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COOPERATION IN SPECIALIZED TRAINING AND EDUCATION FOR
AFRICA'S SOCIO-ECONOMIC DEVELOPMENT - A RELEVANT PROGRAMME

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I. Introduction

The most striking feature of the African socio-economic landscape is a technology gap that extends in all directions, circumscribing endogenous developmental efforts of all types. The most serious economic aspect of this encirclement is that the regions consumer needs are far beyond her production capabilities in terms at least, of the requisite skills. The needs are therefore supplied by external commercial interests which, ipso facto, have to be vested for their survival, in the perpetuation of the gap.

The strategies that we must muster and the countervailing bridgeheads for breaking out of this blockade have now been clearly identified, particularly in the past decade, at several world fora. The United Nations has declared the 1980's the Decade of Industrialisation for Africa. The Vienna Accord with more tenacity than glory has sought to salvage what it could from the so-called North-South Dialogue on the New International Economic Order, and has at least led to the establishment in 1981 of a distinct United Nations Secretariat for Science and Technology Development for Developing Countries, albeit launched with an interim fund of under 10% of the estimates for its operation. The Group of 77 have repeatedly and with becoming fanfare set targets for the share of the world industrial market by African countries, 2% by 2000 AD, the so-called Lima Target of 1975.

Nearer home, African Heads of State steered by the indefatigable think-tank roles of the ECA and the OAU, and unprecedentedly in our history, have produced an ambitious workable article of faith in self-reliance, the Lagos Plan of Action that has now been adopted by the United Nations General Assembly also.

In the chapter of the Plan on Science and Technology which is, significantly, by far the longest chapter, the African Summit declares:

"Top priority should be given to the creation of Science and Technology infra-structure of manpower, knowledge, skills, innovative capacities to absorb and adapt imported technology on the one hand, and on the other to develop technology locally for the identification, exploitation and exploration of national resources, and the conversion of raw materials into semi-finished and finished goods. This would entail a drastic change in the orientation of education ... At advanced levels training programmes need to be reorientated towards the production of not

merely engineers in the various traditional disciplines, (but) technologists in production and service-type situations must be given top priority in order to produce the professional with the versatility required to solve design problems ... The development of research and development should be in a competitive environment... geared to development needs."

"Cooperation and collective self-reliance in manpower development," the declaration continues, "can only be effective when African States pool their resources to develop and operate newly established training and research institutions in support of the manpower requirements of priority development sectors and product lines, and to strengthen and make full use of existing institutions ... and needs commitment on the part of policy makers to create adequate institutions and restructure and reorient existing ones to enable them to provide effective solutions to the problems of development."

In similar vein at the international level the Vienna Plan calls for modification and if necessary redefinition of objectives, policies and criteria in response to the general commitment.. to treat science and technology as an integral part of the New International Economic Order."

In these extracts encapsulate the main themes of this paper, namely the design of a cooperative programme that takes adequate account of the technological handicaps peculiar to the Less Industrialized Countries (LICs) in order to produce manpower that is as relevant to our industrialization needs as at least in the counter part manpower in the More Industrialized Countries (MICs) to their own needs. The preoccupation with technology needs no apology. When one speaks of viable nationhood to-day one refers to modern industry and technology; indeed as long ago as the turn of the century Vitte, the father of Russian industrialization at the time of Russia's own industrial transformation, was guided entirely by the principle that to be militarily strong a nation has first to be industrially strong; what a far cry from, and what a lesson to our countries to-day on the ordering of budgetary priorities! In a word, development to-day is synonymous with modern industry and technology. The extracted quotation sets the immediate objectives of this technological capability as: the efficient utilization of imported skills and goods, their innovative adaptation to solve endogenous industrialization problems; and finally the development of indigenous skills, services and goods that at least match the imported varieties in appropriateness, for example the exploitation^{by} ourselves of our national resources including value-added processing

The second key phrase in the extract is the "reorientation of education", all education. If development is synonymous with technology, the completeness of our encirclement by the technology gap is a measure of the inability of our technologists, no matter how erudite, to translate this erudition into practical hardware as efficiently within our own socio-economic environment as do their MIC counterparts in theirs. I believe however that the fault is not in our technologists but in their stars, to misquote Shakespear. For the past quarter century the LICs have fashioned the critical developmental resource that the technical cadres are, by methods and curricula whose prototypes derive from the very different, technologically much richer backgrounds of the most developed third of the world. Educators come from there with this background and orientation, sometimes not surviving the change that at best is called a clash of cultures, a change that, survived or not, significantly limits the delivery efficiency of this and other exogenous efforts no matter how resolute. Indeed in some situations as with multinationals, when training is closely linked to commercial interests, the protection of commercial secrets has often to be added to the list of disorienting, centrifugal forces of non-indigenous educational management.

