

CHAPTER ELEVEN

CAREER GUIDANCE

BY

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11.1 INTRODUCTION

The story of engineering and technology is the story of civilization throughout the ages, dating back to the discovery of fire when man first harnessed energy and to Egyptian civilization when they were harnessing water from the Nile for irrigation and the building of the pyramids. Like medicine, architecture, agriculture, it is as old as man's appearance on earth. Civilization is the process (through advancement, development and progress) whereby man seeks and exerts himself so as to overcome all the obstacles on his way whereby he becomes the master of the environment.

Engineers are always at work seeking to understand the physical laws of the universe so as to adequately use them to harness the resources of Nature for the benefit of all. An effect of the engineering activity is the whole spectrum of technology – the industrial arts; so that the engineers activities leads to the creation of goods and services and hence jobs and employment opportunities. Hence a career in which one harnesses the resources of Nature for the good of all must be a very fulfilling one.

Some regard engineering as a young profession, and also one of the largest professions. Engineers serve the societies in which they live; so that if you are moved to serve in the fulfillment of duties, then young people can make very significant contribution to the progress and development of the society through the engineering profession. To apply the knowledge gained through study, but guided by love so as to attain the good life, can only bring about satisfaction and happiness for what has been permitted to be achieved. If one chose engineering as a career, the limits of his success are limitless.

11.2 ENGINEERING DEFINITION

Many types of definitions have been proposed by engineers throughout the ages. For the purpose of this section we adopt the definition: Engineering is the professional art of applying science to the optimum conversion of natural resources to the benefit of mankind. This must be done now and always without waste of the resources, no harm to the environment.

11.3 DEFINITION OF THE ENGINEER

The definition proposed for the engineer are also many, but each should satisfy the contents in which a particular definition is adopted. In this

context, the following is adopted². The professional engineer, within the meaning and content of this section, refers to a person engaged in the professional practice of rendering service or creative work requiring education, training and experience in engineering sciences and the application of special knowledge of the mathematical, physical or creative work as consultation, investigation, evaluation, planning and design of public or private utilities, structures, machines (electrical and mechanical) processes, circuits, buildings, equipment or projects and the supervision of construction for the purposes of securing compliance with the specifications in the designs of works.

We may also repeat the definition of the engineer as follows:

“A professional engineer is a competent person by virtue of his training to apply the scientific method (of inquiry and investigation or indeed by his unique intuitive guide) and outlook to the solution of problems and to assume personal responsibility for the development, and application of engineering science and techniques, especially in research, designing, manufacturing superintending and managing. We may add to this in a developing economy, maintaining, servicing, operation, selection of devices and equipment for a given purpose, installation and construction of systems and indeed marketing. It is clear from this listing that there is much to do as an engineer. In addition in the professional practice of the engineer, many types of technologies could be created leading to gainful employment for others. And so the engineering as a career renders considerable service to the nation in its advancement and practice; and indeed it is at the forefront in earthly matters of every period of civilization.

11.4 CREATION OF EMPLOYMENT

Engineers are involved in the creation of goods and services from the resources our creator made available to us all. All our achievements are limited to what Nature has made available to us for our development, advancement and progress whilst we are on earth. It is said that, “Natural resources: (energy sources, minerals, crops, birds and animals, trees and wood, etc) and particularly water must be used with care. Also in nature everything is manifold. Besides, it is now most urgently necessary to need the Biological cycle; for indeed Nature did not provide for waste. Hence the engineer must increasingly be concerned with harnessing the resources of Nature by designing machines and systems which obey the cyclic process in the recognition that Nature did not provide for waste; and man must not go against this law of Nature.

Now in the most appropriate and widest exploitation of Nature lies limitless employment opportunities for all. Even the secondary effects of the engineers creation leads to new employment opportunities.

Just consider the employment opportunities in water and electricity supply systems; and the secondary jobs opportunities industry, commerce and indeed the homes. Consider the accounting and personnel sections of an electric power supply authority, consider also exploration for petroleum and

the whole energy supply systems in its whole entirety. It can be seen from these examples that the engineer in his professional practice creates jobs opportunities. And so he who is involved to render services to mankind in creating jobs so as to make others become employed must in the end be happy for helping and be contented.

