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An Accelerator For the 1970's

J M Dickson

In the '30s the atom was smashed, in the '40s pions were produced, in the '50s strange particles were discovered, in the '60s the elusive neutrino was caught, in the '70s ..... who knows what? In this way we could distil the history of accelerators. If there is to be a continuation of this fantastic evolution, accelerators must go even higher in energy, probing still further into the heart of the nucleus. The present range of the physical measurements we can make, spans from 10^{27} cm. the distance to the furthest detected galaxies, down to 10^{-14} cm. the smallest nuclear probe provided by our accelerators. Beyond these limits nothing is known about the laws of physics or the creation and structure of matter.

The highest energy accelerators now in operation are the CERN PS in Europe and the Brookhaven AGS in the United States, both with a maximum energy of about 30 GeV. In Russia a 70 GeV machine is being built and is expected to operate in 1964. The question now being asked in Europe, the USA and in Russia is, what should be the energy of the next accelerator? Let me attempt to summarise the requirements and the possibilities. The accuracy to which we can probe a nucleus with a proton beam is determined by the proton wavelength (λ) and, since this wavelength is inversely proportional to the square root of the energy of the protons, a large step up in energy is needed to be of significant benefit to us. For example – at 30 GeV $\lambda = 2 \times 10^{-14}$; at 300 GeV $\lambda = 0.6 \times 10^{-14}$ cm. Some high energy phenomena vary very slowly as the energy is increased but at very high energies some nuclear properties converge. We would like to have high intensity and high energy beams of pions, kaons, hyperons and neutrinos and also the highest possible energy of protons, for experiments to explore this new region.

These requirements have been studied by various committees at CERN and in Great Britain to formulate a proposal for the future European accelerator programme. At present the proposals are that a proton synchrotron of between 150 and 300 GeV with a current of about 10^{13} protons per pulse should be built by an international laboratory. National or regional machines are also required, such as a 500 – 750 MeV pion factory, a 10 GeV kaon factory and an electron accelerator of at least 10 GeV. Storage rings should be constructed for use with the CERN PS, thus providing two 25 GeV beams which, in collision, would produce effects equivalent to those of protons of 1300 GeV striking a stationary hydrogen target.

A design study of the 150 to 300 GeV accelerator has been carried out over the past year and a report will soon be presented to the CERN council. This machine would involve principally a scaling up of the CERN PS, but it would be necessary to inject into the synchrotron ring at an energy of several GeV. Two possibilities for the injector have been considered; a linac of about 3 GeV and a synchrotron of 6 GeV. The latter is economically and practically much more attractive, although it involves an, as yet, untried component, namely a fast and efficient extractor. The 150 GeV machine

AN ACCELERATOR FOR THE 1970's — cont'd.

would be three quarters of a mile in diameter and would occupy a site of four square miles; the 300 GeV machine, one and a half miles in diameter and about eight square miles of site. (If these dimensions make you dizzy, try comparing Nimrod to a wedding ring and the 300 GeV machine to the rim of a bicycle wheel !)

The 6 GeV synchrotron (or booster) would have a 200 MeV linac injector of about 500 feet long, (about one and three quarter inches on our "Daisy-Daisy" scale). This linac has been studied by some of us in the PLA Accelerator Physics Group, with the following results :- The linac would be a conventional Alvarez machine with eight tanks powered with 5 MW per tank at 200 Mc/s. Since the machine would be heavily beam loaded, the modulators and RF control present one of the major design problems. Known and well tested techniques would be used in the construction of this linac, so that, in spite of its complexity, it should have a satisfactorily high operational reliability, at least 80%. The cost was carefully considered, and the parameters were adjusted to give minimum cost consistent with good design. The linac remains an expensive part of the whole machine, in terms of £.s.d. per MeV, but would cost only 2% of the total.

Time, manpower and money will have to be found, balanced and spent before this giant can be born. Fortunately, the construction time is not proportional to energy so that we could expect to see a 300 GeV machine built in our life-time, possibly by 1972; a 150 GeV could be completed in 1970. The staff of this new laboratory would increase steadily during the construction period and it is expected that at the completion date the total staff for the 300 GeV machine would be about 2000 (one quarter being professional physicists and engineers). The staff requirement is also not proportional to energy, since the planning, design and model work is fairly independent of energy. But the cost of the synchrotron proper is nearly proportional to energy. However, because of 'overheads', the overall cost of a 300 GeV machine would be about 50% more than a 150 GeV machine. It is interesting to note, however, that the annual cost of construction from the fifth year onwards would be the same for both machines, at £20 million. The usual rule-of-thumb would say, therefore, that the operating costs would be the same - this is approximately true.

The output of high energy physicists from British and European universities is expected at least to keep pace with the growth of high energy accelerator facilities. By the early 1970's, at the present rate, there would be over 100 Ph.D. high energy physicists in Britain available to work on the 300 GeV machine and there is no doubt that we, as a nation, would be able to make full use of our share of this huge and exciting accelerator.

A possible site for the accelerator has not been chosen and it is indeed very difficult to find several square miles of flat ground on a suitable geological foundation. Sites are being discussed, including some in Britain.

Looking further into the future, there have been tentative moves towards the planning of a world machine of even higher energy for which America, Russia and Europe would pool their resources. But here we enter the field of politics, where very strange particles can be generated.

The contemplation of the laws of the universe is connected with an immediate tranquil exaltation of mind, and pure mental enjoyment. The perception of truth is almost as simple a feeling as the perception of beauty; and the genius of Newton, of Shakespeare, of Michael Angelo, and of Handel are not very remote in character from each other. Imagination, as well as reason, is necessary to perfection in the philosophical mind. A rapidity of combination, a power of perceiving analogies, and comparing them by facts, is the creative source of discovery. Discrimination and delicacy of sensation, so important in physical research, are other words for taste; and the love of nature is the same passion, as the love of the magnificent, the sublime, the beautiful.

