his own identity: the meaning of science as a profession, and thus of his own actions, is invested less in its use as in its inward attention to normative behaviour in producing and validating scientific knowl-

edge. Science is thus increasingly seen to be not directly accountable to society, for its contribution was guaranteed as long as scientists continue to carefully weave the fabric of knowledge. Later students see that the scientist's involvement in social change threatens the elite character of science. For the individual scientist graduating out of his Ph.D. training, the justification of self provided by the orienting influence of the profession encloses his own identity further and further away from the world outside the laboratory window.

8) The profession as 'orientation reference group': In shaping the meaning of action-as-scientist and the personal identity of scientists that this meaning of action sustains, the profession of science assumes the power of an 'orientational reference group' with the defining characteristics described in the concepts of 'orientational other' by Manfred Kuhn (1964): which refers a) to the others to whom the individual is most fully broadly and basically committed, emotionally and psychologically; b) to the others who have provided him with his categories; c) to the others who have provided and continue to provide him with some of his categories of self and other and with the meaningful roles to which such assignments refers; and d) to the others in communicating with whom his self-conception is basically sustained and/or changed.

The institutionalisation of science education channels the student into a highly specialised sub-world of scientific meaning, and structurally prescribed relationships bond the student to the 'anonymous' profession, whilst closing off the world outside. The profession as an orientational reference group is likely to obtain a degree of psychological power and pervasiveness of impact similar to that which occurs (in Kuhn's conception) in relationships with absent 'orienting' individuals.

As with Mead's concept of 'generalised other', the research student's internalisation of the profession as reference group requires a complex evidential synthesis of 'objective' assumptions that underlie the separate appearances of others. The difference between

the child's construction of the generalised other and the scientist's construction of the orientational other lies primarily in the direction of synthesis. The child learns to construct the generalised other to which 'one' responds out of direct experience of a number of significant others. The research student, on the other hand, has direct and anticipated experience of the professional others through highly codified and constrained interaction (both in publication and thesis examination), so this ideal-typical construction fundamentally mediates his intersubjective experience of the significant other role model his supervisor provides for him.

Because of the anonymity of the reference group on whom he must depend, the student's construction of self in action-as-scientist must remain set within the ideal-typical constructions of the meaning of research action that are consensually shared within the profession – and which embody little freedom for spontaneous change. These ideal-typical constructions are driven into the graduating scientist's identity by the direct experience of seeing the constructions work in the trainee's active synthesis of the 'real' world in his research experience. Thus even when immediate contact with the profession ceases, as may well be the case for some industrial scientists, the profession still exists as a context in which one's individual action is played out.

Scientific Enterprise and Individual Scientist

1) Link between an 'interpretive' perspective and the structure of scientific enterprise: I have tried to be 'interpretive', examining the meanings of the sub-world of science through the eyes of individual actors. However, the meaning of science is bought into individual intention through evidential construction of consensually shared 'objective' meanings of the scientist's social context.

It is therefore legitimate to move from an interpretive level of analysis to suggest social and cognitive features of scientific en-

terprise as a whole. For what is thus being presented is the strata of objective and evidential meanings that are shared within it yet can only be expressed in individual action. These levels of meaning fundamentally structure individual intention of the scientific actor, while at the same time, the expressive meanings of individual actors continue to sustain the objective and evidential levels of meaning shared within scientific enterprise as a whole.

2) Scientific interaction: The link between the individual scientist and the profession is mediated by scientific interaction or exchange.⁵ Whereas the child's contact with his social world is mediated directly and intersubjectively, the scientist's interaction with the profession is largely mediated by formal and anonymous communication. It is only a very narrow stratum of his total experience that the scientist is able to share through communication: it is that stratum of meaning, the form of which can be conveyed unambiguously by word or other symbol, and which conveys a consensually legitimated means of isolating phenomena from their context and agreeing about what is observed. Because of an apparent externality of these symbolic constructions of reality, this narrow stratum of meaning can be brought into the personal experience of the individual scientist if he reproduced it himself. But even if he does not do this, because of the 'given' externality of 'scientific' findings, he can continue to believe in their facticity because some other professional could replicate it. By keeping up with contemporary literature, evaluation of facticity outside one's own sphere of immediate research can be suspended because the journal will do it for you by means of referee filtering, replies, and reported independent replication. Thus the form of scientific communication sustains a passive synthesis of the apparent externality of action-as-scientist, but is built on ideal-typical constructions buried within individual expressive meanings.