In the other direction our sons and daughters join the chase abroad of an even more completely differently oriented educational offering than at home where at least the didactic illustrations of practice can be drawn by the good teacher from the locale. In many cases the hostility of the foreign environment is much less passive than in this example, and makes havoc of many facets of the training, orientation and productivity of impressionable youth. Particularly in technical education a very telling case of this is the difference in practical preparedness of LIC students vis a vis their MIC counterparts with whom they are supposedly being fitted out with the same tools and techniques to perform similar jobs. These counterparts in their technologically rich social milieu see and live with technology twenty-four hours a day. Therefore familiarity therewith is commonplace. Their educational system needs no special elaboration to provide this all-important technology-familiarization component the absence of which in the LICs imbues them with an awe that sees technology as magic and its MIC purveyors as supermen. To this day there are many teachers (alas) who believe that as mere men we LICs can never attain the technological heights scaled by these supermen, can never in other words reverse the trend of the technology gap. Of course this is a ridiculously defeatist starting point for faith in our ability to strive and succeed.

II. The Technological Reorientation of Education

The technological reorientation of education must recognize that above all technology is implementation-oriented in conception and actualization, and has to find a way round the problems of the practical harnessing of resources even when the engineering knowledge is yet to be systematised - for example the individual's precision in the fine machining of a surface or in timing the hot curing of rubber. It is the need to acquire and perfect this "feel" for critical techniques that defines the first guideline for relevantly reshaping our educational process with a strong linkage between classroom and factory floor, for our technical cadres.

The highest priority to-day for the technological capacity of LICs, measured by its needs-supply ratio, attaches to this linkage. The agencies that should ensure its adequate weighting in manpower development programmes are: the designers of engineering curricula in our higher educational institutions given the active backing as distinct from only formulation of government policies on industrialization; then the support of commercial and political friends abroad; the activities of the multi-lateral and non-government agencies; and as substrate to all these the enlightened recognition everywhere of the internationalism of technology which by its nature is not compartmentalisable between the LICs and the rest, and cannot be the preserver of particular nations. In elaborating on the strategy for developing a relevant home-grown education for technological competence in Africa I shall touch on the roles of these agents.

III. Strategy for Developing Technological Education.

We need to be clear first of what we mean by reorienting, not just technical education, but all education into a new technological consciousness. The world of technology is demandingly competitive, but within the constraints of a strict self-discipline and of compelling responsibility that comprehend the livelihood of the workman, the life of the future consumer and the reputation of the whole factory. To think fast and act precisely within the time- and-motion constraints it imposes, to be forced to resist the undisciplined temptation to bend test results to conform to a pattern that pleases most, to take personal pride in the precision of a practical product over and above the average performance for which one is paid, even merely to time leisure so as not to encroach on official time, ... all are part of the modern implication of a technological consciousness, but unfortunately are often discontinuous with traditional attitudes in an agrarian economy. To these our current labour force of

our economically transitional era, whether artist or artisan, must be retrained and the future oriented quickly by innovative revisions to our educational curricula. It is at least a striking coincidence that today's most prosperous nations are not only the most technologically aware but are also the most time-conscious and self-disciplined as societies: Japan, West Germany, the USA, Russia. To sum up, the three modal constraints of the technological society that need new emphasis in our curricula are: individual self-discipline in national duties, a refined time-consciousness, self-confidence in the technologist's capability to translate new ideas into practical accomplishments. How is it to be done?