HUMPHRY DAVY

'Who ever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before would deserve better of mankind and do more essential service to his country than the whole race of politicians put together.'

SWIFT

COMPUTERS

A Survey (II)

J Howlett

In the August issue I gave the important facts about computers, how much information they can store and how fast they operate, for example. I want now to consider them more from the point of view of the user, discussing how we are to get them to do what we want and then to say a little about the future.

The most powerful machine loses much of its value if we cannot communicate with it easily. Communication here means telling it what to do - writing a program and feeding it in - and finding what it has done. There is a very live interest now in the communication problem, which is recognised as one of first importance. The early computers acquired something of an air of mystery with a high priesthood to minister to them, but now we want to make them work for all and sundry and to make it easy for everyone to write his own programs and to get them working quickly. Programs are stored inside the computer in the machine's own language which is extremely precise, highly formalised and entirely different from, say, the ordinary language of mathematics - it is, after all, designed to suit electronics rather than people. Writing in this language is a most tedious business, and certainly the necessity of doing so put off most people in the early days. In the middle 1950's it became clear that the machine itself could be used to translate from some much more natural language into machine code, and so take a large part of the burden off the programmer's shoulders: the great success of, for example, the Autocode language for the Mercury computer illustrates the importance of the idea. The program which translates from such language into machine code is called a compiler, the language itself an algebraic or problem oriented or machine independent language.

Many such languages are being used, and there is certainly a good deal of confusion in the situation at present. The ideal would be to have one or a very small number of languages accepted as standard with compilers for all machines so that programs could be freely interchanged between different centres. There are discernible trends towards this, though with much diversion on the way. Two strong candidates for at least a basis for a universal language are Fortran, devised originally for the IBM 704 and used very widely indeed with IBM machines and many others, and Algol, produced by a European/USA Committee which set itself up specifically to produce such a language. Both Orion and Atlas will have compilers for these, and also for Mercury Autocode. This question of languages is of the greatest importance; apart from considerations of interchange of programs, a good language helps the programmer to tell the machine how to carry out complicated procedures, just as a good spoken language helps in the communication of complex thoughts; and as a good notation is essential to progress in mathematics. My personal view is that, although I am all for some tidying up, I would not like to see any rigid standardisation enforced just now; the subject is too new and we are still a good way from knowing what we really want.

The possibility of timesharing is likely to have important effects on another part of the communications problem, that of contact between the machine and the user. Originally the programmer got his program working by sitting at the console, pressing switches which caused the machine to go through small parts of the program - possibly one instruction at a time - and looking at display lights to see what had happened. This could be very wasteful of machine time - the whole installation stood idle whilst the user tried to decide what to do next, and, as machines have grown more expensive and the pressure on their time greater, it has been displaced by a more highly organised system in which professional operators run the machine, and the result of a test run is a printed statement.

This generally works well enough, but there are many people, whose views command respect, saying that there are plenty of circumstances in which direct control of the machine by the user is the best way of going about things, not only for program development but also for exploratory work with a working program needing trial runs in which parameters have to be varied so as to make the solution have some desired properties. On a timeshared machine this need cause only a slight loss in efficiency; so long as the problem is not so big as to monopolise most of the computer, another problem can be taken up whilst the programmer is scratching his head. We shall try out this kind of thing with Atlas which from the start will have two independent consoles. M.I.T. is just starting an elaborate experiment with several remote consoles attached to a central machine, and has plans to extend this very widely indeed. Incidental to this on-line use is the

COMPUTERS - A SURVEY - cont'd

development of visual displays : the user, especially when experimenting, would often prefer to see his results as graphs rather than as tables of figures, so that he could do his exploratory runs by altering the parameter values until a curve on a screen took some particular shape, or passed through some point or set of points. There is no great technical problem in achieving this, the real difficulty being to produce cheap and reliable equipment.

Finally, a few words about future possibilities. It seems unlikely that machines built with the kind of component used in Atlas and Stretch can be made to go much faster, say much more than ten times as fast. The time for a signal to travel from one part of the machine to another (a millionth of a millionth of a second per foot) is already comparable with some of the times needed for the simplest operations, and will soon become the controlling factor. The next generation of machines will probably use micro-miniaturisation and thin film techniques ; that is, the components will be of very small size and be made by depositing from vapour successive layers of metals or semi-conductors only a few molecules thick. Complete circuits can be formed in this way and complex assemblies built up which can be made orders of magnitude faster than the fastest conventional circuits. The store and processor of such a computer can be made much simpler than, say, Atlas, for with plenty of speed to call on one can afford to forego a lot of circuit sophistication ; but the even greater disparity between input/output and processor speeds will demand even more elaborate arrangements for timesharing these operations with computation. Also, it seems to me quite certain that some of this speed will be used to allow much more powerful programming languages so that it becomes still easier to express complex procedures, and the machine itself does still more of the organisation.

To sum up, my general view is that on the one hand, computers will get more automatic and self-controlled in the sense that they will themselves look after all the pedestrian tasks such as scheduling and organisation of input and output ; and on the other that they will become more amenable to control by the user through the provision of visual displays and convenient and efficient ways for affecting the course taken by the program. We shall be able to take their powers more and more for granted, but at the same time they will offer more and more exciting possibilities for exploring new fields of application.

Why have we built Nimrod?

P F Smith

A year ago a number of articles and letters on the general theme "Why build accelerators", appeared in ORBIT. Nimrod is now working, and during the first few years of its life will not be able to cope with the experimental demand ; decisions will have to be made about the order of priority of experiments, and, whether certain experiments are to be attempted at all. The specific question, "Why have we built Nimrod ?" has therefore become all the more significant ; will we always choose the easiest and most convenient experiments, and try to accommodate the largest number of university teams ? Or are we going to have the courage to devote a substantial fraction of the time to experiments of the greatest scientific value, even though they may also be the most difficult, lengthy, and inconvenient ?

