LABORATORY LIFE

The Construction of Scientific Facts

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Introduction by Jonas Salk

With a new postscript and index by the authors

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NOTES

1. We make no attempt here systematically to relate our methodological procedures to those used in anthropological studies. For preliminary discussions on the relevance of anthropology for the study of science, see Horton (1967) and the readings in Wilson (1970). More recent discussions include Shapin (forthcoming) and Bloor (1978).

2. Medawar (1964) formulates his argument in terms of the "processes of thought" which are misrepresented through scientific reports. While agreeing with the general point that these reports are a source of considerable obfuscation, we have severe reservations about any quest for the "thought processes" which "underly" the construction of these reports. As we argue in detail in Chapter 4, explanations of scientific activity in terms of thought processes are themselves considerably misleading.

3. The point has been made by a number of authors. See, for example, the discussions in Lakatos and Musgrave (1970) and Bloor (1974; 1976).

4. This argument is developed at length in Woolgar (1978).

5. This theme is taken up again in Chapter 6 with reference to the game of "Go." At the beginning of the game, any move appears as possible, or as good, as any other.

6. The rationale for this strategy and its effects on the relationship between observer and participants will be discussed in detail elsewhere.

7. A number of French authors have recently discussed laboratory science. See, for example, Lemaine et al. (1977), Callon (1978). For a remarkable history of the biology laboratory in the eighteenth century, see Salomon-Bayet (1978).

Chapter 2

AN ANTHROPOLOGIST VISITS THE LABORATORY

When an anthropological observer enters the field, one of his most fundamental preconceptions is that he might eventually be able to make sense of the observations and notes which he records. This, after all, is one of the basic principles of scientific enquiry. No matter how confused or absurd the circumstances and activities of his tribe might appear, the ideal observer retains his faith that some kind of a systematic, ordered account is attainable. For a total newcomer to the laboratory, we can imagine that his first encounter with his subjects would severely jeopardise such faith. The ultimate objective of systematically ordering and reporting observations must seem particularly illusory in the face of the barrage of questions which first occur to him. What are these people doing? What are they talking about? What is the purpose of these partitions or these walls? Why is this room in semidarkness whereas this bench is brightly lit? Why is everybody whispering? What part is played by the animals who squeak incessantly in ante-rooms?

But for our partial familiarity with some aspects of scientific activity and our ability to draw upon a body of common sense assumptions, a flood of nonsensical impressions would follow the formulation of these

questions. Perhaps these animals are being processed for eating. Maybe we are witnessing oracular prophecy through the inspection of rats entrails. Perhaps the individuals spending hours discussing scribbled notes and figures are lawyers. Are the heated debates in front of the blackboard part of some gambling contest? Perhaps the occupants of the laboratory are hunters of some kind, who, after patiently lying in wait by a spectograph for several hours, suddenly freeze like a gun dog fixed on a scent.

Such speculations and the questions which give rise to them appear nonsensical precisely because we as observers do presuppose some knowledge of what the laboratory could be doing. For example, it is possible to imagine the purpose of walls and partitions without ever having set foot in a laboratory. We attempt to make sense not by bracketing our familiarity with the setting but by using features which we perceive as common both to the setting and to our knowledge or previous experience. Indeed, it would be difficult to provide any sensible account of the laboratory without recourse to our taken-for-granted familiarity with some aspects of science.

Clearly, then, the observer's organisation of questions, observations, and notes is inevitably constrained by cultural affinities. Only a limited set of questions is relevant and hence sensible. In this sense, the notion of a *total* newcomer is unrealisable in practice. At another extreme, an observer's total reliance on scientists' versions of laboratory life would be unsatisfactory. A description of science cast entirely in terms used by scientists would be incomprehensible to outsiders. The adoption of scientific versions of science would teach us little that is new about science in the making; the observer would simply reiterate those accounts provided by scientists when they conduct guided tours of their laboratory for visitors.

In practice, observers steer a middle path between the two extreme roles of total newcomer (an unattainable ideal) and that of complete participant (who in going native is unable usefully to communicate to his community of fellow observers). This is not to deny, of course, that at different stages throughout his research he is severely tempted towards either extreme. His problem is to select a principle of organisation which will enable him to provide an account of the laboratory sufficiently distinct from those given by scientists themselves and yet of sufficient interest to both scientists and readers not familiar with biology. In short, the observer's principle of organisation should provide an Ariadne's thread in a labyrinth of seeming chaos and confusion.

In this chapter, we follow the trials and tribulations of a fictional character, "the observer,"[1] in his attempts to use the notion of literary inscription[2] as a principle for organizing his initial observations of the laboratory.

Literary Inscription

Although our observer shares the same broad cultural knowlege as scientists, he has never seen a laboratory before and has no knowledge of the particular field within which laboratory members are working. He is enough of an insider to understand the general purpose of walls, chairs, coats, and so on, but not enough to know what terms like TRF, Hemoglobin, and "buffer" mean. Even without knowledge of these terms, however, he can not fail to note the striking distinction between two areas of the laboratory. One area of the laboratory (section B on Figure 2.1) contains various items of apparatus, while the other (section A) contains only books, dictionaries, and papers. Whereas in section B individuals work with apparatus in a variety of ways: they can be seen to be cutting, sewing, mixing, shaking, screwing, marking, and so on; individuals in section A work with written materials: either reading, writing, or typing. Furthermore, although occupants of section A, who do not wear white coats, spend long periods of time with their white-coated colleagues in section B, the reverse is seldom the case. Individuals referred to as doctors read and write in offices in section A while other staff, known as technicians, spend most of their time handling equipment in section B.