Historically the manpower linkage with industry has operated by various trial mechanisms - apprenticeships, industrial attachments, sandwich training or cooperative education, teaching factories and the so-called total technology environment. We should critically assess the qualities of these and their suitabilities to the LIC environment so as to utilize the only advantage of the LIC status, the avoidance of the inevitable frustrations of reinventing the wheel. The common characteristics of these mechanisms is that their linkage is with real-life industry, and the more realistic the factory floor environment the higher is its rating. A world of difference exists between on the one hand, the sheltered atmosphere of a teaching or even a research laboratory, with flexible test schedules to suit slower students and often experiments having predetermined outputs, and on the other a pressured factor in competition for profits and quality against time and talent on routines that vary from the boring and repetitive to the painstaking and demanding.

At least to start with we must inject into the curricula a training element studiously designed to compensate commensurately for the outstanding weakness in hardware coverage of our social milieu. Why should project work and tests in engineering education perponderate in the minutiose examination of components and their characteristics, often with outputs that are well-known a priori, instead of being extended overhauling of whole engineering systems and subsystems - their disassembly, parts repair and reassembly with marks awarded on the compared test performance before and after the overhaul? Why should building engineers and technicians be closetted in controlled intra-mural laboratories and model workshops for longer than they are exposed to the ripening sum of extra-mural industry where more often than not profit motives and disciplined timing are the rule, and unexpected windfall or rush maintenance routines continually demand resilience and resourcefulness? And for the increasing numbers of technical trainees who these days obtain short attachments in industrial houses during school vacations, how good are the on-the-job supervision and accreditation arrangements? What preference do we

give objective research over basic research during this juncture of the Industrialization Decade when African countries "stand at a watershed in the history of their development"? How long does an important new technique like that mighty mite of modern electronics, the microprocessor, as technique rather than just as a principle, take to invade the curriculum?

These are the kinds of questions we asked ourselves at the design stage of the programme of the African Institute for Higher Technical Training and Research which I shall discuss further later; they are a test of the realism of our curricular match to our environments, as compared with technologically self-reliant nations where these needs of technique and hardware familiarisation would already be serviced societally, as witness the current case of a wholly new industry termed "personal computing" long before the appropriate committees of university senates have laboured through the minutiae of a new curriculum. We further asked, in view of the position that LICs cannot afford the luxury of such leisureliness with teaching curricula, what extra awareness in curricula response to the well-known poverty of our technological environment and economic output are higher educational institutions showing over and above programmes the prototypes of which exist in the MICs?

For example why cannot we break free from the tradition of separate institutions for the production of professional and "sub-professional" technical cadres - why not, when indeed it promises a much better husbanding of the expensive but overlapping resources both require? Where is that badly needed innovation in science education that should emphasize the answers to LIC problems and events? In face for example of the desertion of physics by undergraduates - a trend traceable to the same inadequacies of the technological milieu and to the natural embarrassment of student marooned on islands of the 20th century esotericities of physics in seas of near pre-science - what curricular modifications are universities exploring, flexibly to meet the day's needs of largely increased intakes into physics and other basic sciences that generate inputs into technical courses?

What steps to start the publication locally of physics and mathematical texts at all levels, and appropriately to extend science teaching to all faculties, a minimum start to the reorientation of all education to a technological age, not forgetting extra-mural education.

This is an obvious area for very effective inter-university cooperation - from the devising of teaching strategies and curricula - a dual-channel physics programme for instance in which one channel takes longer to cover mainly the subjects of applications interest to engineering - to the establishment of a joint high-quality

inter-university publishing and review house for books and journals particularly in the physical sciences, and covering fully the primary to the tertiary levels. The Association of African Universities can play a lead role in promoting a venture or ventures that will contribute significantly in the battle of the technology gap.

One more point needs to be made. We cannot expect an authentic and efficient matching of our educational and environmental needs to be made exogenously. Foreign expertise despite its highly valued contributions can after all impart only the kind of cooperation derived from its own authentic experience acquired mostly in its own locale to solve its own needs. Any blaming of overseas education for disorienting our sons and daughters is largely misplaced therefore. Such disorientation is at best inevitable and plausibly incidental. Its sole remedy is the provision at home of the level of expert training and of facilities such as qualitative publishing houses, for which we still rely largely or wholly on extra-regional sources.