Exactly which experiments are to be placed in the latter category may be controversial, but there can scarcely be any argument about what we mean here by "scientific value". The aim of this type of research is to discover how physical phenomena are inter-related and, in due course, to evolve a single unified theory covering all phenomena and able to predict the result of any new experiments. Every experiment we carry out will be of some help, but of greatest value are those experiments which result in the most rapid progress towards this ultimate aim.

In high energy physics, however, it is difficult to judge which experiments will be the most useful. R. P. Feynman, probably the most communicative and intelligible of contemporary theoretical physicists, has often pointed out (see quotation in the August ORBIT) that further data on elementary particles is of little use at the present time, and that it is new ideas, rather than experiments, that are needed. Theory is twenty or thirty years behind experiment ; there is a profusion of numerical data with no theory to account for even a fraction of it. The most urgent need, therefore, is for experiments specifically chosen to provide a guide and a stimulus for new theoretical ideas.

To see more clearly what this could mean, let us step back a moment from fundamental particle physics and remind ourselves that relativistic, gravitational, electromagnetic, and quantum phenomena must eventually all be incorporated in any satisfactory theory. Suppose we ask what single discovery in any of these fields would have the greatest effect on current theoretical ideas ? There can be no doubt about the answer to this : nothing would have more dramatic consequences than a demonstration that the velocity of light varies (however slightly) with wavelength ; relativity theory would collapse (except as a useful approximation), classical ideas of space, time, and simultaneity would return, and some form of aether would have

WHY HAVE WE BUILT NIMROD? - cont'd.

to be rapidly reinstated. It is as well to realise that this imagined discovery could easily become a reality, so it is unwise to be too complacent about the fundamental status of relativity. Unfortunately, at the present time it is technically impossible to achieve the accuracy required in this type of experiment so we can hardly hope for any results as sensational as this. Nevertheless the mere possibility serves to illustrate how single crucial experiments can still alter the course of physics.

Returning to high energy physics it appears that, within the energy range of existing accelerators, most of the experimental work of greatest significance has already been carried out. A range of short-lived 'particles' has been identified and the list now seems essentially complete; antiparticles have been discovered; 'resonances' and 'particles' have been recognised as similar phenomena and it has become evident that some are simply excited states of others. These are the type of clues to new ideas that have been provided by research with accelerators. Until the new ideas have been formulated, we shall be for the most part filling in details – determining more accurate lifetimes, cross-sections, branching ratios and so on.

There is, however, at least one clear exception to this: there are some major gaps in our basic knowledge of neutrinos. We do not even know yet whether there is more than one type; recent experiments suggest a difference between those associated with electrons and μ-mesons but may merely show an energy dependence of neutrino behaviour. Then there is the question of the neutrinos from the different K meson decays; which sort are they, or is there a third and fourth type, or are they all the same? Moreover the whole neutrino question is of vital theoretical significance. For example, it still appears possible that neutrinos are simply a form of electromagnetic radiation (and this is not just a personal view) but a simplification of this nature may prove very difficult unless there exists only one type.

It has been calculated that experiments with neutrinos should be feasible with Nimrod, even with neutrinos predominantly from K decays. When Nimrod achieves its full beam intensity, will the difficulty and inconvenience of these neutrino experiments be allowed to outweigh the potential theoretical value of the results?

An obvious reply to this is that Nimrod must not be considered in isolation but as one of many high energy accelerators and, since extensive programmes of neutrino experiments are already being planned at CERN and Brookhaven, it will perhaps be argued that Nimrod should be confined to experiments for which it is better suited. It is of course disappointing that these are, for the most part, rather ordinary experiments, the filling-in of details mentioned above. Nimrod is predominantly for useful rather than exciting work, and this will apply even more to our 4 GeV electron machine. (Will someone give a scientific, rather than political, answer to the question "Why build Nina?"). However, even if neutrino experiments on Nimrod are judged inappropriate or inconvenient, we can still hope that not all the time will be allocated to the orthodox type of research. No one denies the necessity, and ultimate value, of the latter but more adventurous experiments which could direct the course of new ideas are of greater urgency at the present time.

The Accelerator World

A group of senators from the mid-west USA are launching a major campaign to get authorisation through the US Atomic Energy Commission for the construction of the high intensity accelerator recommended in the Ramsey report. The accelerator, at an estimated cost of $150 million would be operated by the Midwestern Universities Research Association (MURA). A letter stressing the importance of the project has been sent to President Kennedy and is now under 'active consideration.'

A 2 MeV 'helium injector' has been added to the 12 MeV tandem accelerator at the National University in Canberra, Australia. When not in use injecting helium ions into the main machine the helium injector can be run back on rails, turned through 90 degrees and used as an accelerator in its own right. The injector was supplied by HVEC at a cost of £56,000 and is the highest energy machine of its type in the world.

The US Airforce Aerospace Research Laboratories have acquired a tandem accelerator from High Voltage Engineering Company (HVEC) for $¾ million. The accelerator, known as the 'ICT Tandem' can supply positive beams of energies up to 8 MeV or 10 mA, 4 MeV electron beam. HVEC are also providing Van de Graff accelerators, at $½ million each, to the University of Kentucky and the Massachusetts Lowell Institute of Technology.

On 19th September the National Institute of Nuclear Physics in Italy stated that lack of funds had virtually brought the nation's nuclear research to a standstill. A statement was issued following a three-day meeting of the executive council, which stated "The financing of all nuclear research in the country is at such a low level as to force research personnel and technicians to almost complete inactivity."