11.5 JOBS OPPORTUNITIES

The engineering profession is very wide indeed. Over the years many fields have developed. The more important ones, a person in search for a career may look up to are:

Civil	Chemical	Electrical
Mechanical	Production	Petroleum
Electronics	Computer	Automotive
Nuclear	Aeronautical	Astronautical

Related to the above listing are water, highways, metallurgy, power and many more sub-units. All these are possible job opportunities as career guidance.

Within each of the engineering fields are many sub-fields leading to the development of various technologies in which each technology developed holds the great potential of increased job opportunities.

Let us consider the electrical machine, generator or motor. In order to manufacture and later repair, service, maintain and operate it many technologies have to be developed. The windings lead to copper mining and refining technology. The art of winding machines is a technology. The manufacture and production of the core of electrical machines led to the development of laminations Production Technology. Whenever electrical machines get burnt out as a result of electrical flux, many are rewound leading also to armature/transformer re-winding technology. Just reflected on the hundreds of thousands of electrical machines produced from various factories worldwide, pushed out as equipment in the service of mankind at one location or the other. Even writing manufacturing industries will fill a whole book. Then reflect on water supply, computers, the motor car, etc.

The job opportunities are there and we should all wake up to this responsibility placed on our shoulders.

11.6 JOBS AND MEMBERS OF THE ENGINEERING FAMILY

There are very few professions in which job opportunities surpass those of the engineering family. Members of the family are Engineers, Technologists, Technicians and Craftsmen, or Artisans. In addition there are many though not qualified in any way who work as services to technicians and

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craftsmen, and who in certain cases are apprentices. And so the engineering family builds up from time to time with the passing of time. Indeed, if the Engineering Family is truly recognised, it actually dominates and leads in almost every sphere of life in which the quality of life has to be improved.

11.7 Areas of Employment and Jobs Creation

Engineers design and in the process they solve problems of society in the production of goods and services and therefore they generate wealth from technology by harnessing the resources of Nature. Indeed engineers create almost all the technologies which are the vectors for socio-economic advancement of the Nation.

Areas of employment are inexhaustibly countless as more are created everyday, as engineers expand the spectrum of the profession. In order to show the vastness of the engineering profession a listing of the main areas in the family is shown in table 11.1. Under each title are many more activities which are also possible. The leaders and leadership of a people or country should recognise the creative activities of the engineers and technologists, and exploit them for the good of all. We can then say that unemployment will not exist in our midst. And so the earlier the leaders recognise this, the better things will become in the years ahead. Some areas may be considered for the year person in search of a career.

11.8 Business

In their booklet "100 Ideas For Businesses in Nigeria" the authors listed many small scale businesses which people can go into: Cottage/Industry, Manufacturing, Re-winding of Electrical Motors, Business Equipment Repairs, Diagnostic Laboratories, Cars, Van and Bus Leasing and Television set spare Parts and Repairs, etc, are all equipment based on the work of engineers and technologists providing career opportunities to many. In these small scale activities, a small workshop, testing and measuring instruments and working tools are necessary.

Engineers are persons who by education, training and aptitude harness the resources of Nature for the betterment of society in such areas as Health Services, Transport Services, (Road, Air and Sea), water and electricity supply, mechanical services, refrigeration and air-conditioning, lifts, public health and sewage treatment and agro-allied industries, etc. They participate fully in the provision of food, shelter and clothing for the society by keeping a balance between supply and demand through mechanization and automation in industries.

Industrial productivity has been increased because of the electric drive systems worldwide. In this, the electric motor is the "king" of all industrial, commercial and domestic drives. Other technological developments are heating, drying, storage, for processing, and many types of entertainment. In fact, there is no sphere of activity in which engineering profession does not

play a major role. Such a profession should attract every young person in search of a career.

Table 11.1: Classification of Engineering by Branches and Sub-branches.

