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DOES ARTIFICIAL INTELLIGENCE THREATEN GENUINE FAITH?

The idea that robots, based on future generations of computers might one day develop an independent intelligence of their own is now a commonplace. Dr Gordon Clarke asks what is meant by intelligence in such a context and whether it could in any way threaten Christian faith.

1. *INTRODUCTION*

The desire to create mechanical or organic artefacts which possess 'intelligence' has long fascinated humankind. It was discussed in abstract by some of the pioneers of computing machines in the last century, but only in the last forty years has it started to emerge into a shady kind of reality with the advent of powerful general-purpose computers. Thirty years ago, the subject was raised for the first time before this Society by Donald Mackay, who stated that "Factual developments make it no longer derisory to ask: could an artificial mechanism be said to have a mind?"[1] He concluded that we could not reject this possibility on logical, philosophical or theological grounds. Indeed, the impetus given to Christian thought by the development of such artefacts should serve to illuminate our understanding of the Christian doctrine of man, rather than undermine it. At that time, the questions raised were largely hypothetical as computing machines (although most impressive compared to pre-war devices) were clumsy, bulky and slow by modern standards and did not have the capacity to deal with more than straightforward repetitive calculations, let alone the simulation of human thought.

Many believed, however, that Artificial Intelligence (AI), as the science of modelling human thought processes on computers has come to be called, was a worthy and achievable goal. Since the 1950's, AI has grown out of nothing to a major research interest in the USA, in Japan and to some extent in the UK. In the next few years, as cheap microcomputer technology brings computing power within the reach of more and more investigators, the field is bound to expand apace. Recent declared objectives of the Japanese computer industry anticipate that human-like intelligence in computers will be with us by the 1990's. These aims are ambitious, but they have been taken seriously in the US and resulted in some alarm in UK government circles.

It is a good time, then, to re-examine the impact of machine intelligence on Christian views of man and society, for if it can be shown that intelligent behaviour (meaning activities with which we would normally associate human reason), thought or indeed consciousness can be programmed into a machine, what do we learn about the nature of our intelligence, thought and consciousness?

For Christians, the issues raised by AI include:

(i) A priori philosophical problems about the nature of man and human society, and

(ii) Practical effects of applied AI.

In the first category, the possibility that human-like intelligence could be simulated in machines makes us ask questions such as:

(i) Is our thinking merely mechanical? Hence what of free will, rational choice and moral responsibility? Is faith an illusion — an artefact of the flickering of action potentials in the brain — as reductionists have claimed?

(ii) If machines can exhibit mind-like behaviour, what is the mind? How do mind and brain relate? What of the 'soul'?

(iii) Is there any room for the supernatural in the scheme of things? What about survival after death in particular?

(iv) Does machine intelligence demean our status as human beings or undermine our notion of ourselves as rational and indeed spiritual creatures? How would this affect our behaviour towards each other?

In the second category — the impact of widespread use of intelligent machines — we should examine the psychological effect on individuals working with such devices as well as the social issues like employment, privacy and control which also demand a Christian response. These problems are only considered cursorily in this paper, however, as it is important to clear the philosophical ground first.

My aim is to air the philosophical issues in a comprehensible way and lay some of the ghosts which prevent us thinking clearly about brains and minds, be they begotten or created. I intend to demonstrate that the conclusions of Prof. Mackay's paper[1] remain valid; that AI, properly understood, is not a threat to faith, and that it can help us to discern our own nature more clearly.

I will begin by mapping out briefly the achievements of AI research to date, then examine objections to the realisation of machine intelligence in principle, and explore the mind-brain problem. Thence, the inevitable step is to assess the issues involved in machine consciousness. Finally, I will discuss the implications of AI for the Christian faith in the light of the questions listed above.

Setting out on this task at the junction of my own fields of interest, I am aware that I may oversimplify the issues. I can only ask the reader to bear with me and assess the validity of the conclusions on their own merits.

2. *HOW FAR HAS AI RESEARCH PROGRESSED*

To give a bald definition, AI is the attempt to duplicate in an artefact intellectual activities which we would normally expect to require human reason. Research has ranged from game-playing programs to intelligent 'assistants' which embody and manipulate expert knowledge. We need to examine the rationale of these developments and see how far research has progressed.

It is intrinsically very attractive to draw parallels between the digital computer and the brain[2,3,4] — both being general purpose information processing devices which achieve their results by carrying out large numbers of primitive operations at great speed using standard 'on-off' components. However, the parallels are somewhat superficial, for example:

(i) The brain is not wholly digital in its operation. The frequency, not just the presence or absence of nerve impulses is important; so is the integrating capacity of nerve cells, which fire according to the net effect of excitatory and inhibitory inputs.

(ii) The brain carries out much processing in parallel and as such is more like a conglomeration of computers than just one. Large modern computers, too, often contain a number of processors, but not yet to the same extent.

(iii) The memory system of the brain is far more sophisticated than computer memory — it is distributed, so patterns can successfully be rebuilt from part information.

(iv) Functions lost through damage can be taken over by other parts of the brain. Some redundancy of memory is present in modern computers for the same reason, but back-up processing is rare as yet.

(v) The brain uses a different kind of symbolism from that normally used by computers — its notation is such that it can locate information by its relationships with other information very quickly, but it cannot easily carry out complicated calculations. 'Relational' data retrieval in computers is at an early stage of development.

Nevertheless, it was demonstrated in the 1930's that the digital computer is capable of simulating any process which can be specified as a series of logical steps,[5] so it should not be impossible to reproduce within the very different hardware of the digital computer the logical processes which go on in the brain. For example, distributed memory could be simulated mathematically in a computer program by Fourier Synthesis which also describes the relationship between a diffraction pattern and its image. The brain-memory could be seen as a transform of the information it carries[6] in the same way as a diffraction pattern is a transform of an optical image (in a hologram, for example).