Each of sections A and B can be further subdivided. Section B appears to comprise two quite separate wings: in the wing referred to by participants as the "physiology side" there are both animals and apparatus: in the "chemistry side" there are no animals. The people from one wing rarely go into the other. Section A can also be subdivided. On the one hand, there are people who write and engage in telephone conversations; on the other hand, there are those who type and dial telephone calls. This division, like the others, is marked by partitions. In one area (the library) eight offices surround the perimeter of a conference room with table, chairs, and a screen. In the other area ("the secretariat") there are typewriters and people controlling the flow of telephone calls and mail.

What is the relationship between section A ("my office," "the office," "the library") and section B ("the bench")? Consulting the

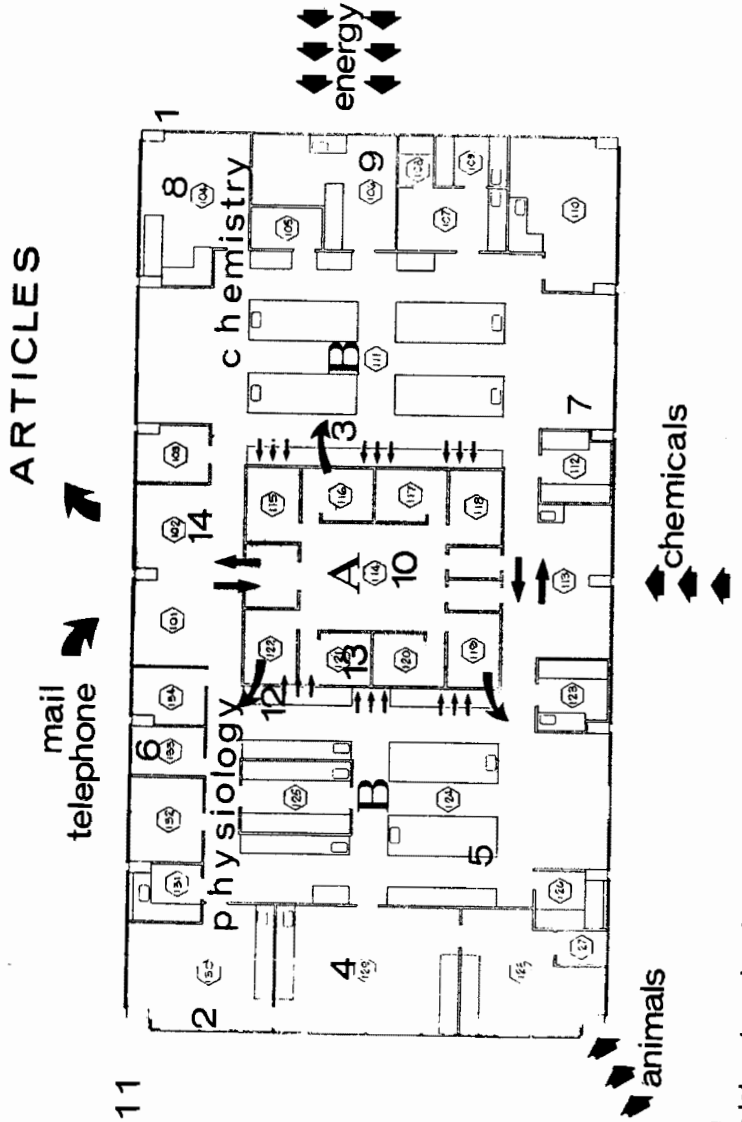


Figure 2.1
Map of the laboratory showing partitions and the main flows described in the text. The numbers on the map correspond to photographs in the file (page 91). The map shows the extent to which the differences between section A and B, and between the chemistry and physiology wings, are reinforced by the architectural layout of the laboratory.

map he has drawn, our observer tries to imagine another institution or setting with a similar division. It is hard to call to mind any factory or administrative organisation which has a similar set up. If, for example, it was a factory, we might expect the office space (section A) to be much smaller. If it was some kind of administrative agency, the bench space (section B) would be entirely superfluous. Although the relation between the two wings of the office space is common to many productive units, the special relation between office space and bench space is sufficient to distinguish the laboratory from other productive units. This is apparent on two counts. Firstly, at the end of each day, technicians bring piles of documents from the bench space through to the office space. In a factory we might expect these to be reports of what has been processed and manufactured. For members of this laboratory, however, these documents constitute what is yet to be processed and manufactured. Secondly, secretaries post off papers from the laboratory at an average rate of one every ten days. However, far from being *reports* of what has been produced in the factory, members take these papers to be the *product* of their unusual factory. Surely, then, if this unit merely processes paper work, it must be some sort of administrative agency? Not so: even a cursory look at the papers shows that the figures and diagrams which they contain are the very same documents produced in section B a few days or weeks previously.