CIVIL ENGINEERING

Structures	Airport	Construction	Flood control
Mechanics	Spaceport	Transportation	Irrigation
Hydraulics	Bridge	City Planning	Waterways
Soil mechanics	Building	Water supply	Oceanography
Foundation	Highway	Sanitary	Surveying

MATERIAL ENGINEERING

Geological	Metallurgy	Material Science	Science
Mining	Beneficiation	Structures	Properties
Petroleum	Extraction	Thermodynamics	Mechanical
Ceramics	Processing	Kinetics	Electrical
Plastics	Fabrication	Synthesis	Optical

MECHANICAL ENGINEERING

Air conditioning	Gas turbine	Machine design	Materials
Aircraft	Nucleonics	Steam turbine	Handling
Applied Mech.	Power Plant	Systems design	Heat transfer
Auto. Control	Process design	Machine tools	Heating and
Fluid mechanics	Product design	Instrumentation	Ventilating

AEROSPACE ENGINEERING

Aerophysics	Structures	Guidance	Air transport
Aerodynamics	Power plants	Stability	Instrumentation
Orbital mech.	Controls	Environment	Gasynamics

ELECTRICAL ENGINEERING

Bioelectronics	Solid state	Computers	Circuit theory
Quantum electronic	Microwaves	Instrumentation	Communication
Integrated circuit	Machinery	Telemetry	Control systems
Energy conversion	Power	Navigation aid	Electron device
Information theory	Propagation	Electroacoustic	Radio astronomy
Information Technology	Building Services		

INDUSTRIAL ENGINEERING

Economy	Production	Manpower	Data processing
Statistics	Methods	Motion study	Operations
Cost control	Quality control	Job evaluation	Research

CHEMICAL ENGINEERING

Heavy chemicals Paints Petroleum Food processing
 Pharmaceuticals Plastics Soaps and fats Process control
 Paper and pulp Rubbers Synthetic fibre Biosynthesis

AGRICULTURAL NUCLEAR ARCHITECTURAL COMPUTER

The engineer is also basically a problem solver. In the process, he develops the necessary knowledge and strives to take the best decision with respect to the many solutions he might have worked out. He is also deeply concerned with the economics of his solution, the benefit cost ratio as well as the usefulness/cost relationship in his effort to take final decisions. The engineer uses many techniques in arriving at the solution of his problems. One of them is the optimisation process or procedure. It is in this process that he decides which of the solutions he has worked out to take.

11.9 **THE DESIGN PROCESS**

The tools the engineers use in solving problems are many. The most important of all the tools in the decision process as to do something or not to do it, and how to do it. A problem therefore arises from the decision to act and therefore to achieve a transformation from one state of affairs to another. For example, converting an energy source coal to electricity. Once a decision is taken to act, the next important tool for solving problems is the design process; of which there are many phases, namely:

- (a) Problem formulation by defining it as broadly as possible.
- (b) Problem Analysis, which should include deliberation, investigation, consultation, so as to completely specify all the stages of the problem.
- (c) The search for alternative solutions during which process the engineer should call up his inventiveness usually guided by his intuition and his creative powers;
- (d) The Decision Phase for selecting the best solution out of all the alternative solutions arising from (c) above. This process is the elimination procedure thereby reducing the alternative solutions with the most appropriate reasons.
- (e) Specification of a Solution. This is the climax of the Design process. By the time the engineer arrives at this final stage, he would have used lots of factual knowledge, previous experiences, computational methods and use of the computer and even develop new technologies so as to arrive at the final solution. Figure 1 shows some of the activities the engineer goes through.

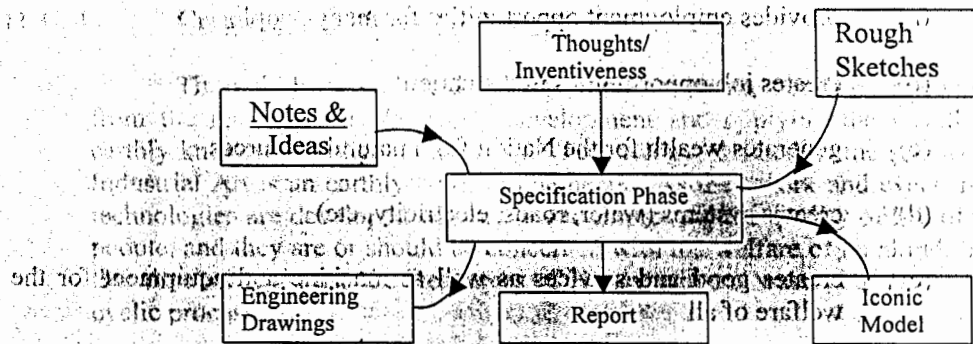


Fig. 11.1 Some of the Engineers Activities

Finally the complete design cycle will then be achieved; hence the process of transformation embarked upon from one stage to another (wood pulp to paper manufacture) would have been achieved for the benefit of all. The Design Cycle Process³ is as shown in figure 2.