It is likely to prove very difficult, however, to carry out such detailed 'simulation' of brain processes on a computer or even a network of computers. We know so little about the processes themselves. A more promising line of AI research is that of the 'synthesis' of intelligent responses, such that a machine appears to behave intelligently to us, regardless of whether the intelligence is achieved by the same processes as the brain uses.[3a] In practice, the approaches of simulation and synthesis have run along side by side, with synthesis becoming possible because of discoveries about how the brain does things, and ideas about brain processes being investigated via synthetic experiments. It is fair to say that the progress made so far is somewhat disappointing compared to the expectations of thirty years ago,[5a] but there have been some remarkable successes. What follows now is a conceptual rather than chronological chart of the developments, spotlighting some of the important milestones.

(i) Information processing

Early ideas on modelling human thought, in the 1940's, were based on the concepts of cybernetics, with feedback as the central notion,[3b,5b] providing a means by which purposive behaviour could be explained – just like process-control systems.

The goal to pursue seemed to be that of modelling the brain at the structural level – neural networks and the like – to try to reproduce some of the results of brain activity. The correspondence between the on-off behaviour of both neurons and electronic switches seemed to suggest that substantial brain structures could be modelled on digital computers. The practical difficulties of this approach, however, rendered it ineffective, except for the related discipline of 'automata studies' in which logical chunks of brain function are modelled, rather than physical brain structures.[7] Instead, an entirely different idea became central; that of modelling the brain not as a biological object but as an information-processing mechanism.

In this context, it is hard to decide whether to refer to intelligent machines, or intelligent programs. The issue certainly does not arise until they are brought together. We start to see here the logical independence of the functions the brain performs and the structures which embody those functions. Thus as general-purpose digital computers which could execute stored programs began to develop in the 1950's, AI research began to flourish; the digital computer as a symbol manipulator modelling the function of the brain as a symbol manipulator. Primitive game-playing programs and programs which could prove theorems in mathematics or formal logic (sometimes in innovative ways) soon appeared.[5c]

(ii) Rules of thumb

The rationale of programs of this kind was largely a matter of trial and error pattern matching, searching a large number of possibilities for the optimum solution. The clever thing was the way searches were economised by 'heuristics' – rules of thumb built in by the programmers. Heuristics act as a kind of filter for solutions, so that inappropriate ones are quickly rejected and the best is located without wasted effort.[3c,8] Recent highly successful chess and backgammon-playing programs have exploited these techniques.

(iii) Internal models

Despite the prevailing beliefs of behaviourist psychology, it was evident that humans and animals carry around within them a 'model' of their world. In the same way, it was realised, an intelligent program must be able to access a great deal of information about its world in order to display any intelligence in its activities, however restricted. The program could explore this internal model (which included information about its own capabilities), before coming up with an answer to a problem it was given. The responses would thus appear remarkably sensible, since many unfruitful lines of approach could be rejected straight away. By the mid-1960's, it proved possible to produce programs of this kind, with limited success.[9a]

The fascinating subject of programming computers to understand natural language illustrates the need for internal models. The problems of understanding a sentence in 'plain English' are enormous. Consider statements like "The man with the girl with the long hair hit the dog with a hammer with vengeance" or "The old man's glasses were filled with sherry". To interpret a sentence requires complex information-processing involving problem-solving at a number of levels in a hierarchy of goals and sub-goals.[3d] All the time reference must be made to a vast stock of information concerning syntax, grammar and the relationships between concepts. In 1950, Alan Turing[10] suggested that genuine machine intelligence would have been achieved when a human being could converse *via* a terminal with either another human being or a machine for some minutes without being able to tell the difference. Within a very limited context there are programs, written nearly 20 years ago, such as the famous computerised psychotherapist, ELIZA,[11] (see also Ref[12]) which begin to meet this criterion. Nevertheless, they are not interpreting language 'intelligently' as described above. Their operation is based on pattern-matching, picking out particular key words in the input and then selecting appropriate responses in the light of previous conversation. They do not in any sense 'understand' what is going on.[9]

(iv) Knowledge as a process

A major step forward in the development of programs which accept natural language input and respond in natural language was made by Terry Winograd[13] in the early 70's. His novel departure was to regard language, meaning, knowledge and reasoning as integrated parts of human thinking rather than entirely separate processes. Thus rather than our hearing or reading a sentence, analysing it for meaning and then working on the meaning using pattern matching, all these processes would occur together, referring to each other through many cycles of refinement. Knowledge is actually embodied in the way these processes inter-relate, so the structure of the program itself forms part of its internal model.[9b]

This led to a fundamental change in the way natural language programs were written. It has been suggested that the original example of this technique — SHRDLU, a program which responds to natural language commands to move around objects simulated in the machine — is the first program that actually understands what it is doing,[5d,12b] in a very limited but real sense.

(v) Self-improvement

The ability to learn is central to human intelligence. Problem-solving, creativity, language all depend on it. Thus the simulation of intelligent processes on a machine also depends on the ability of programs to learn; that is modify their own instructions without external intervention in response to information gathered from the environment. G.J. Sussmann[4a, 9c] has produced such a program (called HACKER) which resembles SHRDLU in its activities, but learns by its mistakes. It is able to reprogram itself to accomplish tasks it has failed to carry out at the first attempt. This significant achievement owes something to the particular computer language developed by Sussmann et al for its implementation.[9d] The development of suitable languages for AI work has absorbed much research effort, but is central to many of the crucial steps.