It occurs to our observer that he might be able to make sense of laboratory activity according to one very simple principle. For him, the scene shown in Photograph 13,[3] represents the prototype of scientific work in the laboratory: a desk belonging to one of the inhabitants of the office space (referred to as the doctors) is covered with paperwork. On the left is an opened issue of *Science.* To the right is a diagram which represents a tidied or summarised version of data sheets lying further to the right. *It is as if two types of literature are being juxtaposed:* one type is printed and published outside the laboratory; the other type comprises documents produced within the laboratory, such as hastily drawn diagrams and files containing pages of figures. Beneath the documents at the centre of the desk lies a draft. Just like the drafts of a novel or a report, this draft is scribbled, its pages heavy with corrections, question marks, and alterations. Unlike most novels however, the text of the draft is peppered with references, either to other papers, or to diagrams, tables or documents ("as shown in figure . . . ," "in table . . . we can see that . . . "). Closer inspection of

the material lying on the desk (Photograph 13) reveals, for example, that the opened issue of *Science* is cited in the draft. Part of the argument contained in a *Science* article is said in the draft to be unrepeatable by virtue of what is contained in documents lying to the right of the desk. These documents are also cited in the draft. The desk thus appears to be the hub of our productive unit. For it is here that new drafts are constructed by the juxtaposition of two sources of literature, one originating outside and the other being generated within the laboratory.

It is no surprise to our observer to learn that scientists read published material. What surprises him more is that a vast body of literature emanates from within the laboratory. How is it that the costly apparatus, animals, chemicals, and activities of the bench space combine to produce a written document, and why are these documents so highly valued by participants?

After several further excursions into the bench space, it strikes our observer that its members are compulsive and almost manic writers. Every bench has a large leatherbound book in which members meticulously record what they have just done against a certain code number. This appears strange because our observer has only witnessed such diffidence in memory in the work of a few particularly scrupulous novelists. It seems that whenever technicians are not actually handling complicated pieces of apparatus, they are filling in blank sheets with long lists of figures; when they are not writing on pieces of paper, they spend considerable time writing numbers on the sides of hundreds of tubes, or pencilling large numbers on the fur of rats. Sometimes they use coloured papertape to mark beakers or to index different rows on the glossy surface of a surgical table. The result of this strange mania for inscription is the proliferation of files, documents, and dictionaries. Thus, in addition to the Oxford dictionary and the dictionary of known peptides, we can also find what might be called material dictionaries. For example, Photograph 2 shows a refrigerator which houses racks of samples, each of which bears a label with a ten-figure code number. Similarly, in another part of the laboratory, a vast supply of chemicals has been arranged in alphabetical order on shelves from which technicians can select and make use of appropriate substances. A more obvious example of these material dictionaries is the collection of preprints (Photograph 14, background) and thousands of files full of data sheets, each of which also has its own code number. Quite apart from these labelled and indexed collections

is the kind of paperwork (such as invoices, pay cheques, inventory schedules, mail files, and so on) which can be found in most modern productive units.

When the observer moves from the bench space to the office space, he is greeted with yet more writing. Xeroxed copies of articles, with words underlined and exclamation marks in the margins, are everywhere. Drafts of articles in preparation intermingle with diagrams scribbled on scrap paper, letters from colleagues and reams of paper spewed out by the computer in the next room; pages cut from articles are glued to other pages; excerpts from draft paragraphs change hands between colleagues while more advanced drafts pass from office to office being altered constantly, retyped, recorrected, and eventually crushed into the format of this or that journal. When not writing, the occupants of section A scribble on blackboards (Photograph 10) or dictate letters, or prepare slides for their next talk.

Our anthropological observer is thus confronted with a strange tribe who spend the greatest part of their day coding, marking, altering, correcting, reading, and writing. What then is the significance of those activities which are apparently not related to the marking, writing, coding, and correcting? Photograph 4, for example, shows two young women handling some rats. Despite the protocol sheet to the right, the numbered tubes on the rack and the clock in the foreground which controls the rhythmn of the assay, the women themselves are neither writing nor reading. The woman on the left is injecting a liquid with a syringe and withdrawing another liquid with another syringe which she then passes on to the other woman; the second woman then empties the syringe into a tube. It is only then that writing takes over: the time and tube number is carefully recorded. In the meantime animals have been killed and various materials, such as ether, cotton, pipettes, syringes, and tubes have been used. What then is the point of killing these animals? How does the consumption of materials relate to the writing activity? Even the careful monitoring of the contents of the rack (Photograph 5) makes the situation no clearer to our observer. Over a period of several days, tubes are arranged in rows, other liquids are added, the mixtures are shaken and eventually removed for refrigeration.

Periodically, the routine of manipulation and rearrangement of tubes is interrupted. The samples extracted from rats are put into one of the pieces of apparatus and undergo a radical transformation: instead of modifying or labelling the samples, the machine produces a sheet of figures (Photograph 6). One of the participants tears the

sheet from the machine's counter and, after scrutinising it carefully, arranges for the disposal of the tubes. In other words, the same tubes which had been carefully handled for a week, which had cost time and effort to the tune of several hundred dollars, were now regarded as worthless. The focus of attention shifted to a sheet of figures. Fortunately, our observer was quite used to finding such absurd and erratic behaviour in the subjects of his studies. Relatively unperturbed, therefore, he braced himself for his next surprise.