The first cyclotron to be used in a hospital is being built for the Barnard Skin and Cancer Hospital, St. Louis, USA. The second cyclotron likely to come in use in a hospital is scheduled for the Hammersmith Hospital, London.

An 80 inch liquid hydrogen bubble chamber is now in operation with the 33 GeV AGS machine at Brookhaven. This is at present the largest bubble chamber operating in the world. Together with all its associated equipment, the chamber cost about $6 million and took some four years to design and construct.

A new method of illuminating bubble chambers has been developed at Berkeley and is now in use on their 30 inch propane bubble chamber. The bottom of the chamber is coated with a material acting as a diffusing medium which reflects light but prevents the formation of confusing mirror images of tracks. Bubbles four times smaller than with the previous methods of illumination can now be photographed (ionising tracks of about a tenth of a millimeter in diameter are visible).

High Magnetic Fields

A 'small group of enthusiasts' at the Laboratory from Magnet and Beam Handling Group have achieved pulsed magnetic fields of over 200 kilogauss Conventional techniques were used (discharging a 500 μf capacitor bank into a coil) and the usable volume of high field was about 30 ccs High magnetic fields of this order are used in photographic emulsion work. The tracks left by particles in the emulsion are short and if charged particles are to be identified by the curvature of their tracks high magnetic fields are needed

At CERN. 300 kilogauss fields are produced, using a much larger capacitor bank, over a volume of about half a litre for use in emulsion experiments If this type of facility is required by the nuclear physicists at the Rutherford Laboratory the 'know-how' is on hand.

Successful Operation of ZGS

At 4.35 a.m. on 18th September 1963 the Zero Gradient Synchrotron (ZGS) at the Argonne National Laboratory, Illinois. USA reached design energy for the first time. 10^{10} particles per pulse were accelerated to 12.7 GeV. The design energy of the ZGS was 12.5 GeV and the aim is to achieve beam intensities of up to 10^{11} particles per pulse.

Thinking on the synchrotron project at Argonne started late in 1955, authorisation was given on 17th February 1959 and construction work began the following June. The completion date was scheduled for late 1962 but some trouble with the fabrication of the magnet blocks moved the date into 1963. Construction work was complete on 30th July 1963 and all the components of the synchrotron were operated together for the first time on 1st August. On 17th August acceleration to 3 GeV was achieved and acceleration to full energy was reached a month later.

[The unusual feature of the Argonne machine is the magnet design. Accelerators such as Nimrod or the Bevatron keep the proton beam focused as it circles the machine by having the magnetic field decreasing, going radially outwards across the magnet gap. These machines are called Constant Gradient (CG) or Weak Focusing machines. The CERN PS and Brookhaven AGS are Alternating Gradient (AG) or Strong Focusing machines and in these, the direction of the magnetic field gradient alternates from decreasing radially outwards to decreasing radially inwards in sections around the machine. This arrangement alternately focuses and defocuses the beam as it travels round giving an overall focusing effect (just as a system of converging and diverging lenses of equal strengths may give an overall focussing of light).

The Zero Gradient Synchrotron has, as its name indicates, no magnetic field gradient – the field is constant across the magnet gap. Vertical focusing is achieved instead by specially shaping the end of each magnet block to give a decreasing field going radially outwards. The machine is therefore weak focusing but because of the efficiency of the H-magnet design, higher peak fields, up to 22 kilogauss where the steel saturates, can be used. This means that the radius of the ring can be smaller and the cost of the magnet greatly reduced. The ZGS magnet uses some 4,000 tons of steel compared with 7,000 tons on Nimrod.]

Some further parameters of the machine (from 1960 figures) are as follows: The injector is a 50 MeV linear accelerator giving pulsed beams of 20 to 50 mA for 250 to 500 μs; Injection at 476 gauss is possible for 110 turns with the magnet field rising at 20 kG/s; Magnet radius is 71 ft, peak field 21.5 kilogauss; Vacuum chamber cross section is 32 × 5 inches; RF Cavity supplies 20 kV per turn and has a frequency swing from 4 Mc/s to 14 Mc/s; Power supply (motor-alternator-flywheel) peak current is 11,000 A, peak voltage 12,600 V.

EDITORIAL

The topic of 'Science and Technology' has been much in the news recently. The surge of publicity began with Harold Wilson's speech 'Labour and the Scientific Revolution' at the Labour Party Conference in Scarborough on 1st October. The speech amounted to a declaration that science and technology will be used as the main instruments of a social revolution to change the face of Britain. Richard Crossman called it 'the birth of a new political idea' and quoted Mr. Wilson as saying 'the party will be able to liberate the frustrated energies of thousands of young scientists, technologists and specialists. . .' It is obvious that the Labour party is very excited and has drawn great strength from the idealism of Mr. Wilson's oration and the vision of the future that it holds before them. It is also obvious that 'the scientific revolution' will be a major plank in their election platform.

The Conservative Party insist that, far from being 'the birth of a new idea', the idea is virtually a teenager in their political philosophy. In fact Lord Hailsham protested on the eve of Mr. Wilson's speech, that the Labour Party have lifted their policy for science from his own public pronouncements on the subject. A Party leaflet issued on 6th October (with the scientific title –'Acceleration') puts emphasis on the Conservative efforts since 1951 (D S I R grant increased by a factor of four; double the number of students in Universities and Colleges; Industrial spending on research trebled etc . . .). But it seems that they are waiting for Robbins and waiting for Trend before working out the detail of their election campaign attitude.

The discussion that has been stirred up covers many interrelated topics – education of scientists and technologists; persuading scientists to stay in this country; Government control of sceintific research; encouraging industrial research; automation and redundancy; social attitude to change; assistance to underdeveloped areas – any of which could keep minds occupied and pens scribbling for a long time. But when the dust settles it is certain that a modified approach to science and technology will come about whichever Party holds the reins. The increased awareness of the issues which have come up will bring changes and the changes, especially with Labour in power, will mean greater Government interest in, and control over, the progress of science and its application in Society.