(vi) The interacting specialists

SHRDLU, HACKER and other Question/Answer programs are able to cope remarkably successfully with their own very-limited worlds. The path to simulation of more extensive thought could be to integrate a large number of such specialist programs on more-realistic worlds. Because the representation of knowledge seems to be inextricably linked with how it's used, this seems a more promising approach than trying to find a general way in which human thinking solves problems.[5e]

(vii) Some current achievements

Having glanced briefly at the history of AI research, we might ask what the fruits of it are today.

The idea of limited-domain intelligent programs has found expression in the new discipline of 'Expert systems'. This is one of the first examples of commercially viable applied AI, although its basis is a little different from some of the developments described above. 'Expert Systems' (or 'Knowledge Bases') are really intelligent databases which assimilate information about a limited area of specialism (a 'domain') from a human expert and can then make inferences from that knowledge to answer questions. In this way, the Expert System can act as an intelligent assistant, being able not only to answer questions, but also to explain how it comes to its conclusions. Expert Systems have been used successfully in a number of specialised domains e.g. mass spectroscopy, prospecting for minerals, planning the configuration of computer systems and some medical diagnosis and legal problems. It is likely that such systems will take off commercially in the next few years.[14,16,17]

Programs which provide a natural-language interface for interrogation of business databases are now commercially available and despite high cost, have attracted a healthy number of customers, indicating their genuine usefulness.[15,16]

Some success has been achieved in machines that can understand spoken, rather than typed, language. This is tricky because not only does one need to separate the words in order to understand the sentence, but one often needs to understand the sentence in order to separate the words. Nevertheless there has been some limited success here.[15]

A very significant area is that of vision research. It is relatively straightforward to set up a programmable industrial robot if you can guarantee where and in what orientation the object that it must work on will be found. But what if the part is wrongly positioned or faulty — an intelligent robot needs to deal with these things. In the picturesque words of Margaret Boden, we need intelligent robots that can "move about the place without crashing through the window or trampling on the cat".[9e]

There have been a number of developments in computer-aided teaching and learning which owe a lot to AI research.[5f,9f] The problem is to get these out of the laboratory and into practical use.

Much research in cognitive psychology, the theory of thinking, is now couched in terms of computer programs.[4b] These computational models have revealed faults in earlier theories and are themselves a great aid to the development of our understanding of human cognition. Michael Apter suggests that "the computer may prove in the long term to be as important to psychology as the telescope has been to astronomy and the microscope to biology".[3e] AI has given us a new set of 'mental tools'[4b] which helps us to think systematically about complex mental activities, and how they are actually put into practice. How does a robot arm go about threading a needle, for instance? Expressing cognitive theories in the form of programs, moreover, makes explicit some of the questions which lurk unasked within a purely verbal statement of a theory.

AI research, then, has made impressive progress in the last couple of decades, but it has been slower and much more difficult than expected. The optimism of early protagonists has not been borne out.[5a] In the future, particularly in view of the Japanese proposals mentioned above, we could expect to see rapid development in commercial applications of AI such as Expert Systems, robotics and natural language interfaces. Use of AI in education, programming methodology and personal computing may blossom too[16,17] but we are far from the 'Ultra-Intelligent Machines' which have been predicted by some to be the salvation of humanity from bureaucratic chaos and our lack of competance to deal with the complexity of our own affairs.[18a] Revolutionary developments in computer architecture ("5th generation computers") and the proliferation of cheap personal computers, however, put us in a very different world in the 1980's, and AI will no doubt ride on the back of these developments. Commercial opportunities for AI now opening up will also speed progress, so although the performance of AI prophets in the past counsels us to be cautious in the estimation of future achievements, we could find ourselves in the age of the intelligent machine sooner than we might suppose.

Nevertheless, there are still doubts in some quarters about the extent to which machines *can* carry out processes which normally require human intelligence. The possibility that an appropriately programmed machine could embody thought in any human sense at all is denied by some; it is to their arguments that we will now turn.

3. *CAN AI BE ACHIEVED IN PRINCIPLE*

Some philosophers believe that human thought could not in principle be simulated by computers. There are at least five lines of argument here:-

(i) *Gödel's theorem.* A mathematical or logical system, Gödel's theorem states, cannot prove everything that can be stated in its own terms, even though its statements might be obviously true to us, standing outside the system. It follows that an intelligent program might not be able to decide the truth of a statement, whereas its programmer could. Therefore, the argument goes, machines can never be as intelligent as humans. This argument is simply mistaken.[3f, 9g] Gödel's theorem is only true for systems which are 'closed', i.e. nothing more can be added to their rules. A program which can learn would be free of this restriction, so Gödel's theorem does not apply.

(ii) *Tacit knowing.* Polanyi pointed out that mental processes are not entirely conscious or overtly logical.[19] They involve leaps of intuition, for instance, or inspired guesswork. In addition, a vast background of implicit knowledge, not accessible to introspection, underlies human thinking. To construct a system which mimics human intelligence we would have to systematize this body of knowledge, and formulate ways in which the system might make intuitive leaps. This would be difficult for us to do (e.g. how do you recognise a face or perceive someone as beautiful?) but there is no reason to suppose that it is impossible *a priori*.[4c] Otherwise we could be accused of a kind of "humanity of the gaps". Perhaps an intelligent program could examine its processes more freely and suggest some mechanisms, or we could set up experimental programs to test our own inspired guesses about how we make inspired guesses!

(iii) *Human emotions.* It is argued that a machine could have no understanding of human emotions because it hasn't the physiological apparatus to 'feel' them. There is more to emotions than their subjective element, of course. For a machine to simulate the experiencing of emotions, there must be effects on the machine's behaviour — i.e. on its physical states. Feelings might not be relevant at this level, even if it were demonstrable that there could be no machine analogue of them.[9h] The psychological origins and effects of human emotions are as significant as their symptoms, for the latter may vary with the context. The same physiological correlates of feelings, e.g. high adrenalin levels, may be interpreted as excitement or fear depending on the context. If a machine could handle the language of emotion appropriately, then, we could say that it understood emotions, regardless of whether it felt them in the same way as we do.