IV. The Need for Political Will

Given this conclusion the next question is on the necessary political will to provide such facilities cooperatively where there are strong reasons for so doing. Unfortunately here most African countries are not reputed for a strong enough political will to back up by action even their most ardently expressed wishes and needs. We have for instance remarked the need already strongly enjoined in the Lagos Plan for locally establishing innovative technological institutions of the level and quality of professionalism that attract, but do not adequately meet the needs of, our youth abroad. Apart from ensuring the correct educational orientation this would considerably assist in damming the so-called reverse technology flow or brain drain. Accordingly the ECA and OAU have characteristically assisted African countries to set up in the past quinquennium a number of specialized technology - indigenisation institutions, the first of their kind in OAU-member States, for the industrial transformation of the region during these closing decades of the century.

One of these in particular, the African Institute for Higher Technical Training and Research, is Africa's sole and collective effort at self-reliantly developing an institute of technology for the strong industrialization momentum traditionally generated by this type of institution but also in this case innovatively designing to achieve this from an inside knowledge of Africa's technological handicaps.

Now the specialized complementary role of this type of institution to the general engineering education provided in engineering universities and universities of technology has to be emphasized, and will become clear in the sequel; and this role is certainly validified by the striking correlation between the most successfully industrializing countries and the strong presence of institutes of technology. Thus Japan with some fifteen top-notch Institutes of Technology has also well over 100 engineering universities; India, a particularly relevant illustration owing to its demographic and sociological similarities to our own environment, is serviced by five national Institutes of Technology reputedly the most virile among its numerous university-level institutions, and by the regional Asian Institute of Technology in Bangkok; and Brazil, the phenomenal example of a successful developmental competition against a much more industrialized world, is serviced by its Institute of Technological Research of Sao Paulo with a 30,000 student population; and so on - West Germany, Russia and the USA may all be cited. Only in Africa of all regions did one remark the total absence till the founding of the African Institute for Higher Technical Training and Research, of the kind of applications-oriented education and training in industrial disciplines which these institutes per excellence pursue. For several years before the founding of the African Institute these facts have been dinned in the ears of Africa's policy-makers and technocrats, but the astonishing weakness of political will to come and work together to help ourselves is clear from the event that for a full year now this Institute has had to struggle hard merely to find its feet.

And we are entitled to ask why? Why do we, of all regions, appear largely indifferent to effective action now to ensure a seed cadre of technologists and technocrats who can man our factories and plan our industrialization self-reliantly? Why do we complain of the lack of relevant technical manpower, yet ignore precedents in the matter of taking resolute action - ignore that Russia, Japan and others at the start of the present century resolved similar situations by according a far higher priority than we appear ready to do to the funding of special technological institutions and programmes?

Is the answer that we listen more to advice on such matters and seek more their funding from without than from within Africa? To the clamorous calls from friendly but sly industrialists, and their governments, that we limit ourselves to soft technologies because they abroad already possess enough of the hard-technology capability to supply us in exchange for our unprocessed products? Or is it simply that in practice as distinct from policy we have still not got our own priorities right? That we still prefer to disburse foreign exchange importing tranquilising drugs and drinks (including drinking water) rather than invest in a seriously import substituting teaching factory for the agro-food and drugs

industries? That in place of starting a centre of excellence in electromechanical technologies and industrial design, set up with the training needs of African trainees in mind, where for instance they can produce while learning and learn by producing commercially competitive goods under the eyes of our own technologists and teachers who are concerned that the economic future of our whole region is at stake, we prefer to pick educational crumbs for the "lucky" few of our sons and daughters in programmes designed abroad for appropriate use abroad and meeting our own needs only wastefully at enormous cost to our talents and wealth?

To avoid possible misunderstanding one hastens to add that the self-reliant process implies not isolationism but more indigenous involvement so that we can move responsibly accept and manage cooperation from abroad. Referring to this "external" component of cooperation in what it terms "the general commitment" the Vienna Plan asks for "the full and adequate use of the bodies within the United Nations system... and that the adjustment of the policies of the bodies so as to support effectively the development objectives and priorities agreed upon by the countries should be taken fully into account". Unfortunately it fights shy of the outright injunction to pursue such policy adjustments actively; but it goes on: "There is a manifest need for channelling additional resources on a predictable, continuous and untied basis for science and technology ... in the developing countries."

The political will to self-reliance has to contend with and provide for the event that external collaboration may not be "untied". The policy constraints of cooperation, particularly North-South cooperation can affect the priorities chosen in the South and hence the viability of South-South cooperation. For example, in face of the language barrier to inter-country projects in Africa, I find it deplorable that some bilateral North-South projects exacerbate the situation by explicitly tying their assistance to the purveying of a non-science language in this age of technology; and the weaker the Southern partner is the more insistent does this assault on its future tend to be. To accept such strings is almost patriotic.