It will become all the more essential that the Government is fed with responsible, informed assessments of the scientific needs of the country. A detailed plan for bringing this into effect may come out of the report (due in the next few weeks) of the Trend Committee, which is examining the problem of assembling the necessary information and of presenting it to the Government. It is already obvious that the allocation of one quarter of Lord Hailsham as the spokesman for science in the Cabinet is inadequate. A Minister strongly supported by a representative team from the scientific community is needed.

Ideally that Minister should be a man of scientific training. A scientist would be better able to appreciate the needs and share the enthusiasms and hence better able to present the scientific case to the government. But more than this is needed. He would need to be of broad outlook within science – a fervent specialist could hardly help overweighting his own interest where he could see the problems and the prospects more clearly. And he would need to be more than a scientist. A Minister whose contribution to the government of the country was a clear appraisal of the overall scientific position would be useful but he must also be able to reconcile his interests with those of his colleagues. To constantly press for more expenditure on science without balancing this with the other needs of the nation's life would in the long term be more of a menace than a blessing. Regardless of the clamour from the scientific lobby, he must accept that science is just one of the factors which involve and mould human lives, albeit one which is at present having great impact on the material well-being of Society, and never allow it to swamp other needs.

At present the Minister is not a scientist nor in the immediate future is he likely to be. Probably most scientists deplore this fact and some deride Lord Hailsham, present Minister of Science, and Richard Crossman, shadow Minister for Science, for their lack of scientific education. To deride their policies is fair enough but to jeer simply because they are not scientists is ignorant. It shows a lack of understanding of the job of the Ministry and it ignores a simple fact. Whose fault is it that the Minister of or for Science is not a scientist? Has the scientific community produced men in any number who enter politics? The number of scientists willing to become involved in the political life (as distinct from the public life) of the country is very very small and until this position is changed we must expect to be represented by men of other disciplines and must bring scientific influence to bear through them.

Letters to the Editor

Letters may be addressed to 'The Editor, ORBIT, Building R1'. Pseudonyms are accepted provided the authors name is known to the Editor.

Sir,

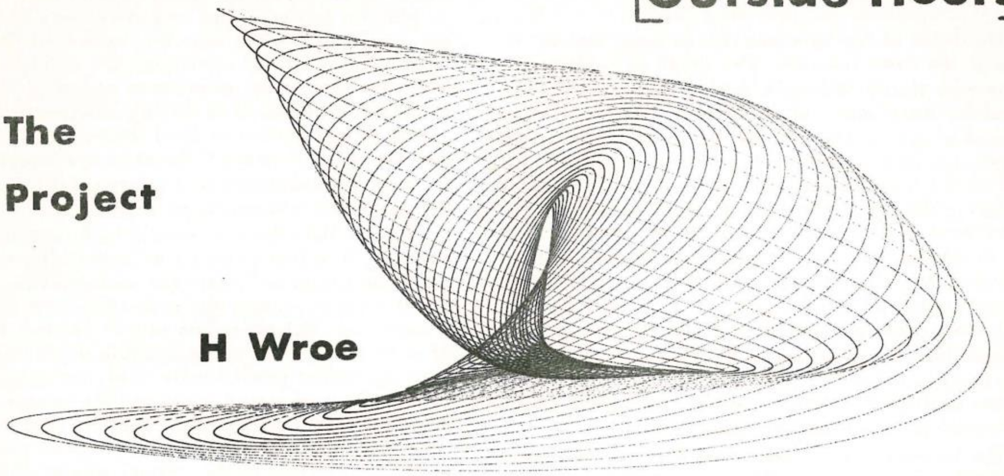
The item in September's copy of ORBIT in which you quote "the twelfth meeting of the Rutherford Laboratory Suggestion Awards Committee was hell on Thursday . . .", may possibly lead your readers to the entirely erroneous assumption that this was a typographical error.

In any case the article by the Laboratory's mythologists which appears in the same issue, surely implied the existence of a Tower of Babel as one of Nimrod's associated works on this site.

D G J ROSE.

The Project

H Wroe



It all started innocently enough one wet Sunday afternoon, when H and his elder son were wondering what to make with their Meccano set.

"I know," said H, "Let's make one of those things with pendulums, for drawing patterns."

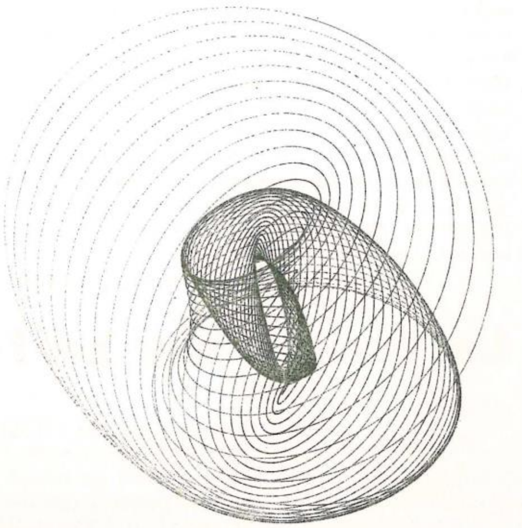
So as to forestall the question, "What's a pendulum Dad?" H plunged straight into the construction and soon the Mark I Machine was ready. It had one pendulum about 18 inches long carrying a small board with a sheet of paper pinned to it and another, separate one, which carried a pencil and oscillated at right angles to the first. The pendulums were set in motion and a meaningless scribble appeared very faintly on the paper. H's son was not impressed.

"Ah well," said H, "We haven't made the pendulums rigid enough and we need a better suspension."