(iv) *Thinking by analogy.* It is claimed by some that no purely mechanical device can 'think' because the origin of the thinking is not intrinsic to the device, but merely the outworking of the programmer's thinking.[9i] Hence any intelligent behaviour in the machine, even one programmed by another machine, is ultimately traceable to a human being, and as such is only an imitation or analogy of human thought rather than 'true thought'. It would not be too difficult, of course, to apply the same argument to the programmer!

This is quite possibly a semantic problem to do with what we mean by 'think'. At present in our conceptual framework, the word doesn't extend to machines, but language appears to shift its meaning at deep levels according to the cultural environment. It may become easier to conceive of machines thinking purely because our language changes. It was not so long ago that European aristocrats could not conceive that the peasants could think, or even that women could.

(v) *The paranormal.* If we include in human thought the paranormal phenomena for which much evidence has been amassed in recent years[20] it can be argued that AI machines constructed according to physical principles could not exhibit such behaviour and would not therefore fully simulate thought. This follows from a dualist view of mental phenomena, which will be discussed in the next section. However, if mental phenomena (with their subjective correlates) could appear in a machine, it is not immediately obvious that psychical phenomena could not. They are both equally 'non-physical'.

Overall, the philosophical objections to the realisation of machine intelligence are not convincing;[9h] certainly no more so than they were 30 years ago,[1] although in practice, of course, the task is still immensely difficult to conceive. We do not have to proceed far along this road, however, before a major problem arises, which we have touched on briefly above. That is the relationship between mind and brain, whether the 'brain' is organic or not. It is at this point that the relevance of AI to the Christian world view begins to emerge.

4. *THE MIND-BRAIN PROBLEM*

What is the connection between the mind and the brain, and indeed is it meaningful to ask such a question? It is necessary to clarify this problem to some extent before we can discuss the nature of machine intelligence further. There are two separate issues I wish to distinguish. The first is the relatively trivial question of the relationship between physiological processes in the brain and the 'having of experiences'.[42] Scientific evidence suggests strongly that we can correlate the 'having of experiences' with particular biochemical/electrophysiological events going on in the brain at the time, and implies that there is no objection in principle to correlating all mental events with brain processes.[4d,21a] All mental events, that is, from the point of view of an external observer. That brings us to the second problem — that of our subjective experience of mental events; the experiences themselves, in other words, rather than the 'having of experiences'. How can subjective experience come about in an objective causal mechanism — the brain?[9j] Bridging both issues, the problem of pre-eminence arises. Does the mind control the brain (and hence the body) as our subjective feelings affirm, or do the deterministic processes going on in the brain dictate what goes on in our minds?

The traditional approaches to these problems have been along two lines. Firstly a 'dualist' approach, in which the mind and the brain are considered to be two different 'substances', and secondly a 'monist' approach wherein the mind is not considered as separate from the brain for a number of quite distinct reasons.[3g,6b,22a]

Dualist philosophy may be traced back to Plato, but its best known exponent is Descartes, the 17th century philosopher. Descartes' view was that the mind had an existence of its own, unrelated to that of the body, except that they interacted by way of the pineal gland — a unique structure in the centre of the brain. The mind was firmly in control. As far as our everyday lives are concerned, this is still very much the common sense position.[3h] It 'feels' as if the mind controls the body, except for those 'I couldn't help myself' situations. The usual objection to this dualist and 'interactionist' position is that if mind and brain are different kinds of thing, obeying different laws there is nothing that could count as an interaction between them.[23] Moreover, if a physical system were set in motion (even through a hair trigger) by a non-physical entity, the principle of conservation of energy, it is claimed, would be violated.[6c] This is not strictly true. If energy appeared at one place within the system and disappeared at another when an interaction of this kind occurred, or was paid back later in time the principle would not be violated.[20] It is difficult to envisage a mechanism for such a process, however.

An alternative to Descartes' view was put forward by his pupil Geulincx and is known as 'parallelism'. In this form of dualism, there is no interaction between mind and matter. The mind and the brain travel on parallel tracks, as it were, and correlate perfectly for no discernible reason. The best objection to this is probably, in the words of Bertrand Russell, that it is very odd! Parallelism begs all the questions and gives us even more to explain.

The third dualist view regards mental events as by-products of brain processes and is knwon as 'epiphenomenalism'. It is associated with T.H. Huxley, and is held (implicitly or explicitly) by quite a number of scientists.[6d] It is clear that changes in the brain induced by drugs, damage, or electrical probing do indeed result in certain changes in the conscious experience of the person concerned. However, we must ask how this causation of mind by body is to be explained. We would need to postulate a set of psychophysiological correspondence laws which would account for the existence of the totally non-functional mental 'danglers'.[21b] This view appears to accept full physical determinism for mental events, and as such many of its proponents would consider themselves 'monist' rather than dualist in their philosophical position. Nevertheless it does require a separate mental 'substance', albeit a somewhat superfluous one.