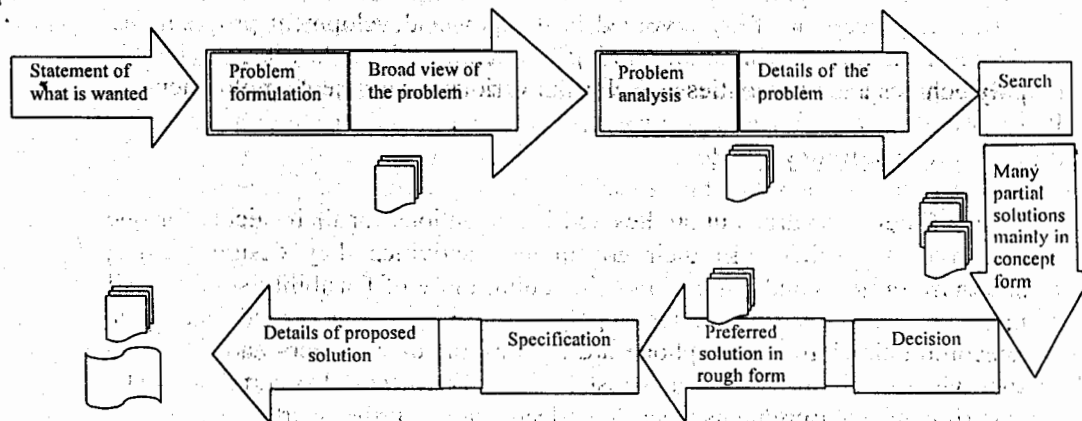


Fig. 11.2 : The Design Cycle Process

11.10. THE ACTIVITIES OF THE ENGINEER

It is not possible to exhaust in one chapter the full activities of the engineer. Table 11.1 has already shown the various classification of Engineering into branches and sub-branches. Under every sub-branch are many sub-sub-branches and the corresponding technologies. For example under energy conversion are the many types of technologies for converting various energy sources (coal, petroleum, hydro, nuclear, geothermal, etc) to electricity. Consider operators, electricians, filter-mechanics, maintenance staff, and so on.

Now in the fullness of the activities of the engineer, he

- (a) provides employment opportunities for many people
- (b) creates job opportunities in the nation
- (c) generates wealth for the Nation from natural resources
- (d) creates systems (water, roads, electricity, etc)
- (e) creates good and services as well as machine and equipment for the welfare of all
- (f) makes sure that spare parts are always available to run the machine, devices, instruments, systems, etc, and
- (g) always develop new technologies which improve old methods and better working environment.

11.10.1 Training – Manpower Development

Engineers are fully involved in manpower development programmes. Some of them are involved in training programmes for industries, teachers in polytechnics and universities as well as in various government employments.

11.10.2 Consultancy Work

Engineers carry out studies and investigations for their clients for one reason or the other. In their consultancy activities they design, advise, supervise projects and write reports including those of feasibility studies. All major systems such as water supply, electricity supply, road networks, telecommunication and telephone are the designs of engineers and they also supervise their construction and installation. Engineers also carry out tests, experiments, measurements, so as to collect data for further work.

11.10.3 Engineering Management

Industrial Management are shifting in favour of engineers. It is said that in many developed societies up to 50% of top management positions are held by engineers. The engineer should normally receive the necessary education to qualify over and above others for the top jobs industry. Because of his training he is almost the best qualified candidate for chief executives and managing directors in industries and systems. Therefore, all young aspiring engineers have rooms at the top if only they work conscientiously. With time, engineers will be at the top in the management of men, money and materials (MMM) in most industries and all engineering enterprises. Clearly these three Ms are the most important tools for actualization of his design, solution to problems, and decisions.

11.10.4 Creating Wealth for the Nation

Through the use of the three Ms, engineers create wealth for the nation from the resources of Nature by development and applying the wealth of earthly knowledge called Technology. Technology, defined as the science of Industrial Art is an earthly work of engineers. As they work and event, new technologies are developed with a view to improving the quality of life of the people, and they are or should be concerned with the welfare of mankind. But this time we must use the Resources of Nature without waste, but rather in a cyclic process.

