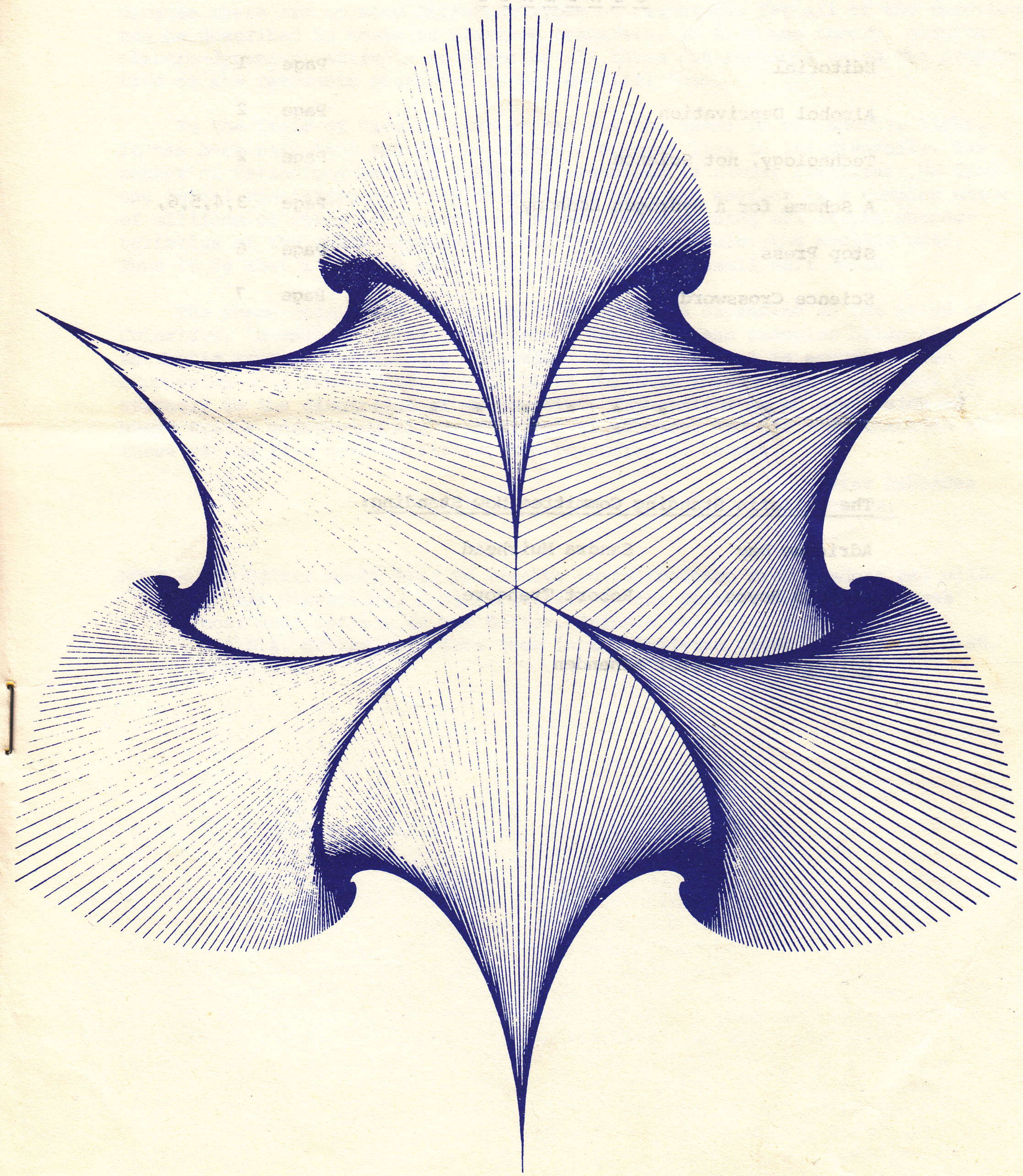
Jane Gibson 50

SCIENCE BULLETIN



THE SCIENCE BULLETIN

The periodical of the Adelaide University Science Association

27th April, 1979

C O N T E N T S

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The Bulletin Standing Committee Now Standing:

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Editor: Peter Ashenden

EDITORIAL

Everybody knows about gravity. One fine sunny day Isaac Newton was out walking in an apple orchard when an apple fell upon his head. "Eureka!" he cried, "I've invented Gravity!" It is unfortunate that many people miss the true point behind this anecdote. What Newton actually saw on that day was that the apple falling obeys the same laws of motion as the celestial bodies as described by Kepler not long before. Universal gravitation was the single underlying force that described the multitudes of interactions between all masses.