It was not long in coming. The sheet of figures, taken to be the end result of a long assay, was used as the input to a computer (Photograph 11). After a short time, the computer printed out a data sheet and it was this, rather than the original sheet of figures, which was regarded as the important product of the operation. The sheet of figures was merely filed alongside thousands like it in the library. Nor was the series of transformations yet complete. Photograph 12 shows a technician at work on several data sheets produced by the computer. Soon after this photograph was taken, she was called into one of the offices to show the product of her labours: a single elegant curve carefully drawn on graph paper. Once again, the focus of attention shifted: the computer data sheets were filed away and it was the peaks and slopes of the curve which excited comment from participants in their offices: "how striking," "a well differentiated peak," "it goes down quite fast," "this spot is not very different from this one." A few days later, the observer could see a neatly redrawn version of the same curve in a paper sent out for possible publication. If accepted, this same figure would be seen by others when they read the article and it was more than likely that the same figure would eventually sit on some other desk as part of a renewed process of literary juxtaposition and construction.

The whole series of transformations, between the rats from which samples are initially extracted and the curve which finally apears in publication, involves an enormous quantity of sophisticated apparatus (Photograph 8). By contrast with the expense and bulk of this apparatus, the end product is no more than a curve, a diagram, or a table of figures written on a frail sheet of paper. It is this document, however, which is scrutinised by participants for its "significance" and which is used as "evidence" in part of an argument or in an article. Thus, the main upshot of the prolonged series of transformations is a document which, as will become clear, is a crucial resource in the construction of a "substance." In some situations, this process is very much shorter. In the chemistry wing in particular, the use of certain

pieces of apparatus makes it easy to get the impression that substances directly provide their own "signatures" (Photograph 9). While participants in the office space struggle with the writing of new drafts, the laboratory around them is itself a hive of writing activity. Sections of muscle, light beams, even shreds of blotting paper activate various recording equipment. And the scientists themselves base their own writing on the written output of the recording equipment.

It is clear, then, that particular significance can be attached to the operation of apparatus which provides some kind of written output. Of course, there are various items of apparatus in the laboratory which do not have this function. Such "machines" transform matter between one state and another. Photograph 3, for example, shows a rotary evaporator, a centrifuge, a shaker, and a grinder. By contrast, a number of other items of apparatus, which we shall call "inscription devices,"[4] transform pieces of matter into written documents. More exactly, an inscription device is any item of apparatus or particular configuration of such items which can transform a material substance into a figure or diagram which is directly usable by one of the members of the office space. As we shall see later, the particular arrangement of apparatus can have a vital significance for the production of a useful inscription. Furthermore, some of the components of such a configuration are of little consequence by themselves. For example, the counter shown in Photograph 6 is not itself an inscription device since its output is not directly usable in an argument. It does, however, form part of an inscription device known as a bioassay.[5]

An important consequence of this notion of inscription device is that inscriptions are regarded as having a direct relationship to "the original substance." The final diagram or curve thus provides the focus of discussion about properties of the substance. The intervening material activity and all aspects of what is often a prolonged and costly process are bracketed off in discussions about what the figure means. The process of writing articles about the substance thus takes the end diagram as a starting point. Within the office space, participants produce articles by comparing and contrasting such diagrams with other similar diagrams and with other articles in the published literature (see pp. 69-86).

At this point, the observer felt that the laboratory was by no means quite as confusing as he had first thought. It seemed that there might be an essential similarity between the inscription capabilities of apparatus, the manic passion for marking, coding, and filing, and the literary

skills of writing, persuasion, and discussion. Thus, the observer could even make sense of such obscure activities as a technician grinding the brains of rats, by realising that the eventual end product of such activity might be a highly valued diagram. Even the most complicated jumble of figures might eventually end up as part of some argument between "doctors." For the observer, then, the laboratory began to take on the appearance of a system of literary inscription.

From this perspective, many hitherto strange occurrences fell into place. Many other types of activity, although superficially unrelated to the literary theme, could be seen as means of obtaining inscriptions. For example, the energy inputs (Photograph 1) represented intermediary resources to be consumed in the process of ensuring that inscription devices functioned properly. By also taking into account the supply of animals and chemicals, it was clear that a cycle of production which ended in a small folder of figures might have cost several thousand dollars. Similarly, the technicians and doctors who comprised the work force represented one further kind of input necessary for the efficient operation of the inscription devices and for the production and dispatch of articles.

The central prominence of documents in our discussion so far contrasts markedly with a tendency evident in some sociology of science to stress the importance of informal communication in scientific activity. For example, it has been frequently noted that the communication of scientific information occurs predominantly through informal rather than formal channels (Garvey and Griffith, 1967; 1971). This is particularly likely where there exists a well-developed network of contacts as, for example, in an invisible college (Price, 1963; Crane, 1969; 1972). Proponents of this argument have often played down the role of formal communication channels in information transfer, choosing instead to explain their continued existence in terms of an arena for the establishment of priority and subsequent conferral of credit (Hagstrom, 1965). Observations of the present laboratory, however, indicate that some care needs to be exercised in interpreting the relative importance of different communication channels. We take formal communication to refer to highly structured and stylised reports epitomised by the published journal article. Almost without exception, every discussion and brief exchange observed in the laboratory centred around one or more items in the published literature (Latour, 1976). In other words, informal exchanges invariably focussed on the substance of formal communication. Later we shall

suggest that much informal communication in fact establishes its legitimacy by referring or pointing to published literature.