The Mark I was dismantled with much grumbling from the junior member of the team, who considered that it was always him who had to take things to pieces, and Mark II quickly took shape. This was a superior affair with the pendulums swinging on knife edges and this time interesting patterns began to appear when the pendulums were released at the right times. H's son began to catch on and was wildly enthusiastic for all of five minutes until the sound of Fireball X L 5 blasting off in the next room drew him away.

To H, however, the whole situation presented a challenge. What determined the form of the pattern? How did the damping of the motion affect it, or the masses of the pendulums? Tremendous technological problems were posed. The main difficulty seemed to be the development of a satisfactory pen - it had to draw a fine distinct line and yet be frictionless and long-lasting. Pencils wore down too quickly so the house was ransacked for an old fashioned pen. Several holders were turned up but no nibs. The most promising line seemed to be a pen made from glass tubing drawn down to a fine capillary, but only about one pen in six was any good.

The next day, at the Rutherford Lab., an informal symposium on the whole subject took place and it was clear that there was considerable interest in Harmonic Patterns. It was suggested that the second pendulum should be suspended underneath the first, so that the interaction of the two would produce a greater variety of patterns. H was convinced of the soundness of this principle and saw that, if he was to make any significant contribution to the subject, there was an urgent need for a really good Harmonic Machine.

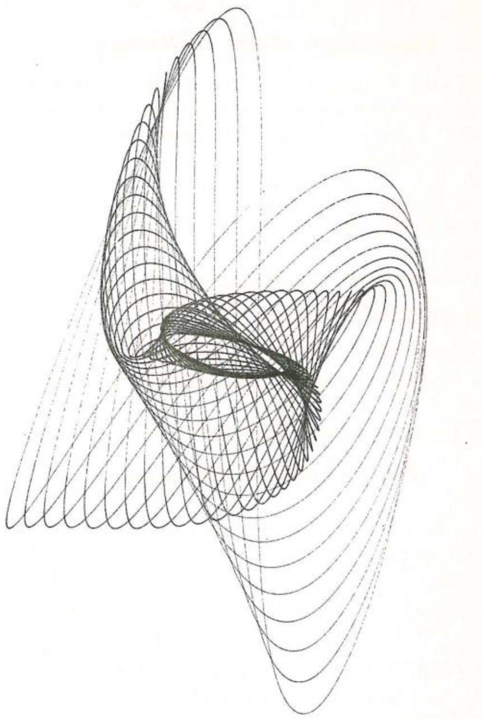


That evening H moved out to the shed and started the construction of the Mark III Machine - this meant that he could pretend that he hadn't heard the boys calling from their bedroom so that Mrs. H had to go up and see to them. The Mark III had wooden pendulums, each one suspended in gimbals, and a special arm to carry the new glass pens. This was very light but rigid and could be counter-balanced so that the pen exerted very little pressure on the paper. Very fine patterns were immediately produced. The first experiment carried out on the Mark III was to investigate the effect of varying the ratio of the pendulum lengths and it was soon discovered that the most interesting patterns were produced when the lower pendulum was about twice as long as the top one.

It was about this time that H began to see certain commercial –– that is to say he noticed that some of the patterns had artistic merit – they were quite Henry Moorish really. Most people seemed to find them attractive –– they went rather well with stainless steel and fibreglass furniture and H could almost see them in the pages of "House and Garden"

"Why, if these things catch on," he said, "there's a fortune to be made."

Unfortunately, the Mark III Machine turned out rather small patterns and H realised that much larger ones were required if he was to flog them as modern paint –– that is to say, if their full artistic potential was to be realised. A design study for a Mark IV Machine was put in hand and it became clear straight away that the present buildings were too small to house the new experiment. After much thought, it was decided to move into the loft and hang the pendulums from the roof of the house so that the lower one could project down through the trap door, if necessary. In the Mark IV, the top pendulum carries a half imperial drawing board to hold the paper and is four feet six inches long. It turned out that the lower pendulum had to be eleven feet long to produce good patterns - so it seems that these machines don't scale linearly. H's



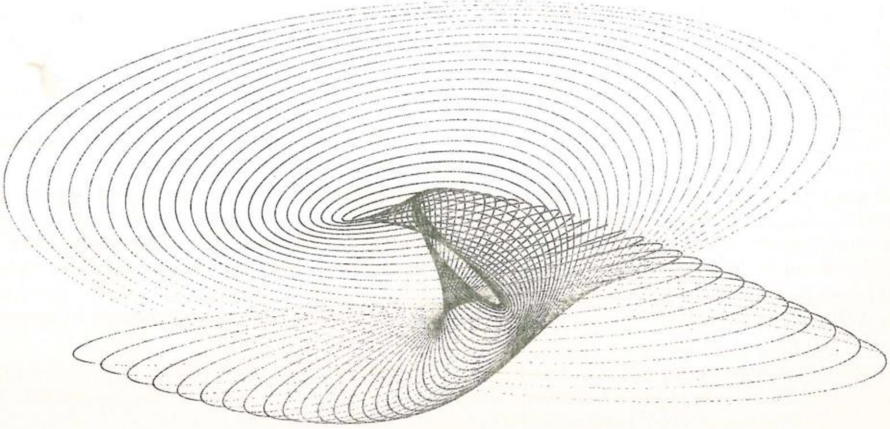
family complained that the pendulums were a nuisance to people walking along the landing, but he brushed this objection aside.

"Where's your dedication to Art?" he said.

One evening, after a successful session of pattern drawing H was dreaming of the possibility of a really big Machine when his elder son appeared.

"But Dad, how am I going to play with it when it's right up there in the loft?" he said.

"Oh, it isn't for you to play with !" said H.



Personnel News

Comings and Goings

Dr. J.M. Charap has a fixed term appointment and is stationed at Imperial College, London.