Even of more moment is the tendency, probably related to the same culture-domination strings, of some agencies to prefer "country-oriented" cooperation to multinational programmes despite the latter's economies of scale and greater capacity for the cross fertilization of diverse backgrounds. Particularly in the African context, the maximum spin-offs from cooperation projects derive from those that increase the chances of harmony between quite likely recently belligerent neighbours rather than accentuate imbalances in their economic progress and their social and political differences. This is particularly feasible through programme linkages in technology development where the levels of capital-intensive investments

of the critical mass of a project and of individual national budgets create a strong incentive to inter-country collaboration. From the relatively inexpensive operation of Clearing Bureaux to facilitate inter-country exchanges of technical manpower and technical information to the relatively expensive capitalization of the heavy-equipment and electronics industries, and the training vital to the operation of the bureaux, South-South cooperation in multi-country projects deserves the priority attention of technical assistance agencies. Self-reliant efforts like ECOWAS should be single-mindedly reinforced rather than watched with misgivings from the side-lines.

V. The Need for Cooperation

However just as cooperation involves at least two parties, so do complaints on the lack of it. The North has its criticisms also of the mechanics and modalities of the expenditure in the South of developmental funds invested by multinationals and friendly governments. It believes us to pay very close heed to these complaints, even irrespective of their justification if they are not justified we should not only say so but demonstrate that they are mistaken. But that said, we know that some of the criticisms ring true. It is certainly essential to the proper utilization of technical assistance that the receiver's absorptive capacity be adequate to ensure that it is channelled to the agreed projects. While self-reliance is not a negation in itself of cooperation and need not imply self-sufficiency, accountability is crucial in winning cooperation for self-reliance, and it is a negation of this principle not to manage well the resources provided for development. The collaboration MIC would be justified in concluding that the LIC is not prepared to the assisted or else should have the assistance also managed for him.

Aside from technical manpower training, or educational institutions are interested in the kinds of collaboration sought by LICs for the establishment of production lines are commonplace in the MICs - motorised transport, assembly lines for communications equipment, food processing plant, petroleum and bulk energy production the upgrading of traditional industries and techniques. It is time now to add to these the fabrication of some of the inwards, including the driving elements - motors, pumps, solid-state electronic components for the maintenance of computer and communications hardware the most modern makes of which now invade LICs and MICs indifferently, alloying and heat-treatment techniques for steels petrochemical processes and plants and the insertion in technology packages for these of substantial training and product-research undertaking in collaboration with educational institutions. This is an important topic to dwell on because considerable resources of know-how and hardware are available to multinationals such as the U. N. O., UNESCO, ILO in the industrial manpower and research

development which is the field of almost exclusive interest to the economic contributions our higher educational institutions can make but which, the multilateral agencies complain, is not being anything like fully tapped, possibly because of a lack of awareness not only of the extent of their availability but of the procedure for availing oneself of them.

I suggest first that groups of our institutions organize seminars and workshops on the processing of multilateral agency collaboration, to be addressed by such of our heads of departments and divisions who already know the ropes and by representatives of the agencies themselves who are very willing to do so or even to support such workshops, especially when they are institutional, financially. These days also the three earlier-mentioned regional institutions on technology development are constitutionally required to assist or coordinate in their respective fields, this activity: They are the African Regional Centre for Technology (Dakar) in the field of technology policy in all its aspects, the African Regional Centre for Engineering Design and Manufacturing (Ibadan) in hardware design and development, and the African Institute for Higher Technical Training and Research (Nairobi) in manpower development and related hardware research. Following the catalytic and promotional actions by these regional, by subregional or by national institutions as earlier suggested the same collaborative process should be extended to the actual implementation of the resultant projects. One should not pass the opportunity here of underlining our need now for action rather than words, for every such endeavour to have as the main objective a practical implementation of real-life programmes, not just resolutions and recommendations as sometimes is the case with policy seminars important as these are, and not even merely model workshops or further seminars. One such socio-economic activity which tends itself eminently to fruitful cooperation in all its modes - North-South, South-South, intra-regional and inter-institutional - is the linkage between manpower development and industry, and in particular I shall in the second half of this paper, discuss what I consider a programme well-tailored to such cooperation and above all to Africa's needs now.