With the recent advances in brain research, a number of phenomena have come to light which inspire a contemporary restatement of the Cartesian position known as 'emergent interactionism'. The experiments of Roger Sperry on individuals who have undergone 'split-brain' surgery for the relief of epilepsy, for exampe, may possibly imply that the two halves of the brain can exhibit separate consciousness.[6e] Taking this to be so, Sperry suggests that 'mind is an emergent property of cerebral excitation'.[6f] A related but somewhat different view has been expressed for many years by Sir John Eccles, most recently in his book written with Sir Karl Popper *The Self and its Brain.*[25] Eccles takes a specifically interactionist position, and attempts to locate the mechanism by which mind and brain influence one another. He originally suggested that the synapses, with their probabilistic operation, provided a chink in the armour of mechanism. Lately, he suggests that an area of the neo-cortex he calls the 'liaison brain' is the site of the interaction. Many would feel, however, that this approach smacks of a 'God of the Gaps' argument, and does not offer unambiguous evidence for the existence of a mental 'substance'.[22b]

The 'monist' philosophical tradition can trace its pedigree back to Aristotle, by way of Spinoza, Hobbes and perhaps Leibnitz, who argued that body and mind are different *aspects* of the same substance. There have been various schools of thought here, from the 'idealism' of Berkeley and the 'hypophenomenalism'[24] of Schopenhauer where the material world was a by-product of mind, to the 'materialism' of Hobbes, where mind was reduced to matter.[3i] In modern times, the antithesis between idealism and materialism is reflected in the phenomenological vs. behaviourist schools of psychology.[3i] In the former, only mental events are considered significant, and in the latter, only physical.

It is from behaviourism, though, that some very significant monist views of mind and brain have developed. Around the middle of this century the working assumption of behaviourism (that psychology could best be studied by observing measurable behavioural events) gradually turned into a belief that mental events, to all intents and purposes, do not exist at all.[6g] This neatly disposes of the mind-brain problem but has the drawback that it is in fact nonsense. Over the last 20 years or so, this has become apparent, and psychology has begun to explore more fruitful avenues. In parallel, a philosophical offshoot sometimes called 'logical behaviourism'[23] suggested that the meaning of mental statements was analysable purely in terms of behaviour (including physiological changes). From there, it is a short step to the 'Mind-brain identity theory' as developed by Feigl[21] and by Place,[26] in which mental events are just physical events described in another language. This position is restated more emphatically as 'central state materialism' by a group of Australian philosophers including Smart and Armstrong.[27]

Identity theory has a lot to say about the first problem I distinguished at the beginning of this section, namely the relationship between brain processes and the 'having of experiences'. It says that these are two ways of looking at the same events. Thus it is meaningless to talk about one causing the other — they are one and the same.[28] Unfortunately, however, many of the stricter 'identity' formulations completely sidestep the second issue, how the experiences themselves arise from pure physiology. Patently, a train of nerve impulses is not the same thing as smelling garlic; it doesn't hurt any less if you know that the pain you feel is merely the activity of your central nervous system. However, to say that 'A is B' is not as simple a statement as it might appear. Identity theorists maintain that the 'is' in 'a mental event is a brain process' translates one language into another, whereas it may in fact be a reductive statement like 'lightning is an electric discharge' which is not an identity statement because it's not symmetrical i.e. 'an electric discharge is lightning' is not strictly true. However, we know from our own experience that mental events like images, emotions, pains etc. *do* exist *and* are not the same things as the brain processes underlying them.

Logical behaviourists such as Carnap and particularly Ryle in his iconoclastic book *The Concept of Mind*[23] have argued that the mind is not a 'thing' or a 'process' at all but merely refers to a disposition to behave in certain ways. Thus there is no more a 'mind' in which I have thoughts, than a 'lurch' in which I might find an unfortunate bride. There is something valuable here in that it shows up how much of our thinking about mind is couched in dualistic terms. We tend to think of mind and body as distinct *things*, both of which actually exist, although when we ascribe mental states to other people ('He is angry') we are in fact deducing information about their feelings from their physical behaviour. None the less, extending Ryle's analysis to ourselves does give us just this difficulty because we *do* have experiences and thoughts which are not observable *and* not merely dispositions to behave. To deny this we would be deceiving ourselves.[4e]

Overall, then,the monist positions assert the identity of brain processes and the 'having of experiences', but do not explain the origin of subjective experiences themselves in the deterministic brain. Ayer points out that we do not need to postulate a causal relationship between mind and brain, that the physiologists' story is complete in itself, but nevertheless we cannot throw out the *language* of mind.[28] The two languages — those appropriate to mind and to brain — do not mix, but they are both equally valid. Neither is superfluous. Boden adds that language which employs subjective concepts cannot be translated into purely mechanistic terms because sentences expressing 'intention' have a different pattern of logical implications from those which do not include subjectivity.[9k] So we reach an impasse — the brain processes are there, the experiences are there, the correlations are there, but the connections remain obscure.

On the face of it, some form of dualism is necessary in that subjective experiences are *not* the same as brain processes any more than a slide is the same thing as its projected image.[3j] On the other hand, there is no unambiguous evidence for the existence of a mental 'substance'. Moreover, it is not at all clear that the categories used to discuss these issues are themselves adequate to formulate answers to the problem.[29] It seems likely that the mind-brain problem genuinely takes us to the limits of our comprehension. Perhaps the only way forward here is computer modelling — it is the only tool for the job which we do not share with the ancients.

From the Christian point of view, I feel, the most satisfactory account of the problem is MacKay's 'Comprehensive Realism' which agrees with traditional dualism that mental processes are just as real as physical events, but agrees with classical monism in rejecting the idea of a separate mental substance. Thus brain events and mental events are not two distinct sets of occurrences, but 'outside' and 'inside' aspects of a single set which are *logically* separate even though they both arise within the brain.[30]

It is important to note that MacKay's solution does not entail a panentheistic view of the universe, in which God is considered to be merely an aspect of the physical universe. The transcendent God of the Bible is neither physical nor mental in substance, and the way in which He affects our lives and we communicate with Him remains a profound mystery whether we consist of one, two or many 'substances'. To do justice to the Biblical revelation of the nature of God, we must see Him as both beyond nature *and* intimately involved in it, upholding natural processes in their *normal* operation, not only in miraculous interventions.[31]

On the subject of transcendent events, it has become apparent that our understanding of causality in the universe is, at best, incomplete. Parapsychological phenomena and more commonplace 'coincidences'[32] as well as religious experience all seem to transcend our notions of physical causation. Some find this convincing evidence for dualism,[20] although I do not subscribe to this myself, as I do not feel that these phenomena are necessarily non-rational or indeed have no physical basis. Gravity, after all was pretty mysterious before Einstein, although its laws we must admit were far easier to elucidate.