11.11 Energy

We cannot do justice to this word yet we can only say that without energy, nothing happens. Indeed, energy is the most important invisible effect or input to every activity and process. Energy is the elixir of life on earth and without it there will be no industries, water supplies, technologies, even engineering profession, all will cease to be. For every thought, work or deed that come from each person uses energy for within. But yet energy comes from carbon, hydrogen, sulphur and oxygen combination. In the wisdom of the Creator, he has made it so. But engineers must increasingly use it without waste; and this using energy without wasting it is now the engineers greatest concern. Since the engineers, scientists and technologist who can all also be called technical scientist jointly and separately exploit the resources of Nature and thereby create employment and wealth from technical sciences (or technology) for the nations and mankind, they are also equally responsible for the consequences of all they do in the exercise of their Freewill in the decisions they take leading to designs, solutions to problems, construction, installations, etc. No one can escape from the consequences of each of his decisions which he takes and puts in creation. In the decisions he takes lies the automatic responsibilities he bears for each of his decisions in the Law of Giving and Receiving. And of "What ever a man sows, that shall he reap many time over". Since this is also widely the case, we can see why we technical scientist must struggle harder and harder, with the greatest effort and expenditure of energy to use the Resources of Nature the Almighty put at our disposal for work and life on earth without waste, be it energy, water, minerals, food and most importantly all that we call waste today, which indeed should be raw material for another process in a cyclic order. In this way we respond to the law of cycle in Nature or in the whole of the Great Universe created by God for us as our sphere of Eternal Activity in His Creation.

If we can approach all this as indicated above, using the resources of Nature as the CREATOR OF THE RESOURCES wants them to be used; then the wealth, facilities and systems and every activity in thoughts, words and deed we put in Creation will then bring us peace and happiness, and with our works so changed the earth will increasingly become a better place for us all.

11.12 Waste Management

The production processes and use of the devices and systems including agriculture and farming generate waste, residues and refuse everywhere. Hence in their professional practice, engineers generate waste which pollute the environment. This is a major problem which has to be tackled and addressed and the problems solved, since the creator did not provide for waste.

The environmental sanitation and pollution problems almost choking us out of existence are to a large degree the visible, and after effects of the works of the engineer. The atmospheric pollution from coal fired power stations, the acid and global warming problems are very clear implications of what various technologies are causing mankind because no one wants to heed the law of cycle which the good Lord has but everywhere in the wonderful creation.

The young technical scientist must recognise very early that in his choice of career in the very huge spectrum of engineering leading unto the vast fields and types of technologies, he also has a part to play in combating the problem of waste management which in certain cases is an economic resource. Waste management, and future design, for installation and construction which takes into account the problem of waste abinitio should be very early and therefore needs the corresponding attention as new technologies are developed whilst at the same time the older technologies are modified whenever possible to minimize wastes outputs.

In the management of waste and their possible disposal, certain innovative ideas and concepts will have to be unfolded in the course of time. Just reflect on many obsolete electronic gadgets, which have to be, disposed off, or old motor cars. The problem of disposing off plastics in their entire ramification has become the greatest eyesaw of our time, when burnt they emit very objectionable odour and the black substance which remained constitutes a problem. Waste management and disposal must assume a field of research and development so that new findings leading to acceptable solution may be found.

It is time to recognise the natural Law of Cycle in all research and development work including production and manufacture of all goods and services. The future disposal of all old, obsolete and useless devices equipment and even machinery ought now to form part of our research and development work. With this approach, a way will be found for the management of waste and the disposal and the re-use of obsolete devices. With time, a new and neater environment which will now be pleasing to our Creator will emerge. May this become possible.

G. Tyler Miller, Jr. made the point "A Sustainable-Earth society based on energy flow and matter recycling, reuses and recycles renewable matter resources, wasteless matter and energy. It reduces unnecessary consumption, emphasizes pollution prevention and waste reduction and controls population

growth. The above statement may be represented diagrammatically in figures 11.3 and 11.4.

