The Exploratory Interactive Science Centre
Plan for Action 1, February 1983

1. THE HISTORY AND AIM OF THE EXPLORATORY

The concept of the EXPLORATORY, as we see it, can be traced back to the Seventeenth Century: to Francis Bacon's fragment of a book which appeared in 1627, the year after his death – The New Atlantis.

Bacon's New Atlantis is in imaginary country, based on America. In this country is the fabulous House of Salomon. Established, as he imagines, before Greek philosophy – which he rejected as ineffective logic-chopping – the House of Salomon contained the engines and instruments of technology and exploratory science with all manner of experiments, which the people of New Atlantis could try out for themselves. It was a place to stimulate and amuse; a place to find out about the natural and man-made world, the Universe as seen by the eyes and understood by science, and to discover oneself. Here is a taste of Bacon's House of Salomon in his words:

'We have also perspective-houses, where we make demonstrations of all lights and radiations; and of all colours; and out of things uncoloured and transparent, we can represent unto you all several colours; not in rain-bows, as it is in gems and prisms, but of themselves single. We represent all multiplications of light, which we carry to great distance, and make so sharp as to discern small points and lines; also all colourations of light: all delusions and deceits of the sight, in figures, magnitudes, motions, colours: all demonstrations of shadows. We find also divers means, yet unknown to you, of producing of light originally from diverse bodies. We procure means for seeing objects afar off; as in the heaven and remoter places; and represent things near as afar off, and things afar off as near; making feigned distances. We have also helps for sight, far above spectacles and glasses in use ... We make artificial rainbows, halos, and circles about light. We represent ail manner of reflexions, refractions, and multiplications of visual beams of objects ...'

'We have also sound-houses, where we practise and demonstrate all sounds and their generation. We have harmonies which you have not, of quarter-sounds, and lesser slides of sounds ... We represent and imitate all articulate sounds and letters, and the voices of and notes of beasts and birds. We have certain helps which set to the ear do further the hearing greatly ... We have also means to convey sounds in trunks and pipes, in strange lines and distances.'

'We have also perfume-houses; wherewith we join also practices of taste. We multiply smells, which may seem strange. We imitate smells, making all smells to breathe out of other mixtures than those that give them. We make divers imitations of taste likewise, so that they will deceive any man's taste ....'

'We have also engine houses ... Also fire works for pleasure and use. We imitate also flights of birds; we have some degrees of flying in the air; we have ships and boats for going under water, and brooking of seas; also swimming-girdles and supporters. We have divers curious clocks, and other like motions of return, and some perpetual motions. We imitate also motions of living creatures, by images of men, beasts, birds, fishes, and serpents ...

'We have also a mathematical house, where are represented all instruments, as well of geometry and astronomy, exquisitely made.
We have also houses of deceits of the senses; where we represent all manner of feats of juggling, false apparition-, impostures, and illusions; and their fallacies. And surely you will

easily believe that we have so many things truly natural which induce admiration, could in a world of particulars deceive the senses, if we would disguise those things and labour to make them seem more miraculous.'

There is, indeed, a House of Salomon, in New Atlantis – the EXPLORATORIUM in San Francisco which was founded some twenty years ago by Dr. Frank Oppenheimer. It is Bacon's dream come true: an enchanted palace where anyone can by their own initiative, discover how things work; and a great deal about how he, himself or herself, understands and sees.

We propose to follow the lead of Francis Bacon and of Frank Oppenheimer, to combine science and technology without the glass cases of a conventional museum so that people can explore and discover for themselves. The general scheme is based closely on the Exploratorium, at San Francisco, which is highly successful and has indeed affected science museums throughout the world with its emphasis on interactive demonstrations and experiments which can be carried out by members of the public, generally without special permission or arrangement. It is critical, both for the American Exploratorium and for our proposed Science Centre that they are not science museums in the sense of housing and protecting valuable exhibits or artefacts: the exhibits are, rather, demonstrations and experiments. They may be made in the Centre, designed to be repaired or replaced at low cost. It is clearly impracticable for interactive encounters with original, valuable artefacts. The Science Centre will in no sense be in competition with Science Museums housing historical collections.

The intention is to introduce people to science as an exciting activity and quest of knowledge and understanding of the physical world, and of the nature of people – perhaps especially themselves. Central, will be demonstrations and experiments on perception and understanding. This makes science start with the individual, (Gregory, 1982). The EXPLORATORY may indeed become a research centre for understanding the nature of understanding.