Mrs. J.M. Cheney and M.A. Jones join Bubble Chamber Group;

Dr. J.D. Prentice joins High Energy Physics with a fixed term appointment.

H.P.S. Powell joins Nimrod Beams as a research student;

P. Odle joins Nimrod Engineering.

Miss R. Reynolds and Miss E.M. Perkins join Atlas Laboratory.

L.L.J. Vick and Dr. A.D. Martin join Theoretical Physics on fixed term appointments.

R.J. Dearlove joins Central Engineering;

K.D.H. Cattenach joins Administration.

D.J. Wagon and C.J. Collie join Theoretical Physics.

F.N. Mead has left us.

C.E. Jefferies retired on 27th September.

Congratulations to -

Jae Fraser, Library, on her recent engagement to Keith Hitchen of the Oxford City Police Force

Suzette Cotter, Atlas Laboratory, and Michael Harold, Magnet Group whose engagement was announced on 1st October.

Jerry Thompson, R.F. Group, on his marriage on 26th October.

Suggestion Awards

Awards totalling £32 were made at the thirteenth meeting of the Rutherford Laboratory Suggestion Awards Committee held on Wednesday, 18th September.

£10 to Mr. D.B. Gregson for his design of an Optical Level Mount which has been made and used with a resultant saving of considerable time and effort.

£5 to Mr. C.W. Haines in respect of a Cable Stripping Tool which has been tested and found to be practicable and efficient.

£2 to Mr. W. Ballard who drew attention to the safety hazard occasioned to cyclists by the concrete duct covers in the roadway adjacent to Building R11.

£2 to Mr. P.G. Whelan whose suggestion sought to eliminate a possible danger to users of Magnetic Base Drills in the event of a power supply failure.

£3 to Mr. S.E. Nunn for his proposals to improve the standard of ventilation in lifts and the Committee was informed that action to effect such an improvement is being taken.

£2 to Mr. J. Vanstone whose suggestion that suitable reflectors should be erected adjacent to the gate-post of the gate in the fence to the west of Building R 14, reducing the hazard during the hours of darkness, is to be adopted.

£2 to Mr. W. Lord who proposed that in the interest of safety, the Paper Towel dispensers in the R 1 toilets should be moved to an alternative position.

£2 to Mr. A.V. Wells for his suggestion that the handrail to the main stairs in Building R25 should be modified to eliminate the possibility of injury to users of these stairs.

£2 to Mr. A. Hickman who proposed the installation of a permanent platform on top of the Magnet Hall radial crane to provide safer access to the roof lighting.

£1 to Mr. C.D. Moreton in addition to the Interim Award previously made for his suggestion on the sale of waste paper. The Committee was informed that a contract has now been placed with a dealer.

£1 Encouragement Award to Mr E Iberson for his suggestion regarding rectification of Target Actuators

D.G.J. ROSE

1st Anniversary of the Suggestion Awards Scheme

The first meeting of the Rutherford Laboratory Suggestion Awards Committee was held on 1st October, 1962. Under the Chairmanship of Dr. Valentine, the Committee consisted of two Official Side representatives, two Trade Union Side representatives and two Staff Side representatives, with Mr. McDonald as Secretary.

During the subsequent twelve months thirteen meetings of the Committee have been held at approximately monthly intervals and during this time the duties of Chairman and Secretary have passed to Mr. Goode and Mr. Rose respectively. The Trade Union Side representatives are changed at fairly frequent intervals, so that everyone gains some knowledge of the inner mysteries of how awards are made.

Before a suggestion is considered by the Committee, appropriate officers are asked to give their assessment of the merit and practicability of the idea and the Committee has regard to the opinions and recommendations of these assessors when a suggestion is under discussion. To date 185 suggestions have been considered and the authors of 94 of them have received awards totalling £231; it will be apparent that in submitting a suggestion the author stands a better than fifty-fifty chance of gaining an award. The largest award made so far is £15 and, although 36 awards of £1 each have been made, the average award is approximately £2. 10s. 0d.

The Committee is empowered to make awards of up to £100 and as all NIRNS employees and attached staff (excluding Contractors' employees) are eligible to participate in the scheme, the Committee still expectantly awaits the celebration to mark the first £100 award.

D.G.J. ROSE

EMERGENCY CALL

"Sorry to bring you out at this time of night Doctor Smith."
"What seems to be the trouble ?"
"It looks as if she's dying, we were afraid of a complete breakdown."
"Hm, Hm, How long has she been like this ?"
"Since early in the evening. Before that everything was going well and then things suddenly took a turn for the worse."
"Pulse rate ?"
"Well below normal."
"Hmm – pulses are becoming very irregular."
"Noticed the colour ?"
"Yes – that greyish-white colour is a very bad sign. Have you tried giving her a bit more gas ?"
"Yes, we've been gradually increasing the gas supply all night but it hasn't done any good. We've had to stop injecting by the way."
"Hmm – almost looks like poisoning to me, but we've taken so much trouble over cleanliness. I can't think where the muck can be coming from."
"This is the fourth case of this type that we've had recently."
"I know, it's very mysterious why they should suddenly die like this, in spite of the best we can do."
"We could open her up and have a poke about inside if you like – major operation of course, but we might find something. What do you think ?"
"I'm afraid there isn't time. Anyway we often seem to do more harm than good by messing about. The post mortems we had on the last three cases didn't tell us much."
"She won't last long at this rate."
"I'm afraid there's nothing we can do – – better make the usual preparations."
"O K chaps, we're going to have to change the ion source again !"