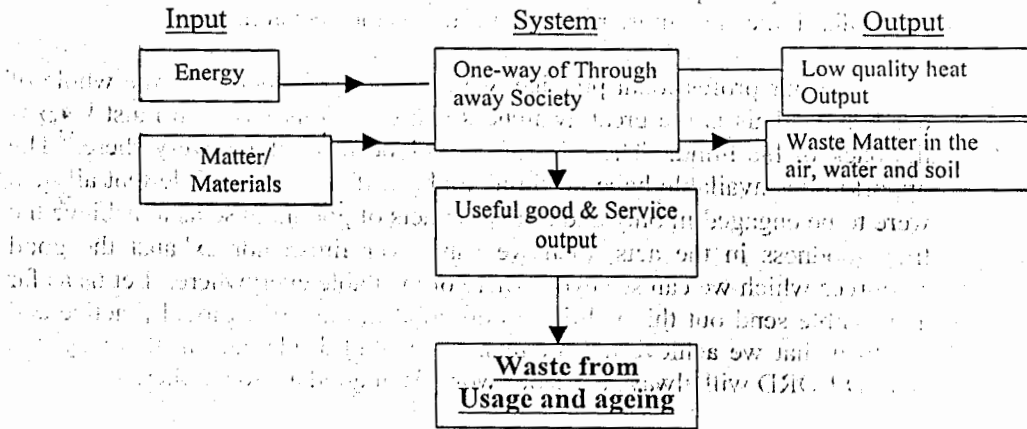


Fig. 11.3: The Input/Output Waste Relationship

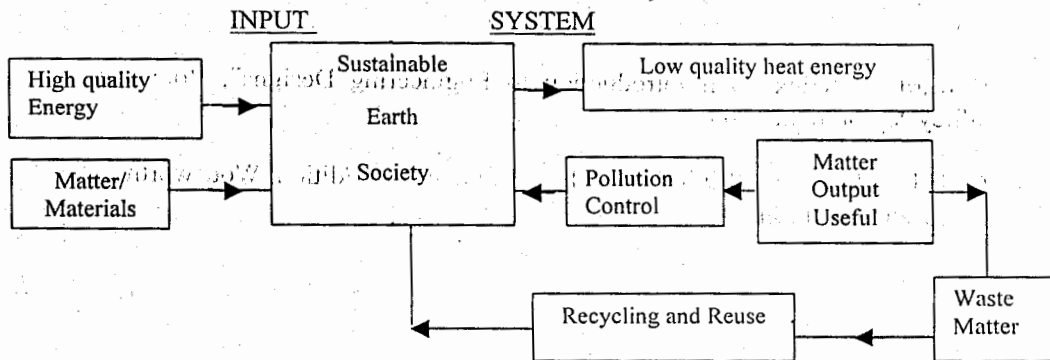


Fig. 11.4. Engineering/Technology Flow with a Recycling Process in Society.

11.13 CONCLUSION

A career in engineering or technical science can be very rewarding indeed if only we approach it as we all should do. This universe is a creation of a CREATOR – THE ALMIGHTY. So also is the earth. We, the creatures must live the way the Creator intends we must do. We must first of all know this His intention which, if we keenly observe the World of Nature we can see every where. Indeed, as we engineers create systems, machines, equipment and tools for carrying out all we do and want to do and make them work so as to bring comfort, harmony and welfare every where, so must we relate with our Creator. Therefore, we must recognize this in all education and at all levels of education. That is, man must know the WILL OF GOD which is also the LAW and adjust, adopt it as well as adapt himself in his freewill to this WILL if he really wants to be happy throughout his existence on earth or in the beyond.

As the young technical scientist contemplates or thinks of a career in the very wide spectrum of the engineering profession, he is basically deciding that he shall participate to serve mankind in accordance with the Will of God. No profession can be more rewarding if this is the decision.

In our professional practice, we must now do good with the whole of our being. This is the great awareness and consciousness each must keep at the back of his mind. There is so much good to be done everywhere. The opportunities available have no limit. Indeed, if it were possible that all men were to be engaged in only and strictly in acts of goodness so as to achieve the true goodness in the acts, then we can never finish nor exhaust the good resources which we can see everywhere or available everywhere. Let us as far as possible send out this volition to do good in our professional practice and see to it that we achieve in thoughts, words and deeds; and in this way, the GOOD LORD will always bless our work from good act to another.

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