It will not be 'elitist', as it will be open to anyone; but there should be available levels of explanation. Here we would like to go rather further than either the Exploratorium or the large and highly ambitious Toronto Science Centre: we would aim at availability – though without pushing it – of detailed accurate explanations, with historical sources. Here we propose to carry out setting-up experiments on how best to present a minimum of background information or explanation, but at the same time make available sophisticated explanations and background information without intimidation or overloading. We have ideas for this; but these will not be presented here.

The EXPLORATORY will provide informal education, and cater for visitors of all ages – individuals, family, and school groups. The idea is to provide an environment for individual exploration, with available guide lines. This is where the interactive approach developed at the Exploratorium is so valuable. Absence of personal evaluation or scoring is important here: where there is scoring of achievement this should be by micro-processor – as in computer games.

We should not be afraid of technology. It is, rather, important to present basic concepts and selected examples of technology as intellectually and emotionally interesting. Physical principles underlying steam engines, car engines, telephone, radio, television, atomic power

and other familiar but surprisingly little-understood products of the late Nineteenth and Twentieth Century will be presented. This should help to counter the present (as we see it) large scale rejection and fear of technology. This we believe, has serious social and economic consequences which an interactive non-intimidating Science Centre should help to dispel.

It is quite remarkable that even educated people generally do not understand how television, transistors, or engines work. (And very few people can say why mirrors reverse sideways, but not up and down!). Fewer still, perhaps, wish to understand the basis of physics, or of psychology. Whether this is a criticism of education is not for us to say: but we do suggest that such an interactive Science Centre would be a further chance to gain excitement and understanding, and to get switched in to conventional education end the possibilities of further education.

It seems essential to have our own workshop, design office, and photographic facilities. These facilities should be to invent and develop new ideas as well as provide the essential maintenance.

Conceptually The EXPLORATORY will start from the observer, and especially the powers and limitations of human perception. This should do something to redress the 'de-humanising' effect of the mathematical sciences which, since the early Seventeenth Century, have for their own good reasons adopted the goal of ’objectivity’ in which observers – ourselves – are as much as possible rejected in favour of various kinds of operationalism. By making the observer – the visitor – primary and the centre from which understanding and appreciation’ starts, we should help to humanise science. The EXPLORATORY should indeed, with its philosophy, become a centre for research into communication and learning; using and developing new techniques, such as micro computers and video discs.

Time travelling through the history of science will not be by viewing collections of original instruments, and other artefacts, but rather by re-enacting experiments with the technology available in previous centuries – to show at first hand the immense if still not generally appreciated significance of technology for science, and also indeed philosophy, from the earliest times to now.

The visitor, whether child or adult, should find the EXPLORATORY stimulating and fun. It will not be like school, as it is not constrained by the need to cover topics exhaustively for exams. It will aim to be more suggestive than complete in any topic; but it will provide knowledge and experience in some ways beyond the range of any school, and so it should be appreciated by children and teachers, as well as parents and the public in general.

2. THE EXHIBITS – 'PLORES'

The bastard word (ex)Plores is coined here, as the usual 'Exhibits' is too passive. 'Plores' is intended as a reminder that the visitor will explore ideas, laws of nature, and mechanisms – as well as his own perception and understanding. There will be surprising experiences, and challenge; as well as light hearted fun and games to match the way we are.

The following tentative list of main topics is given serially, but the EXPLORATORY will be for individually chosen exploration among the wide variety of its 'Plores'. The order given

here is, however, intended to suggest the underlying theme of development – from the individual out to the world of physics, and processes and mechanisms of biology and technology – with a maintained emphasis on not only the Laws of forces and motion and so on of the traditional sciences, but also of information and computing. This leads to the new challenge and opportunities of Artificial intelligence, as we find some of our powers of perception and thinking mirrored in computers, grown from the pre-historic seed of the Abacus.

i ACTIVITIES AND CONTENTS – PLORES FOR EXPLORING

A. The Observer: – The Visitor him/herself.
a. Sensing: – Measuring basic sensitivities of the eye, the ear, touch, temperature, balance etc. The principles of detecting patterns from the external world; for touching, seeing and hearing, and the other senses.

b. Perception: – Showing procedures by which sensory signals are ’read’ to give perception of objects and events – and how and why and when the mechanisms and procedures of perception lead us into experiencing the various phenomena of illusion. Many examples of perceptual illusions, with interactive adjustments etc., to measure and show how perceptions – true and false – relate to behaviour and errors.

c. Judging: – Betting on probabilities, e.g. in gambling and conjuring situations. Judging people, such as criminals and saints, and idiots and geniuses from static pictures, and in real life situations with video. Aesthetic judgements, which Visitors can compare. (How 'objective' are any of our judgements?).

d. Thinking: – Visual and mental puzzles and games; Deductive v. Inductive logic, with examples to try; Laws of Thought (Boole). Learning and memory experiments.

e. Human Physiology: – Especially non-invasive and non-harmful sensing of bodily structures and functions: e.g. ultrasound imaging of organs of the body in real time; ECG; EEG; heat sensing; muscle recording including recording with surface electrodes.