Before we leave this topic, it may be instructive to return to the theme of programs and computers, which throws an interesting sidelight on the mind-brain problem. In the computer it is clear that the physical description of events is not the whole story; much clearer, indeed, than in organic systems. It is not only the physical machine which must be considered, but also the logical structure of the program, if we are to obtain the results we want. For example it is possible to run the same program on two different computers and obtain the same results, even though the electrical processes in the two cases may be quite different. A program embodies a logical process (such as the calculation of my salary). The function of the program can be described as a series of logical steps without reference to the physical processes which underlie their execution. Can we say, by analogy, that mental processes *in* the brain can be considered the equivalent of the running of programs in the computer?[33] We probably can. The relationship between the logical states traversed by a program and the physical states traversed by the computer running the program is very interesting. It cannot be considered causal in either direction, as the machine executes the program, but the program directs the machine. It is not merely a correlation, as there is a definite relationship between the program and what is going on in the electronics. This is true whenever one considers the *state* structure of a system as well as its physical structure. Aleksander has shown[7] how the activity of the brain in certain psychological processes can be described as simple interactions between functional (not necessarily structural) units in the brain; interacting programs in effect. Again, though, we may have missed a turning. Regarding the brain as an automaton with a state structure might help us to understand what the brain processes are that underlie our 'having of experiences', but it still does not tell us the nature of the conversion between brain process and conscious experience. The logic of the program is not, in itself, the conscious experience of the computer, any more than the instructions stored in the cerebellum which enable us to ride a bicycle or tie a shoelace are the same as our conscious experience of those activities.

We need to ask now how the mind-brain problem could be significant in the development of 'thinking machines' and their implications. There seems nothing in the foregoing arguments that would suggest that the programming of 'artificial brain processes' should be impossible in principle, but any suggestion of 'artificial minds' would be more contentious.

5. *THE CONSCIOUS MACHINE*

We have seen that brain activity underlies mental activity in our own case, and we have seen that it is not out of the question in principle for machines to simulate human thinking. The obvious question now is this. Could there be a conscious agent facing us in the machine? Could computational activity in a machine betoken consciousness just as human brain processes betoken consciousness?

It is interesting that neither a dualist nor a monist view of the mind-brain problem would rule out this possibility, *a priori*. If we were to program a machine with appropriate brain processes and test it somehow for having a 'mind', a positive result would please the monist, clearly, but the dualist could reasonably claim that the 'mind' had arisen as a epiphenomenon which we had not built in[6h] or had taken up residence in a structure that exactly suited it. What do we do about the begged question of testing for a mind, though, in any case? This in itself is an example of the general problem of demonstrating the existence of 'other minds' which has exercised philosophers for centuries.

I have already referred to the Turing test (section 2 iii). One objection to this kind of technique for the demonstration of machine intelligence, or machine consciousness in this context, is that it relies so heavily on the equation of linguistic competence with conscious thought. Even though it seems possible in principle to construct machines who think, it is far easier to construct machines who *say* they think, or at least give the impression of thinking in what they say. Similarly, it is more difficult to conceive of a machine which has conscious experiences than one that says it does. Of course if a machine's behaviour at the information-processing level tied in well with my own, and if its description of what it *felt* like to be conscious was like mine, I would perhaps be churlish to deny that it was indeed conscious. Should we apply a stricter criterion here than that which we apply to people? As Turing one remarked[5g] "It is usual to have the polite convention that everyone thinks". Nevertheless for a wide-ranging conversational machine which passes the Turing test, there is no understanding without intelligence i.e. rational thought in the human sense.[91] The problem is whether such intelligence could be generated merely by extending the scope and subtlety of the rules with which the machine was programmed, albeit by orders of magnitude, or whether something else would be necessary.

Experiments with AI so far have revealed at least two 'things else'. One is the necessity for self-reprogramming, which is essential for any living organism adapting to its environment. Not only do brains deal with their own data-capture and information processing, but also with the 'writing' and 'modification' of their processing instructions. For a machine, at present, the programming is external, and any strategic adaptation is only there because someone has programmed it to be.[18b] For machines to develop intelligence and hence understanding, they must be able to modify their programs adaptively — precisely the ability displayed by Sussmann's HACKER (see 2 v) in a primitive way. There is already considerable evidence that programs can be written which program better than we do i.e. producing more efficient and economical programs from a human programmer would.[34] It becomes increasingly difficult as these processes become more sophisticated, to claim that the program's intelligence is merely a reflection of its programmer's intelligence. The analogy of a person's intellectual debt to his teachers, mentors and heros is more appropriate.

The second essential for programs which understand, is the ability to learn from their environment in order to build up their internal model of the world. For machines as well as humans it is necessary to assimilate a huge body of common-sense information in order to understand even a simple conversation — Polanyi's 'tacit knowledge' again.

It should be remembered that virtually all current computer systems are entirely stupid in the AI sense. They don't reprogram themselves. They don't learn from their mistakes or adapt. This is because they are not programmed to do so, of course, but if we *did* program them appropriately, remembering that any logical process can be simulated on a digital computer, it is hard to deny the possibility that a physical machine with its logical program could embody a conscious individual.