ANOTHER NIMROD

A fourth Nimrod, who lived on the other side of the Atlantic, should be added to the three mentioned in the September ORBIT. This is Nimrod the son of Cohor, about whom we read in the Mormon book of Ether. All we know about him is that he gave away his father's kingdom, in exchange for the privilege of doing what he liked. See Ether 7.22 – 'And now Cohor had a son who was called Nimrod; and Nimrod gave up the kingdom of Cohor unto Shule, and he did gain favor in the eyes of Shule; wherefore Shule did bestow great favors upon him, and he did do in the kingdom according to his desires.'

The book of Ether contains the record of the Jaredites. After the confusion of tongues following the unsuccessful Babel project, Jared and other companions wandered for many months finally arriving on the shores of North America. After many adventures, described in the book of Ether, the Jaredite tribe ultimately split and destroyed itself. Before the end, however, Mormon buried the golden plates containing the record of the book of Ether in the hill of Cumorah (near Manchester, New York State).

The plates lay there until 1827, when the Angel Moroni revealed their location to Joseph Smith. With divine aid, and the assistance of Oliver Cowdery, Smith translated the plates into English, and the book was published in 1830. The plates were collected in 1838 by a heavenly messenger, but their authenticity is vouched for by sworn testimonies of "The Three Witnesses" and "The Eight Witnesses."

J. D. LAWSON.

Who said 'Rafel mai amech zabi almi' to whom and what do the words mean ?

THE TRUTH ABOUT NIMROD – AMAZING REVELATION

The biblical reference 'a mighty one in the earth' initiated the concept of the majestic Nimrod. In modern times Sir Edward Elgar reserved some of his most dignified music for the Nimrod section of his Enigma Variations. This musical portrayal however refers not to the biblical character but to Elgar's friend, A.J. Jaegar (German, der Jäger – the hunter : hence Nimrod). Had Elgar but known that, according to Dante, Nimrod is in Hell, his Catholic and Edwardian soul would surely have insisted on renaming the tribute to his friend.

Yes, Dante found Nimrod in Hell (Inferno – Canto XXXI). And not just in Hell, but

THE TRUTH ABOUT NIMROD – cont'd

in the darkest depths of Hell in the circle next to the last. where Old Nick himself is to be found. There, for his sin of pride in attempting to build the tower of Babel, he sits babeling, unable to make himself understood. It was here that he greeted Dante with the immortal words 'Rafel mai amech zabi almi.'

Now that the true character of Nimrod is exposed suitable measures ought to be adopted. In particular, we are already aware, from Professor Merrison (ORBIT, February, 1963), that Nina is 'a most degenerate bambina' and to avoid imposing further on Lord Denning at this time, it is most desirable in the national interest, that Nimrod and Nina be kept well apart.

(Freely adapted and amplified from information put together by W. Galbraith while 'in a fog off Newfoundland').

Atoms for Peace Prize

The Director of the Lawrence Radiation Laboratory, Berkeley, USA – Edwin McMillan – and the Director of the High Energy Laboratory, Dubna, USSR – Vladimir Veksler – jointly received the Atoms for Peace Award for 1963. The Award was given in recognition of the discovery by the two men, independently and almost simultaneously of the 'principle of phase stability', one of the fundamental ideas which made possible the building of the latest generation of accelerators. McMillan published his paper on phase stability in the Physical Review in September 1945 and it was sometime later that Veksler's paper dated 1944 was received in America.

The Atoms for Peace prize consists of a $75,000 cash prize and a gold medal which is awarded each year by the Ford Motor Company Fund. Previous winners include Niels Bohr (1957) and Sir John Cockroft (1961). For McMillan, winning this award represents a rare achievement for he already has to his credit the Nobel Prize in Chemistry 1961 which he shared with Glenn Seaborg for work on the transuranium elements.

IN THE DISCUSSION FOLLOWING A PAPER ENTITLED 'A SPURION MODEL OF THE Ξ PARTICLE' –
QUESTION: THE EXPERIMENTAL EVIDENCE SEEMS TO GO THE OTHER WAY. WHAT CAN YOU DO IN THAT CASE?
AUTHOR: THEN WE CAN THROW THE WHOLE THING AWAY.....

INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS CERN 1962 p.681

S – OXFAM

'FOLLOWING THE RECENT COLLECTION OF CLOTHING ON THE SITE ORGANISED BY THE AERE TOC H GROUP, A LETTER HAS BEEN SENT BY OXFAM TO AERE NEWS OFFICE RECORDING THE "MAGNIFICANT ACHIEVEMENT" OF SIXTY-EIGHT SOCKS RECEIVED SAFELY BY THE LONDON DEPOT AND THANKING ALL WHO HELPED TO MAKE THIS POSSIBLE.'

AERE NEWS
17TH OCTOBER

'A 1,225-LINE CLOSED CIRCUIT TELEVISION SYSTEM WILL HELP HARWELL SCIENTISTS KEEP AN EIGHT-PICTURE WATCH ON THE WHIRLING ELECTRONS IN THE GIANT NIMROD NUCLEAR RESEARCH MACHINE DUE FOR COMMISSIONING EARLY NEXT YEAR AT CHILTON, BERKS.

EIGHT CAMERAS WATCH THE ELECTRONS AS THEY ARE ACCELERATED TO CIRCLE A 160-FOOT-DIAMETER "DOUGHNUT" SURROUNDING THE 7,000-MILLION VOLT NIMROD, AT A MILLION TIMES A SECOND.'

ELECTRONICS WEEKLY,
SEPTEMBER 25TH, 1963

'THE ATOM-SMASHING MACHINE BERNARD GREGORY WORKS ON HAS BEEN BUILT BY FOURTEEN EUROPEAN NATIONS, INCLUDING BRITAIN, AT A COST OF AROUND EIGHT MILLION POUNDS – TOO MUCH FOR ANY COUNTRY BUT THE UNITED STATES OR RUSSIA TO FINANCE ALONE'

RADIO TIMES,
SEPTEMBER 12TH, 1963.