Let me tell the same story in a different context. Chemical reactions are continuing all around us all of the time. Nearly every process can be considered as a sequence of chemical reactions. Such a wide vareity of processes can occur because there are so many different types of reactions. Yet all of the reactions can be described in terms of electron transfers. In fact one theory, quantum electro-dynamics, attempts to describe all these interactions using the properties of the reactants expressed in mathematical form.

In the field of Biochemistry we can see the theme in yet another light. It has been said that the key to Nature's success lies in its diversity. The number of variations between different organisms is almost limitless. We find one animal consisting entirely of a single cell and another is a complex union of millions of cells of hundreds of types. Yet governing all of the characteristics of the whole organism is one type of molecule: the nucleic acid. Thus it is that a complex entity can grow from two small half cells.

The theme underlying all of these examples is expressed in the words of Coleridge: "beauty is unity in variety'. Each of these examples holds an aesthetic appeal for the pure scientist, and that appeal is aroused by an expression of a fundamental truth. It is for this reason that I am drawn so strongly to the discipline of mathematics. Mathematics is an expression of basic truths underlying all disciplines of science, and the comprehension of these truths is a most fulfilling comprehension of beauty.

Peter Ashenden
EDITOR.

NOTE - The Editor would like to receive correspondence from readers and will, at his discretion, publish letters in the Science Bulletin. Please post your letters to The Editor, Science Bulletin, A.U.Sc.A., C/- S.A.U.A. Office, or place them in the Bulletin pigeon hole in Room S6. Thank You.

ALCOHOL DEPRIVATION

A report on a psychology experiment.

Aims

The experiment was designed to facilitate the study of the effect of alcohol deprivation on persons of varying degrees of inebriation.

Implementation

On Friday, 30th March, the electricity supply to Union House was cut for a period of approximately 45minutes durint the lunch break, the time at which the University Bar is most heavily populated. Thus no sprits could be served and this deprivation was studied. The experiment was to be repeated but the supervisor objected to us cutting the power again.

Content

The effect on the Id, Ego, Super ego, Confrontive Space and Behaviour of each class was studied.

RESULTS

Degree of Inebriation	Group Name	Effecton Id, Ego & Superego.	Behaviour
-10 - 0%	Teatotallers	Superego rules	Cheered
0 - 20%	Beginners & Latecomers	Ego still in control	Grumbled
20 - 40%	Controls	Here goes ego	Booed and hissed - had to begin again
40 - 60%	Typical Norms	Id is not hid	ried to organise riot
60 - 80%	Typical Neuc's	"	Cried
80 - 100%	PAAN	Id is at odds	Didn't Notice

EVALUATION.

The confrontive space grew larger in each case, excepting the 60-80% who had to be consoled and the 80-100% who remained the same - stationary. The behavioural therapy enabled transference to be observed and the confrontive space increase can be explained by consideration of each individual's cognitive development.

Frida Inibishons.

Note: PAAN = Perceptive ablation of the apical neurones.

TECHNOLOGY, NOT SCIENCE

Mind you, I say "technology" and not "science". Science is a systematic method for studying and working out those generalizations that seem to describe the behaviour of the universe. It could exist as a purely intellectual game that would never affect the practical life of human beings either for good or evil, and that was very nearly the case in ancient Greece, for instance. Technology is the application of scientific findings to the tools of everyday life, and that application can be wise and unwise, useful or halmful. Very often, those who govern technological decisions are not scientists and know little about science but are perfectly willing to pander to human greed for the immediate short-term benefit and the immediate dollar.

Isaac Asimov
Footnote to "By the numbers"
Published in "The Tragedy of the Moon"
Doubleday
c 1973 Mercury Press, Inc.

A SCHEME FOR A HYDROGEN ECONOMY

by Paul Moritz

INTRODUCTION

The term "Hydrogen Economy" has been coined to describe an energy system whereby all, or a large proportion of, industrial, domestic and transportation energy needs are fulfilled by the use of hydrogen. The original concept was outlined by Bockris in a memo to the Westinghouse Corporation in 1962.