How far the language of humanity could be applied to such an individual, of course, depends upon the programming. The monsters of horror films are frightening not because they are not intelligent but because they are not human; that is they do not respond in a way we would expect humans to respond, particularly in compassion. Could a program be good or evil then? Could an artificial mind appreciate beauty or experience love or suffering? If we accept that underlying these moral attributes or subjective experiences there are brain processes, then if we knew the logic of these processes we could indeed program them. Whether the machine would subjectively feel as a human would in the same circumstances is impossible for us to know. In the end a monster is a monster to us because it behaves like one.

The truth of the matter is that we don't know whether a machine might embody a conscious agent. It is a genuinely open question, and quite possibly inaccessible to us.[4f]

6. *THE CHALLENGE TO CHRISTIAN WORLDVIEWS*

We have seen that it is not absurd in principle to suppose that machines could embody thinking agents, and thus display human-like intelligence, and even consciousness. This brings us to a crucial point. What are the implications of this for the Christian faith?

Machine intelligence is one of those topics which the non-believer is apt to take up as a cudgel on his behalf, as it seems at first sight to be an issue where the discoveries of science have 'disproved' Christianity. The Christian view of man, in the popular mind, is an unscientific, supernatural one involving disembodied souls, unsubstantiated miracles of healing and sentimental beliefs about the sanctity of life. No wonder the apparent triumph of mechanism in AI is seen as a fatal blow.

Well, is it? In the introduction, I posed a number of questions about the impact of AI in principle on Christian world views, and raised some issues on the effect of applied AI which require a Christian response. As we examine those questions now, it should be clear in the light of our understanding of mind, brain and consciousness that AI does not undermine Christian views of man, and indeed demonstrates eloquently that the mechanistic description of an entity does not tell us everything there is to know about it. Other *complementary* descriptions are necessary if we are to do justice to its nature.

(i) *AI in Principle*

The questions raised at the beginning were:
Is our thinking purely mechanical if machines can model it?
What is a mind if machines can have one?
Is there room for the supernatural and life after death?
Does intelligence in machines demean our human status?

All these reflect the effect of reductionism on the popular view of science. If our existence is grounded in a mechanistic base, it is thought, then anything else is not 'real'. People feel, quite mistakenly, that experience explained is experience explained away. This is quite false.

Christians have fought reductionism long and hard both on the basis of dualist views and along lines which emphasize rather the unity of human nature: viz. multi-level science involving different descriptive languages at different levels[35] and complementarity between observer and actor views of the same events[36] i.e. between mechanism and meaning.

We must ask now whether AI raises any issues which are not satisfactorily dealt with by these traditional arguments. The answer, I think, is no; but there are a number of *apparent* problems which have led some to claim that the creation of an 'artificial mind' capable of at least some aspects of human thought would automatically disprove the claims of theology. This is perhaps more a consequence of issues ignored by some advocates of hard monism, rather than real problems raised by it. Reductionists such as Monod[37] and monists such as Ryle[23] have taken the view that there is no 'ghost in the machine', no 'mind'; it is all mechanism and there is nothing more to be said. 'Everything is stuff and what's not stuff is nonsense'. This, in the popular view would be proven if a machine constructed of nothing more metaphysical than metal and plastic were shown to exhibit intelligence in the sense that we have been using that word. However, as we have seen above, neither dualism nor monism can be proved by AI. We can say that, even now, the results of AI research constitute an existence proof that mental phenomena can be grounded in a mechanistic causal base, in so far as theories of behaviour, belief systems etc. can be presented in terms of computer models. All thinking is mechanistic in that sense, but not *merely* mechanistic since this says nothing about the meaning of those psychological processes to the creature in which they are embodied. That, after all, is what we are concerned with (most of the time) as human beings. That is what constitutes reality for us.

To understand its physical basis does not stop it being real. To understand the physical and indeed psychological mechanisms of faith, similarly, do not stop it being real to us as persons. It is no good refusing to pay your gas bill because you know it's only a piece of processed cellulose with chemical dye marks printed onto it by computer. What it means is what matters.

There is no reason then for Christians to fear erosion of their faith because 'intelligent thought' may one day be attributable to man-made devices.[1] Christians argue for the freedom and responsibility of men's *minds* before God, not their *brains*, for it is people who think, not brains.[4g] None of the developments of the last 30 years make a scrap of difference to that basic premise. The language of free will and moral responsibility is of course mind-language, not brain-language. It is *persons* who make moral and ethical choices and are responsible for them. This is not to say that in the case of brain damage *etc* there may not be some limitations on the extent to which society chooses to *hold* individuals responsible for their actions and so punish them for wrongdoing. That is a judicial issue, not a biological one.

Conversely, there is no Biblical reason to suppose that an artificial mechanism could not be the brain of a conscious individual, so it is neither necessary nor correct for Christians to deny the possibility on Biblical grounds. Hence on the issue of mind, AI holds no threat to faith. Indeed, the relationship between mind and body as two complementary descriptive viewpoints of one set of events has been illustrated by the results of AI research more clearly than was apparent 30 years ago. The concept of the stored-program computer, the logic of whose operation is clearly not derivable from the structure of its components, is an important clue, but beyond this the kind of program capable of simulating cognitive processes — with internal models and the ability to learn from its environment and adapt its own instructions — leads us to a better understanding of conscious thought and the circumstances under which it may arise. Of the machine's subjective experience, of course, only the machine can know.