VI. Cooperation tailored to African Needs

My experience in speaking of Africans' needs is of a need to preface it with Africa's duties thereof. Even more than North-South cooperation, South-South cooperation, it sometimes appears needs more sermonising on haves sharing with have-nots. The begrudging and grasping, politics-commercial approach ill-serves the regional development process, particularly through manpower development the benefits of which, given the OAU charter and the Plan and Final Act

of Lagos, are almost automatically extensible from the national to the regional are Technological endeavour being in sum one monolithic edifice to which every community owes a contribution commensurate to the height from which it can build, the more such contributions the faster the building; but those higher up owe the duty to assist others to maximise their own contributions. That this building process requires the equitable distribution of world resources is the gravamen of the argument for the North-South dialogue and the new world economic order that have born successfully the Plans of Action of Vienna and of Lagos. To accelerate maximally this equitability is indeed a natural law-responsibility of the relatively privileged. If some of Africa's few relatively privileged States continue to deny, for whatever reasons they have in the past, their widow's mite but proportionally and politically significant support of inter-governmental projects, regional self-reliance will remain a dream and in the end technological affluence and competitiveness, the main non-wasting resources of modern nationhood, will elude even the so-called high-income LICs.

The post-colonial MIC channels of assistance - education, loans and grants - are progressively now being turned off, at least to the more self-assertive nations. In itself this is not necessarily a bad thing, not if it signals the replacement of exploitative with genuine cooperative assistance. But does it? Does not the Kissinger doctrine of "recycling petrodollars" mean for example that an irredentist LIC like Nigeria with a per capita GNP of \$560, only 5% of the USA's and 5.8% of West Germany's is still being exploited in its bid to industrialise or die, by being forced to pay up to 300% the 'non-recyclement' prices of MIC exports to it, and thus compulsorily and disproportionately to invest in the very exploitation and in the widening of the technology gap, contrary to the ethos of Vienna. In the views of many the oil economy is an ecological mechanism assisting the much-discussed new economic order, including, we not, the huge but voluntary reinvestments of petrodollars by some LICs in the MIC economy. To rob the widow's mite as by the Kissinger doctrine is the example par excellence of the iniquitous use of the technology gap to blockade LIC endogenous development in all directions.

We need only bear in mind that it is a blockade as tenacious as it is pervasive - political, cultural and psychological - to be alive to the role of patriotic, indigenous education in combatting it. The role is above all, during this UN Decade of Industrialization of Africa, to reorient self-reliantly our corporate psychology and culture, i.e., education from the grassroots up, into a new technological consciousness, full aware of Africa's peculiar world environment within which to achieve this. For example the international antagonism to technology transfer to Japan early this century was nothing like as refined or close-knit as ours today;

in the case of Russia some two decades earlier, it was next to non-existent. And then of course each of them is a single state unhampered by the policy clashes of national individualisms, and with a strong traditional disciplinarianism, unhampered by donors, which predisposed it to a quick turn-around. On the other hand we have the considerable advantage of reserves of resources, material and manpower, that are weighty in value, development potential and bargaining power if we pool resource. We have also the single, if doubtful advantage of a developing status in a much more developed world.- we can leap-frog unnecessary intermediate stages.

Therefore the Lagos Plan though labelled ambitious, and the Vienna Plan need not take as long as pessimists forebode. A lot hangs incontrovertibly on how much together we pull. Thank goodness we do have some of the concomitant manpower these days, for it would be simple-minded to suppose that our ills could be diagnosed for us with the same poignant accuracy by doctors of education of an entirely different upbringing. Since our own diagnosis is at least the more sympathetic and probably also the more accurate, we disagree with those foreign commentators who still question the wisdom of 'technology transfer to the Third World' or advocate only a mystical level of 'appropriate technology', a misnomer here for rural industry.