Every presentation and discussion of results entailed the manipulation either of slides, protocol sheets, papers, preprints, labels, or articles. Even the most informal exchanges constantly focussed either directly or indirectly on documents. Participants also indicated that their telephone conversations nearly always focussed on the discussion of documents; either on a possible collaboration in the writing of a paper, or on a paper which had been sent but which contained some ambiguity, or on some technique presented at a recent meeting. When there was no direct reference to a paper, the purpose of the call was often to announce or push a result due to be included in a paper currently being prepared. Even when they were not discussing a draft, individuals devoted considerable energy to devising ways of attaining some readable trace. In these kinds of discussions, scientists anticipated that possible objections to their argument might appear in some forthcoming paper. More important for the present, however, is the omnipresence of literature in the sense that we have defined it, that is, in terms of written documents, only a few of which appear in published form.

The Culture of the Laboratory

To those familiar with the work of the laboratory, the above account will have little to say that is new. For an anthropologist, however, the notion of literary inscription is still problematic. As we said earlier, our observer has an intermediary status: while the broad cultural values which he shares with the scientists facilitate some familiarity with the commonplace objects and events in the laboratory, he is unwilling solely to rely on scientists' own versions of the way the laboratory operates. One consequence of his intermediary status is that his account so far has failed to satisfy any one audience. It could be said, for example, that in portraying scientists as readers and writers he has said nothing of the *substance* of their reading and writing. Indeed, our observer incurred the considerable anger of members of the laboratory, who resented their representation as participants in some literary activity. In the first place, this failed to distinguish them from any other writers. Secondly, they felt that the important point was that they were writing *about* something, and that this something was "neuroendocrinology." Our observer experienced the depressing sensation that his Ariane's thread had led him up a blind alley.

anthropologist feels vindicated in having retained his anthropological perspective in the face of the beguiling charms of his informants: they claimed merely to be scientists discovering facts; he doggedly argued that they were writers and readers in the business of being convinced and convincing others. Initially this had seemed a moot or even absurd standpoint, but now it appeared far more reasonable. The problem for participants was to persuade readers of papers (and constituent diagrams and figures) that its statements should be accepted as fact. To this end rats had been bled and beheaded, frogs had been flayed, chemicals consumed, time spent, careers had been made or broken, and inscription devices had been manufactured and accumulated within the laboratory. This, indeed, was the very raison d'être of the laboratory. By remaining steadfastly obstinate, our anthropological observer resisted the temptation to be convinced by the facts. Instead, he was able to portray laboratory activity as the organisation of persuasion through literary inscription. Has the anthropologist himself been convincing? Has he used sufficient photographs, diagrams, and figures to persuade his readers not to qualify his statements with modalities, and to adopt his assertions that a laboratory is a system of literary inscription? Unfortunately, for reasons which will later become clear (see Chapter 6), the answer has to be no. He cannot claim to have set forth an account which is immune from all possibility of future qualification. Instead, the best our observer has done is to create a small breathing space. The possibility of future reevaluation of his statements remains. As we shall see in the next chapter, for example, the observer can be forced back into the labyrinth as soon as questions are posed about the historical evolution of any one specific fact.

NOTES

1. We stress that "the observer" is a fictional character so as to draw attention to the process whereby we are engaged in constructing an account (see Chapter 1). The essential similarity of our procedures for constructing accounts and those used by laboratory scientists in generating and sustaining facts will become clear in the course of our discussion. The point is taken up explicitly in Chapter 6.

2. The notion of inscription as taken from Derrida (1977) designates an operation more basic than writing (Dagognet, 1973). It is used here to summarize all traces, spots, points, histograms, recorded numbers, spectra, peaks, and so on. See below.

3. A file of photographs of the laboratory is presented after Chapter 2.

4. See note 2.

5. This notion of inscription device is sociological by nature. It allows one to describe a whole set of occupations in the laboratory, without being disturbed by the wide variety of their material shapes. For example, a "bioassay for TRF" counts as *one* inscription device even though it takes five individuals three weeks to operate and occupies several rooms in the laboratory. Its salient feature is the final production of a figure. A large item of apparatus, such as the Nuclear Magnetic Resonance Spectrometer, is rarely used as an inscription device. It is used instead to monitor a process of peptide production. However, the same apparatus, a scale for instance, can be considered an inscription device when it is used to get information about a new compound; a machine when it is used to weigh some powder; and a checking device when used to verify that another operation has gone according to plan.

6. Our observer was well aware of the popularisation of the term due to Kuhn (1970) and of the subsequent debates over its ambiguity and significance for models of scientific development (see, for example, Lakatos and Musgrave, 1970).