In describing this particular scheme, it is intended to show how the energy requirements set out above may be met, by the utilization of hydrogen, using known technology.

Briefly outlined, the scheme being proposed involves the collection of hydrogen from water, and its subsequent use in fuelling electro-chemical fuel cells. The electricity so provided may be fed into the power grid or converted into motive power by electric motors. It is intended that the scheme, once established, will be completely independent of any exhaustible materials such as fossil fuels, or fissionable materials.

HYDROGEN FUEL CELLS - The Basis of the Hydrogen Economy

The working basis of this hydrogen economy scheme is the hydrogen and oxygen/air fuel cell. Those types of fuel cells using hydrocarbons as a fuel source are impractical due to their dependence upon fossil-fuel-derived hydrocarbons.

The same principles are involved in most of the main types of cells. The cell reactions involve, generally, the electrochemical interaction of hydrogen with an electrode, yielding hydrogen ions; and the interaction of those hydrogen ions with oxygen to form water.

For example, the "Gemini" fuel cell, manufactured by the General Electric Corp., and developed by Bacon in 1959[1], has the following reaction scheme:

$$H_2 = 2H^+ + 2e \quad \text{(at the anode)}$$

$$2H^+ + 2e + \tfrac{1}{2}O_2 = H_2O \quad \text{(at the cathode)}$$

In this cell, the electrolyte is a polymer membrane, permeable to hydrogen ions but impermeable to electrons and the atoms of the fuel gases. The electrodes consist of electrocatalysts such as nickel or platinum and are enclosed in separate compartments, separated by the membrane. The electrons produced at the anode pass through an external load, and return to the cathode. H^+ is the charge carrier in the electrolyte.

The optimum operating characteristics of several types of hydrogen fuel are summarised in table I

TABLE I [2]

Optimum Operating Characteristics of Several Types of Hydrogen Fuel Cell

Type	Operating Temperature (°C)	Current Density (mA/cm²)	Power Density (mW/cm²)	% Efficiency
Gemini	60	100	80	50
Union Carbide	60	350	240	55
Allis Chalmers Cappillary) Membrane)	80	350	370	80
Justi DSK	85	240	210	55

The reason for choosing fuel cells as a basis for this scheme is that they can provide energy in almost any situation and at a greater efficiency than most other energy converters. Motive engines can be replaced by fuel cells in tandem with electric motors or full-sized power stations can use a bank of large fuel cells (ERDA in the USA is at present building a 4.8 MW fuel cell power station.

Some proponents[4] of the hydrogen economy suggest the use of hydrogen as an alternative combustible to petroleum or natural gas. This suggestion is made upon the notion that existing facilities such as internal combustion engines and gass turbines would require only minor modifications in order to use hydrogen. However, it has been shown that due to Carnot-type heat losses, the efficiency of such engines is limited to 20% - 25%[4].

However, a fuel cell of the Allis-Chalmers type, when coupled with an electric motor with an efficiency of about 60%, would give a system having an efficiency twice that of an internal combustion engine.

PRODUCTION OF FUEL

The supply of hydrogen, as water, is unlimited. As combustion or electo-chemical oxidation of hydrogen yields water, supply of hydrogen is assured. There are two feasible methods of splitting water into its constituent gases. These are electrolysis and catalytic chemical splitting.

The method by which it is proposed to generate the electricity required for electrolysis is by the use of solar photocells. The electrolysis of water requires a potential of 1.229V units per mole at 25°C. This is well within the range of present-day photocells, and a large array produces a potential proportional to its size. The efficiency of hydrogen production by electrolysis is about 60%[5].

The other method by which hydrogen can be produced involves a chemically catalysed conversion of H_2O) to H_2 and O_2. There are several reactions which can be employed, the simplest being:

$$6FeCl_2 + 8H_2O \overset{840^oC}{=} 2Fe_3O_4 + 12HCl + 2H_2$$

$$2Fe_3O_4 + 3Cl_2 + 12HCl \overset{200^oC}{=} 6FeCl_3 + O_2$$

$$6FeCl_3 \overset{420^oC}{=} 6FeCl_2 \quad (6) \quad + 3Cl_2$$

This proposal, put forward by Bridger and Dell, suggests the use of nuclear heat to provide the temperatures needed. However, as it is desirable to achieve independence of exhaustible fuel sources, an alternative heat source is necessary. One such alternative (7), involves the use of a solar tower 450m high and surrounded by 63 individually steered heliostats, each 0.6m x 7.5m in size. The catalyst is placed at the focal point of radiation, and the reactants flow over it.