On survival and the supernatural, popular ideas are influenced more by Greek concepts concerning the immortality of the soul rather than the Biblical view of the resurrection of the body — that is the whole human being, I would argue. Belief in a disembodied immortal soul is somewhat more difficult to hold in the face of science than belief in the resurrection of the body.[38a] Clearly, for the whole human being to survive death requires a trancendent view of God as expressed above, for (while being wary of God of the gaps thinking) it is hard to envisage a mechanism for resurrection on our understanding of the physical universe alone. Knowing what we know about the running of computer programs on alternative hardware, however, invites speculation about the re-embodying of the logical structure of a personality.[1,4h] We can say no more.

The fear that intelligence in machines would demean our status as human beings is an echo of the foregoing points on the secular level. The trap is to accept that intelligence in mechanical devices means that our intelligence is mechanical and there's nothing more to humanity. On the contrary, however, mental phenomena are *both* psychological *and* mechanistic and the separation of meaning and mechanism is not a matter of opinion but a matter of logic. The only real attack on Christian views here occurs when the *existence* of self-consciousness, reason or free-will are denied[38b] which is to deny our own experience. If machines were programmed to share some of our mental attributes, and ultimately our subjective experiences, this might give us cause to treat them with greater respect for their welfare and even feelings (should we amend a program or switch off a machine against its will, for example), but there is no good reason for this to belittle humanity. If mind-language were to become appropriate for machines and indeed if our brains are properly understood as mechanisms, this does not eliminate our thinking, our feeling, or our spiritual life, for all these are to be understood in the personal, existential dimension, not that of brain cells or electric currents.

The tragedy of this view is that it could become a self-fulfilling prophecy. If people expect to be demeaned by machines they will be. Surely it would be worthwhile for Christians to encourage a more constructive approach, emphasising the *personal* status of human beings before God and each other, and showing that the understanding of the physical basis of personhood does not require us to renounce its reality. It is the legacy of the industrial revolution, perhaps, that we traditionally associate mechanical artefacts with unthinking unfeeling, inhuman behaviour. It is this very association which may soon be found wanting.

(ii) *Applied AI*

It is as well to glance briefly at issues which may become significant in the foreseeable future if the more optimistic predictions about AI are fulfilled.[39]

The first question here is the effect communication with intelligent devices might have on our psychology in the long term. Would lonely people find real companionship in an intelligent machine or would more people become isolated from one another because the machines were easier to get on with than other human beings? Might we become dependant on the machine's intelligence and unable to think for ourselves as in E.M. Forster's story 'The Machine Stops'? Slavery to artefacts chosen in preference to relationships with persons has been a recurrent theme of human history from the Kings of Israel to Rubik's cube, but it is not so easy to define when we're talking about intelligent artefacts. From the human side at least, the tokens of communication or indeed of relationship may appear to be given and received with uncanny ease. A great number of intelligent people have been thoroughly fooled by Weizenbaum's conversational program ELIZA (see section 2 iii), for instance. Again, a clear understanding of what is actually going on in these situations would help us deal with them, but there is no easy answer here.

More immediate social issues are perhaps more important. The effect of intelligent machines on employment is very hard to predict, and must be of significance to concerned Christians. Opinions vary as the long-term effects of technology on employment, but there is no doubt that the introduction of devices capable of high-level clerical skills would encroach on areas of employment which have up to now been untouched by automation. This makes it even more difficult to assess their impact. The main responsibility of planners is again to treat people as people, not brains, machines or numbers. I suspect that fear of unemployment is a major factor in the feeling that AI may belittle humanity.

A final social point is the danger of AI getting out of control. This is not to say that machines may try to take over the world or some such science-fiction, merely that it is possible allow intelligent devices too much unsupervised power over the lives of human beings. A computerised legal system, for example, could leave little scope for argument or appeal. The issues here have some connection with the computer privacy problem. An intelligent machine which could act on information it accessed of its own volition could be as mischievous as any prying eye. The solution here is one of responsible system design and programming, but it is debatable how easy it will be to enforce particular standards in these matters. The detail is so technical that any legislation, necessary as it may be, could turnout thoroughly unwieldy.

The social issues raised by AI are much more far-reaching than those of computer technology today. Indeed the development of intelligent machines may turnout to be as significant to our evolution as the first use of tools.[40] The dehumanising aspects are real if people believe them to be. We need to guard against the tendancy to treat people (and AI devices?) as 'nothing but' mechanism and grasp unequivocally our subjective, existential nature which is far more relevant to us as rational and indeed spiritual beings.[41]

7. *CONCLUSION*

In discussion following Prof. MacKay's paper to the VI in 1952, Prof. Coulson welcomed the changes in apologetics which were being forced on the Christian community by the discoveries of science. In particular, the demise of the view that the understanding of the mind was to be parcelled out between 'science' and 'religion', for as science inevitably grew, religion's region would gradually vanish. The recognition of the true relationship between science and religion would only come by an enlargement of our concepts, such as the idea of complementarity between observer and actor views of the mind. Coulson concluded with the meorable sentence "A Christianity free from the wateful necessity to defend its little strip of the mind's territory can appear more brave, more convincing, more fulfilling than it ever could have been for earlier generations."

The progress made towards machine intelligence in the last three decades has illustrated how important it is for Christians to grasp this point. No longer can we defend the position that the brain is not describable in principle in mechanistic terms, nor should we feel any need to do so. Instead, our role is to emphasise the fact that mechanism alone does not constitute reality for us. The personal, existential dimension — the actor view of events — is the world in which we have our being. What could be a clearer illustration of this than the appearance of mental phenomena in artefacts?

No matter how far or fast AI develops in the future, our dignity as people and our faith as Christians need not be harmed. It all depends on a right understanding of ourselves, fully compatible with the Biblical picture, as multi-faceted creatures — formed of dust and yet living souls. If we appreciate this, then Artificial Intelligence should not threaten genuine faith.

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