7. We use the term "peptide" throughout the following argument. One classical textbook definition of the peptidic bond is as follows: "A covalent bond between two amino acids in which the alpha amino group of one amino acid is bonded to the alpha-carboxyl group of the other with the elimination of H_2O" (Watson, 1976). In practice, "peptide" is a synonym for a small protein. However, it is important to realise that such terms need *not* be defined as if they have a universal meaning beyond that of the specific culture in which they are used. As if they were the terms used by the tribe under study, we shall enclose such terms in quotes in our discussion and attempt to account for them in nontechnical terms.

8. There are only some twenty amino acids in the body; proteins and peptides are made up exclusively of these amino acids; each amino acid has a name, for example, tyrosine, tryptophene, and proline. In the text we often use a simple abbreviation of these names (which uses the three first letters of the amino acid name).

9. These very crude figures are intended merely to give a general idea of the scale. They are based on the volume of space devoted to different topics in the *Index Medicus*.

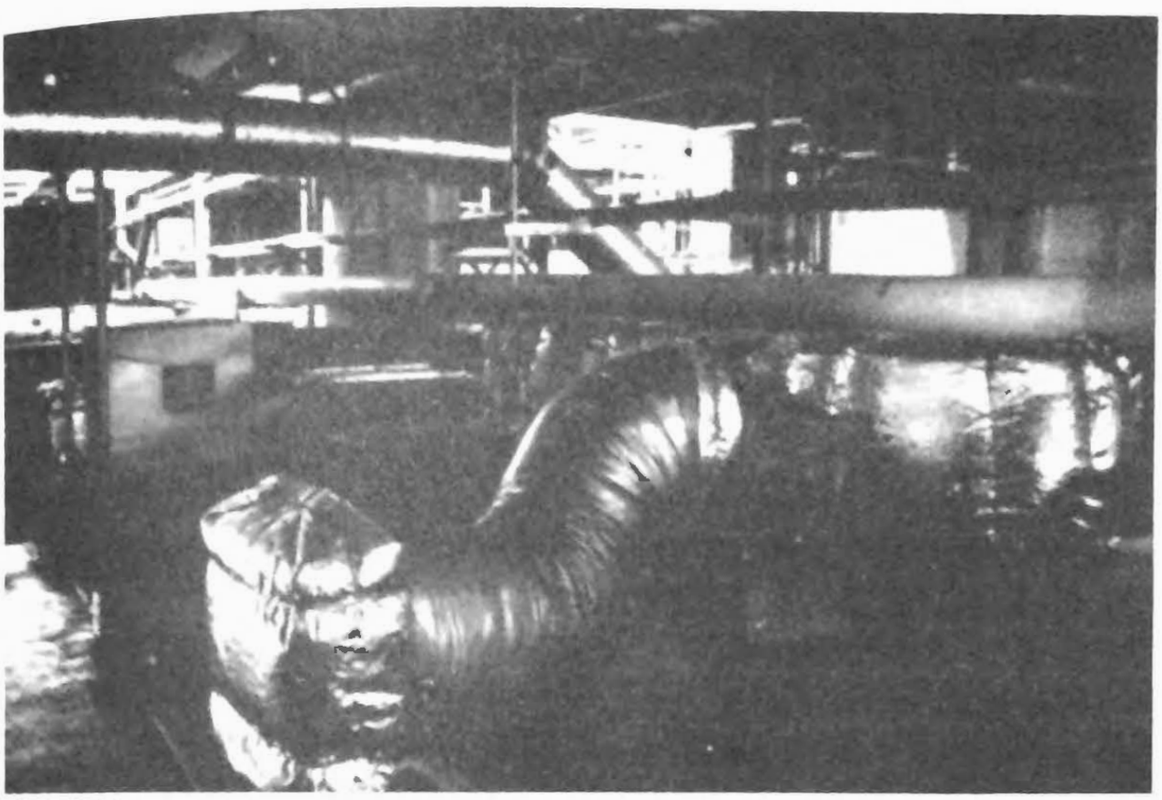
10. Once again, these divisions are extremely artificial in that they are much too large and rigid to correspond directly to members' appraisal of their activities. On the other hand, these programmes have become very stable and routinised by comparison with those of other laboratories. Our intention here is merely to provide the reader with the backcloth necessary for understanding subsequent chapters.

11. The observer would be told, for example, that "when a chemist shows the spatial configuration of somatostatin is such that a particular amino acid is very exposed on the outside of the molecular structure; it may be that by replacing or protecting it, some new activity will be observed."

12. It would be wrong to take differences between what is and is not technical in science as the starting point. These differences are themselves the focus of important negotiations between members. This idea has been especially developed in sociology of techniques by Callon (1975). See also Chapter 1 p. 21ff and Chapter 6.