3) Consequences of specialisation: The content of interaction both abbreviates the reality directly experienced by the researcher

and cuts the 'scientific' stratum of meaning off from other meanings of the experience. The pressure to specialise and to communicate only with others within one's own speciality is reinforced by the structure of training aimed to develop a scientific capability in one small area. With competitive pressure to continue publishing, or at least to remain up-to-date with the current literature, rather than contemplate or retrain, individual scientists and ultimately field of inquiry are bound to the continuation of a search for knowledge down paths more prescribed by past training than by the discipline's (or the society's) present movement. In Australian academia, the location of local institutions with respect to the rest of the world has largely determined which fields of science have developed in the country, further aggravating the tendency towards specialisation. Australian scientists who gain post-doctoral or subsequent experience overseas most commonly want to come back to their home institution, so at least in their early days research schools have tended to grow by collecting former students back into areas of strength. (Armstrong, Hill & Ross, 1966). These graduates were highly specialised, so when they were employed elsewhere in the country they carried their established field of specialisation with them.

There have been 'chain reactions' in which an internationally famous scientist of some forty years ago attracts some of the best students in his field, and these students, having become his intellectual heirs, then enter Australian academic life and perpetuate his influence. The need for supervisors to continue to produce publications means they will enlist their students in their own speciality, thereby ensuring that the production of more professionals within rigidly specified specialities continues. Fields of enquiry are thus chained to the past by the professional training process, and communication within them sustains the boundary definitions that legitimate the existence of that field.

If we relate the argument concerning specialisation back to the nature of the knowledge which becomes legitimated as scien-

tific knowledge, the implications of the earlier observation that a high percentage of research in science is done by Ph.D. students are quite dramatic. First, it suggests that the majority of knowledge to which scientific status is extended emanates from research which was chosen as offering a high chance of success for one man. Therefore, it is usually expected to make incremental advances around an area of established specialisation. Those who contribute the actual research are working under relatively tight social and cognitive constraints, so their action in relation to their particular scientific reality is less free, alive and creative. The creative contribution of the supervisor consists of vicariously perceived patterns and results rather than of the direct experience presented by his own research actions, so freedom in cognition of what otherwise is outside the focus of direct interest is severely constrained. To the extent this pattern of contribution to science by research students is a general one, science as a whole is sedimented into a 'normal' science mode, one designed to solve specified problematics within a prevailing paradigm or nest of interconnected paradigms. It is held there by institutional patterns of research funding and training.

In those case where research is directly funded – where assistants rather than students can be employed – scientific action of greatest potential is supported by vested interests. With Australian Research Grants Committee funding of academic research, projects are evaluated by senior referees on the grounds of scholarly background and professionally specified research potential: those who status rewards are most firmly committed to the discipline make this judgment, inevitably encouraging scientific orthodoxy. Government funding of more mission-oriented research is most likely in areas where long term goals of political and economic expedience might be achieved. The implication of such a split between student conducted 'normal' science and mission or reputation constrained science is that the vested power interests in society

determine which areas of science will have the greatest creative potential. These interests either serve to sustain present specialised (and social non-accountable) views from within the interstices of a discipline; or else they align with ultimate power and control intentions of the most dominant political and economic groups within the country.

4) Individualism and professional conservatism: Finally, the individual scientist comes to closely identify his self-concept with his action within one of these highly specialised spheres of interest. Ultimately the profession is so much part of himself that it loses an immediate referential reality and is seen to provide but a context within which his individuality is acted out. Thus when the individual is playing out his individualism to the profession-as-context, norms of professional conduct (such as those posited by Robert Merton (1968) of organised skepticism, universalism, disinterestedness, and communalism) set the limits to the individual's construction of evidential meaning. But the social reference point they represent is more a limit to how the scientist presents himself when in the eye of his scientific public than a necessary organiser of his action. Consequently, believing in the organised skepticism of other scientists sets limits to what the scientist claims in public rather than to way he reviews supportive vs. conflicting evidence to his own research. Universalism may be espoused, though the scientist still may believe that those outside the elite circles need to be examined more skeptically. Disinterestedness may be the outward face which veils an internal commitment to one school of thought at the exclusion of others. Communalism may be adhered to only because it is in the scientist's status interests to publish anything at all in a refereed journal. 'Objective' meaning, can thus become that which directly feeds one's own research. Reality outside this narrow band of knowledge is increasingly barred from 'professional' dialogue by the sheer size of other professional literatures.

This creates an enormous power of move-

ment in pragmatic 'normal science' activity, but insulates much of the knowledge system of science from radical change. Such change often comes from connection between otherwise disconnected bodies of knowledge, or from questioning the assumptions on which the speciality's symbolic meaning is constructed. Fundamental questioning of the very epistemological roots of scientific knowledge deeply threatens identity as a scientist. It threatens the elite even more as their investment of self in scientific knowledge is more visible. The result is a resistance in science to radical change.