Processes such as the two just described require both a plentiful supply of water, and direct sunshine as experienced in the desert regions of NW Australia, S.W. U.S.A. and the Sinai Peninsula. Clearly, the most suitable positions for any such installations would be, either on the coast in these regions, or anchored at sea in similar latitudes.

There are other chemical processes by which water may be obtained,[8,9] such as the "water-gas" reaction, but these depend to some extent upon the use of petroleum-derived hydrocarbons, and so are unsuitable.

DISTRIBUTION AND STORAGE OF ENERGY RESOURCES

As with present fuel systems, it will be necessary to distribute fuels and energy sources from their place of production to their place of use. Those regions using the largest portion of the world's energy are so located that the use of solar cells and mirrors is impractical.

If only present day technology is considered, there exist three modes of energy distribution : bulk transport of hydrogen, hydrogen gas pipelines and the distribution of energy as electricity. (The possibility does exist, however, for future use of microwave transmission of electricity).

For transoceanic transport of energy, the only presently viable method is by the bulk transport of hydrogen in tankers, similar to those used at present to transport LNG. There is some disagreement as to the form in which hydrogen should be moved. Liguefaction requires 20kWh/kg of hydrogen [10], and the transport of liquid hydrogen involves containing vessels exerting large pressures. Gas compression is less energy intensive, but to carry a given mass of hydrogen requires a larger volume that does liquid hydrogen.

Most authorities deem long distance (greater than 4,000 km) distribution of electricity impractical. A copper transmission line of 4,800 km length may give a typical power loss as high as 55% at 0.6 MV[11]. Hence, distribution of electrical energy would seem limited to short to medium distances.

Conversely, gas pipelines seem impractical for distances less than about 2,000 km. Existing gas pipelines could, by carrying hydrogen, carry only 25% of the energy now carried as natural gas. To obtain the same energy carrying capacity would require pressures of about 5000 k Pa, and about a five-fold increase in compressor capacity and pumping power [12].

Hydrogen, also, tends to cause interstitial cracking of metals, though this may be overcome by plating pipes with certain transition metals.

Road and rail transport of hydrogen would seem suited in those situations where petroleum ang gas products are now distributed in this way. There exist in the USA, road and tail tankers of capacities 60,000 litres - 92,000 litres and 125,000 litres, [13] respectively. These tankers were developed for NASA during the space programme. Over short, urban distances, the distribution of energy through the electric power grid would be less energy intensive than reticulated gas distribution.

The storage of liquid or compressed hydrogen is far more difficult than the storage of today's liquid and gaseous fuels, due to the high pressure containing vessels required. Tanks of a similar nature to today's gas holders are impractical, and similarly sized tanks would have a greatly reduced capacity due to the need for reinforcing of the tank shell. However, it is within reason to envisage large, high pressure, storage tanks being developed if needed.

It has been suggested that exhausted gas fields and salt caverns may be used for bulk hydrogen storage. ICI in England at present uses three salt caverns with a capacity of 200 tonnes of hydrogen at a pressure of 5,000 kPa.[14] Further the small scale storage of hydrogen may employ the use of compressed gas cylinders or metal hydrides.[15]

UTILIZATION OF ENERGY RESOURCES

Energy derived from hydrogen may be utilized in two ways. Namely, through the electric power grid, and through transportation, which together can fulfill virtually all energy requirements.

Many industrial, and all domestic, energy needs can be supplied by electricity. The complementary use of solar space and water heating (and boiler facilities) means that a significant proportion of the energy needs of the average suburban dwelling, and a smaller proportion of industrial energy needs, will not need to be supplied from the power grid. If necessary, hydrogen may also be burned as an industrial fuel.

The versatility of the fuel cell as a power source means that no great change to lifestyles is necessary. Automobiles powered by fuel cells and electric motors would replace present day models. Trucks, trains and all other vehicles using internal combustion engines at present, would need only slight changes in design to facilitate the insertion of the fuel cell/electric motor combination.

The rural dweller (and worker) provides a special case, and the mode of fulfillment of his energy needs will depend to a great extent upon his location. However, it is conceivable that there need not be any great change in the energy using methods of the rural dweller.