B. THE PHYSICAL WORLD

a. Light and Optics: – Reflection, (why mirrors invert sideways, but not up and down) refraction, interference, scattering, polarizing; image forming and Caustics; historical uses of the camera obscura, microscopes, telescopes and other instruments; resolution of eyes and instruments and matching to the eye; particle v. wave account; speed of, with historical re-enactments and modern ways of measuring 'c'; colour mixing, with lights and pigments. Colour temperature and the electromagnetic spectrum, line spectra for various gases, The laser, the hologram.

b. Sound: – Waves, temporal compared with spatial, as in a gramophone; amplitude and frequency, simple and complex waves, beats, resonance, Fourier, velocity measurements with historical methods. How the loudspeaker works. Musical instruments, how they work.

c. Matter: – Basic Properties – inertia, weight, mass, friction (producing heat) compression

and tensile strength, springs, etc. The three states of matter, with gas-liquid changes in boiling water, and in a refrigerator.

d. Energy: – Kinetic and Potential in various forms. Heat and the Second Law. Maxwell's Demon. Experiments on conservation; on our own energy expenditure; conversions and efficiencies. Practical heating systems, and experiments on lagging etc. Available sources of useful energy; high and low grade energy and why important.

e. Forces: – Real and Apparent (Coriolis) forces; mechanical v. electrical and magnetic et;. Inertial forces, gyroscopes; parallelogram of forces; levers and gears; forces of construction and destruction.

f. Friction: – Loss of energy through friction to heat; why lubricants work. Low friction bearings, especially in the development of clocks. Perpetual motion attempts.

g. Mechanical principles and mechanisms: – Degrees of freedom; simple machines, gears, slides, levers, etc.; Mechanisms such as clocks and cars.

h. Electricity: – Historical experiments to modern electronics. including control systems, and computers – there is a huge range here.

i. Magnetism: – Historical emphasis on William Gilbert's experiments on magnetism and the compass; Faraday's coil, and the dynamo and motor; and (by relating with 'h' above) the nature of matter by e.g. deflecting electron beams with magnetic and electrostatic fields with CRT's.

j. Information: – Basic concepts of representing with symbols, and selection of alternatives; channel capacity and coding. (This is not at all easy because unfamiliar. but important).

k. Computing: – Mechanical-electronic computing. Here mechanical models may show logical functions of computers. Analog v. digital. Principles of micro processors – with several to use. Graphics; games, including chess – leading to principles of AI.

C. PAST PRESENT AND FUTURE

a. Re-Enacting key historical experiments: – E.g vacuum pumps; Galileo's falling weights down inclined planes, etc. etc. etc. This should really bring science and its history alive.

b. Technology: – Examples of familiar gadgets, especially around the home – for finding out how things work.

c. Inventing: – How to put ideas together creatively.

ii RESEARCH NEEDS AND POTENTIALS

There are many unknowns. Will there be the kind of enthusiasm in this Country that there is in America for Science Centres? Will there be crippling Union problems, for example over

employing students as ’Explainers’? Most important: Is it possible to make interactive displays – Plores – that will stand up to use? And will there be excessive vandalism?

More generally, there are fascinating questions as how best to design the Plores to he fun and informative – perhaps to stimulate more people into thinking and inventing for themselves and to come to terms better with technology and so write a brighter future, by using our resources more efficiently and imaginatively. A deep problem is how best to present background ideas and knowledge, and to avoid overloading people. This is an opportunity for trying out new techniques ’of presentation, no doubt largely based on computers and perhaps video discs. Information should be on request rather than thrown at visitors willy nilly; but some guidance will be necessary. And why is reading posters so tiring? Perhaps between us, including our visitors, we shall find some useful answers.

In any case, co-operation with schools and educationalists will be essential. The EXPLORATORY should be a forum and a significant source of ideas and of questions for education and human-based technological research. The presence of the University of Bristol will be invaluable. It should be possible for the EXPLORATORY to take on Ph.D. students, for research into new kinds of education and experience.

This version ends here above section 2 iii GUESTIMATE PLORE COSTS