Science (and its relationship to wider society) thus is woven into and from the fabric of personal meanings of scientists who participate in the profession. Reification of the objective knowledge to which scientists lay claim, and which is seen to be independent of whatever the scientist's personal meanings are, is sustained by the particular form of secondary socialisation of research students into the scientific enterprise, and by the structures of exchange that are imposed on scientists who become members of the 'profession'. In the manner by which this training and scientific exchange closes off experience other than that which can be codified into scientific knowledge, and in the depth of identification scientists tend to make of themselves as scientists, we find a closure of actions-as-scientist from the wider culture and from the reflexive scrutiny of scientific epistemology.

This closure of scientific knowledge and action away from wider experience of the world, the reification of this scientific enterprise, and the acceptance of the consequently mystified view of scientific validity by the layman, all reinforce he scientism within our culture; scientific enterprise, arbiter of one's common knowledge, lies outside immediate intelligibility. In addition, the form of closure leads to rigidification of paths of enquiry seen to be open to scientists. It leads to control of the instrumentally applicable edge of scientific endeavour, primarily by those powerful industrial and governmental vested interests who can afford to employ translators

– professional employees able to bridge the scientific and commercial worlds – to draw behind the high walls of science the instrumental knowledge that sustains the institution's own role in a competitive materialist world society. Closure of the scientific world reinforces the instrumentalist value system of the society and the place of scientific enterprise in sustaining this.⁶

NOTES

1. I use the word 'profession' of science deliberately here rather than expressions such as the 'peer group of science', 'cosmopolitan reference group', 'social system of science' and so on. The key dimensions of science as a social system, and of socialisation into it, are similar to those of professions such as law, medicine, or engineering. (Hill, 1973; Hill & Jagtenberg, 1977) All are organised around their hegemony over a specialised body of knowledge. All are characterised by professional socialisation which must deliver out of accreditation an individual who will act autonomously, but within normative constraints of shared definitions of 'professional' behaviour. The key difference between science and other professions lies in the former's inward focused attention to the certification of knowledge it claims, and latter's client-focused attention in preserving uniformity of presentation of knowledge to the outside world. The clients of science tend more to be assumed, while the certification of medical and legal knowledge tends more to be assumed than in science. Social exchange patterns tend to follow this orientation of the profession: science interaction and control tends more to operate at an impersonal publication level than in other professions. But though the forms of exchange differ an essential similarity remains between all professions: the individual during socialisation is joined to the profession by a fabric of connections. The influence of the 'profession' as a reference group can be all of the following: 'cosmopolitan reference group'; 'orientational reference group'; and a reference group of significant others. I use the word 'profession' then to emphasise this social process.
2. I am using 'secondary socialisation' as Berger & Luckmann (1971: 158) do to refer to 'the internalisation of institutional or institution-based sub-worlds'. The data I present in this section about secondary socialisation into science is primarily at two levels: 1) structural features within which research training in science is set, social forms which would appear to have an 'objective' meaning both for the subjects of study and the investigator but which can only be discerned through analysis of evidential meaning; 2) the expressive meanings of individual actors within their social settings, evidentially constructed from subjective responses. The data is primarily drawn from a study of 203 chemistry Ph.D. students (checked against results from study of a further 85

- students), 67 academic scientists and 705 employed government and industrial scientists. The full study is written up in *Ph.D. Education in Australia: The Making of Professional Scientists* (Hill, Fensham & Howden, 1974).
3. Our study implies the students who had published their research findings (50% of all enrolled students, including people in their first year). 90% had published under the joint authorship of the supervisor and themselves, whilst only 2% of all the students had ever published any of their own independently of their supervisor. Meanwhile 80% of supervisors stated that having no Ph.D. students would have some impact on their ongoing research, and almost half of these (39%) stated that not having Ph.D. students would be extremely detrimental to their research.
 4. More than 82% of employed scientists in applied research institutions in Australia were still primarily involved in research remained in the specialty within which they were trained (Hill, Fensham & Howden, 1974: 129); 50% of these scientists had been trained overseas.
 5. My discussion here centres on scientists who continue to interact – through publication their research – with the profession of science. It is on the foundation of this interaction that scientific enterprise is sustained. Scientists to whom I refer are most likely to be found in academic institutions where pressure to publish is a locally reinforced imperative. However, to the extent that they continue to interact with the profession of science, industrial or government scientists also are involved in this mode of sustaining scientific enterprise.
 6. A longer version of this article has been previously published in M. R. Pusey & R. E. Young (eds.): (1979) *Control & Knowledge: The Mediation of Power in Institutional Settings*. Canberra: The Australian National University.

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