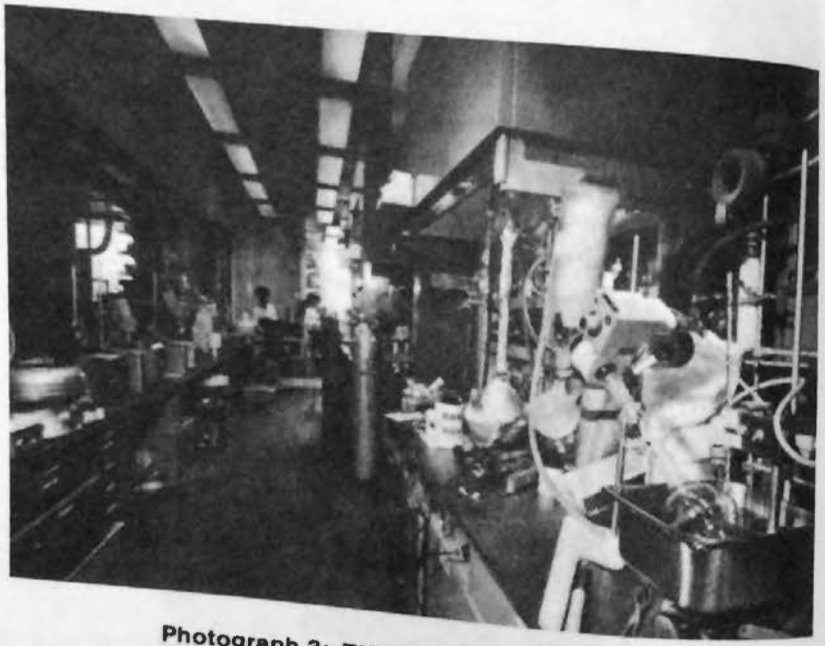
13. The same tendency is evident in sociological discussions of science which uncritically adopt the attitude that material phenomena are manifestations of conceptual entities.

14. During the first year of the study a new method of chromatography was tried in the laboratory. Albert worked on it for a year trying to adapt it to the purification programme of the group. As soon as it became settled, Albert turned the instrument over to a technician, after which it became a purely "technical" matter.



Photograph 1: VIEW FROM THE LABORATORY ROOF

Photograph 2: REFRIGERATOR CONTAINING RACKS OF SAMPLES



Photograph 3: THE CHEMISTRY SECTION

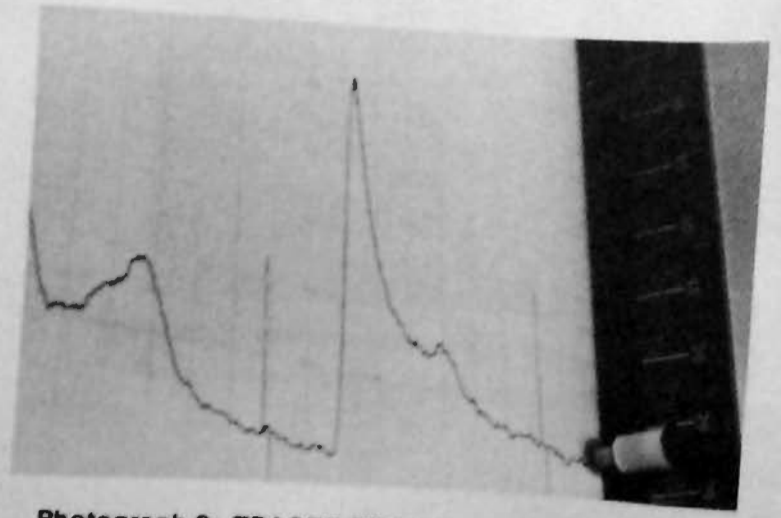
Photograph 4: A BIOASSAY: THE PREPARATORY STAGE

Photograph 5: A BIOASSAY: AT THE BENCH

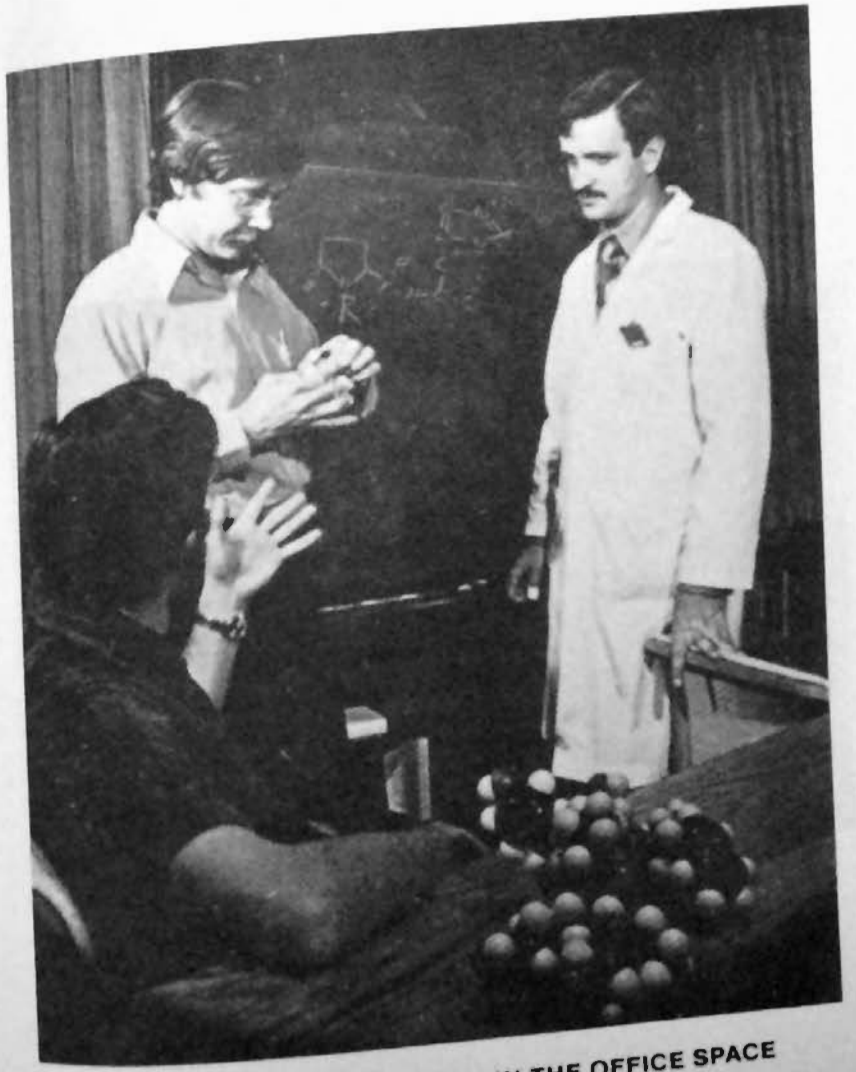
Photograph 6: A BIOASSAY: OUTPUT FROM THE GAMMA COUNTER