CONCLUSION

What is proposed above is merely an indication of the possibilities which exist for a hydrogen economy using present day technolgoy. It was not intended, at any stage, to provide economic justifications for the proposals, as such arguments must be based on projected costs of the proposals and the projected costs of alternatives (such as a nuclear fast-breeder economy). All such projected costs, however, are far from predictable, in view of the unforeseen increases in fuel costs in the past five years.

It is believed that the hydrogen economy is aviable energy system for future use for the reasons:

1) It is not dependent upon exhaustible fuel resources.
2) The technology required is not very far advanced on what is now known
3) There are not the environmental concerns associated with other energy systems such as the nuclear industry
4) Public acceptance will be forthcoming as no drastic change in lifestyle is essential.

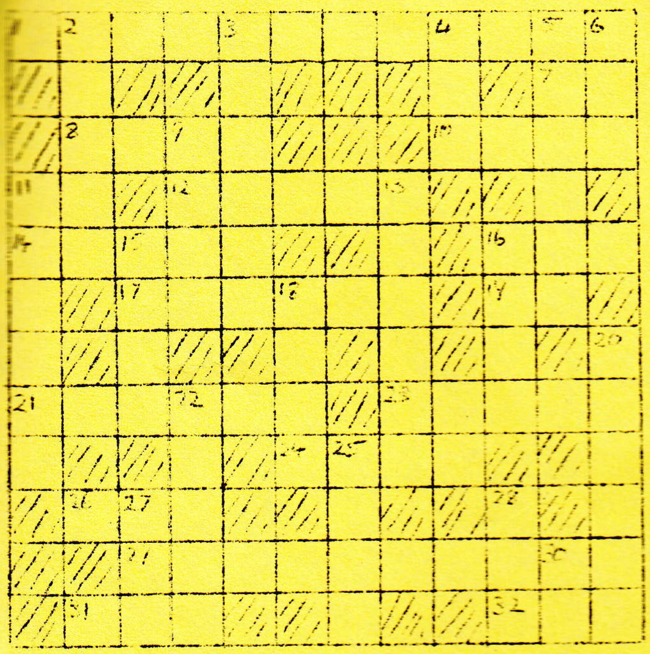
STOP PRESS

The Phantom Flooder Strikes Again!

- Four reports of flooding within the university have now come to hand. In the last Bulletin we reported that flooding had occurred in room S6 in Union House. Since that time, three more attacks have been made upon the sturdy buildings within the grounds. Twice this month, mathematics lectures have been interrupted by the deafening sound of cascading water. Our correspondenttsaid that water was pouring through a breech in the ceiling of the Horace Lamb foyer from the room above.

  On Thursday, 26th April work in the second-year Organic Cehmistry lab. was stopped by flood waters which surrounded a sink and a fume-cupboard. The cause is not yet known. In all cases mop-up operations were underway within the hour.

SCIENCE CROSSWORD



DOWN

2. Commercially useful genus of trees.
3. "Father" of the Hydrogen Bomb
4. Characteristic of pigeons, doves and politically unstable nations.
5. Flowering tree.
6. Definitely not a contraceptive.
9. Deposit of minerals.
11. Mathematical Array.
13. ________ Fermi.
15. Skin Irritation.
16. The environment studied by psychiatrists.
18. Underground rock outcrop.
20. Type of geometry (minus ic)
22. Noble gas.
25. European river.
27. Water crystals
28. Atmospheric water.
30. Large producer of nuclear power stations.

ACROSS

1. The study of matter through its interaction with electro-magnetic radiation.
7. With regard to
8. Zero result.
10. Artist's greatest work.
12. Mediterranean tree.
14. What part of a triangle is a line.
16. Slurry.
17. What many people feel about nuclear energy.
19. Systeme Internationale (reversed)
21. A respirative act.
23. Genetic messenger.
24. Amphibian.
26. Oil drilling apparatus.
29. Study of shells.
31. Open land.
32. Procure.

SOLUTION TO LAST CROSSWORD

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C A R B O N T E N E T
R     A         R N
A L A B A S T E R   T   S
B   N E   H   E N E R G Y
S E T     I     A   O   N
    E     M A C R O P O D
    A     M     I   Y   R
B A T T L E     B       O
E   E     R   B O A R   M
F A R A D   F   S N A R E
O       O   U   E D T A
R A D O N   Z       E T C
E       S I Z Z L E S
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