Photograph 7: FRACTIONATING COLUMNS

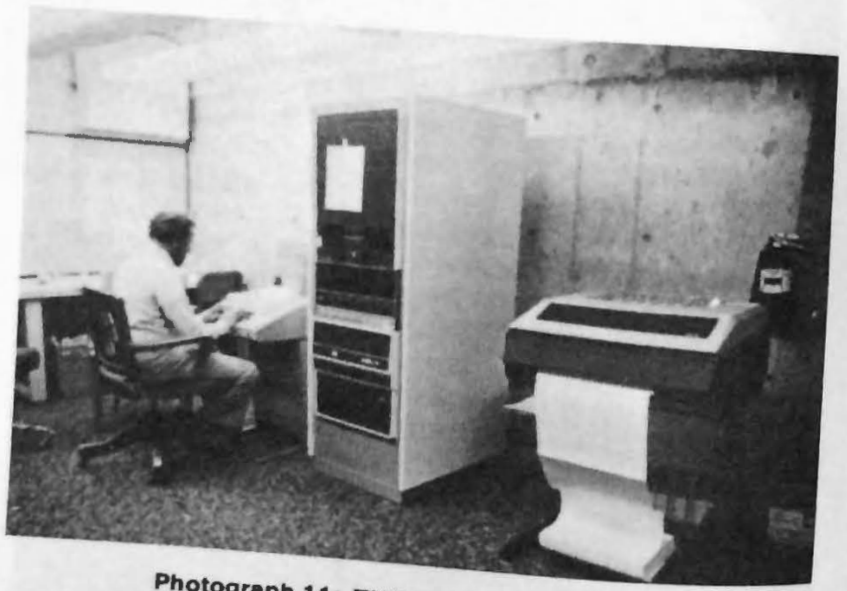
Photograph 8: THE NUCLEAR MAGNETIC RESONANCE SPECTROMETER



Photograph 9: TRACES FROM THE AUTOMATIC AMINO ACID ANALYSER

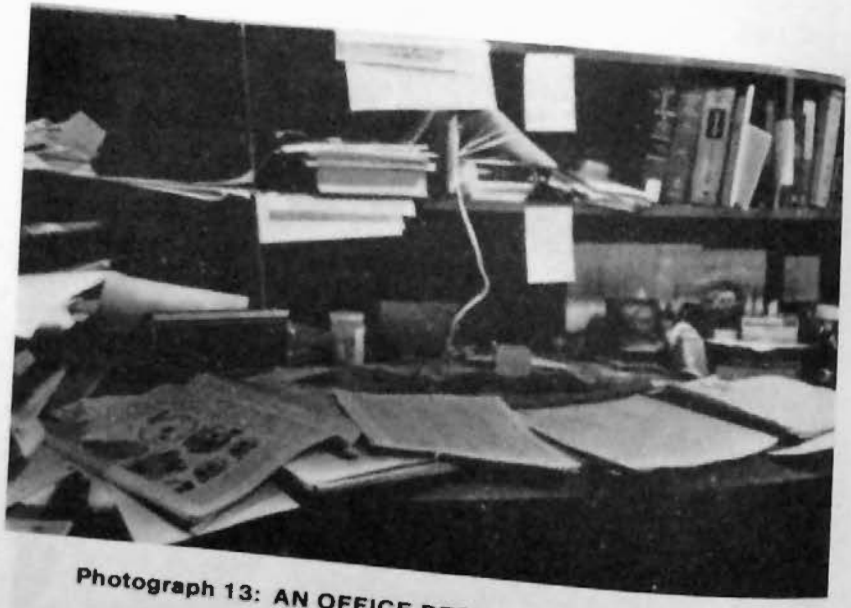


Photograph 10: DISCUSSION IN THE OFFICE SPACE



Photograph 11: THE COMPUTER ROOM

Photograph 12: CLEANING UP THE DATA



Photograph 13: AN OFFICE DESK:
THE JUXTAPOSITION OF LITERATURES

Photograph 14: IN THE SECRETARIAT: TYPING THE FINAL PRODUCT

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