On the contrary we believe that we understand the reason for example for the glaring loss of confidence of our personnel when faced with the need for practical hardware implementation, a failure which the MICs at best marvel at on remarking that the similar implementational bridges are crossed repeatedly by their own technologists not necessarily by a superiority of aptitude, but by a confidence born of a life-long familiarity with industrial hardware, by inspiration that we ourselves are not denied and of course by perspiration. We know therefore that the answer lies in drilling on technical manpower on the kinds of practically-oriented projects that they will encounter in practice, such as through the plant-overhaul projects described earlier. This should both build up faith in the practical competence of our technologists and endow them with the fillip of a familiar environment amongst hardware.

The Vienna Plan programme for the desiderated relevance in expert manpower consists chiefly in developing existing institutions into Centres of Excellence, and so dotting the LICs with such, in all likelihood unidisciplinary but differentiated centres between which interchanges of staff, students and to some extent programmes can obtain. Its merits are obvious, rather more so than its demerits which I shall briefly mention in order to see how we can improve on it.

Its first limitation is that the operation of geographically isolated unidisciplinary centres, loses much of that uncomputerisable component of inter-disciplinarity that makes one plus one equal more

than two! Even where some of the necessary inter-disciplinarity is provided by sister departments, it is as by extra-departmental associates without the same commitment, administrative control or academic guidance. Delaying senate-hall tactics are bound to arise over the balancing and management of the extra-national sponsorship vis a vis its share of the national budget.

Secondly, exclusive use of infrastructurally determined centres means in the LIC context, unlike MIC's, doing without a number of disciplines, some of these of the strongest modern relevance, because of their non-representation in existing institutions. It takes one aback in the Decade of Industrialization for Africa to realise that there are still critical manpower cadres for our sparse industries for which we have to rely wholly on extra-regional crumbs of training, and for others where the training resources are possessed by one or two of the less slowly developing of our countries, inter-territorial linkages in policy and infrastructure are quite inadequate to ensure the desirable levels of technical South-South cooperation. What is particularly in this is that it is precisely in those sectors that tell most on industrial capability in the specialized skills of planning, designing and fabricating hardware including their "top-down" maintenance - the design and development engineer, the mineralogist, the plastics, polymers and fibres specialist, the heat-treatment and cryogenics experts - those are precisely the cadres for which not a single higher educational institution exists, as far as we know, in the OAU member States!

This parlous situation is well-known to our university establishments, estimated at some fifty odd, of which incidentally there is the still more impressive absence of a developed technological university to which, our universities may argue, such practical industrial specializations properly belong. But in the absence of such repositories, where is the flexibility and innovativeness for which academic should be looked up to for solutions to serious manpower constraints? We would appear to have ceded this birthright for donated crumbs from foreign institutions, and should use the opportunity of the new centres of excellence to find a formula for retrieving this right.

A third drawback of the centres-of-excellence concept is its implied restriction to a South-South axis. One need only emphasize again the universalism of technology and the desirability of the widest possible cross-fertilization of ideas in its pursuit.

VII. The AIHTTR as an Institute of Technology

Despite these shortcomings the undoubted appeal of the principle of centres of excellence on the one hand and the said serious gaps in our technical manpower programmes on the other determined the design of the programme of the African Institute for Higher Technical Training and Research (AIHTTR) to provide all African countries with the services of an institute of technology on an innovative programme designed to our industrial and technological environment, and subsuming the closest possible cooperation with existing national institutions. Its main objectives which are closely linked with the Lagos Plan are:

- (i) The training or retraining of production-oriented professionals at both middle levels and high levels to adapt, design and implement solutions to our industrialization problems as effectively as do their MIC counterparts. The input to this educational activity is the output of engineers and technicians from the existing general engineering and science programmes of our universities, polytechnics and colleges. These will be converted or upgraded into more narrowly defined, vertically specialized fields in line with the ascertained needs of industry: for instance the metallurgist or machine tools specialist (as a Bachelor or Master of Technology) from the mechanical engineer or from the applied science graduate, the computer technician or the instrumentation technologist (with a Special Diploma or a B. Tech. Associate) from a gifted general electrical or mechanical engineering technician, the innovative technical trainer or education from the general science teacher, the building technician, etc.
- (ii) The sponsoring of an innovative programme for the reorientation of education to the needs of our technological age. Part of the programme input here will be the services of a Clearing Bureau on technical manpower data including comparative qualifications, available expertise, etc.
- (iii) The catalysing eventually of the establishment in those of our countries that so desire, of technological institutions on the pattern of the AIHTTR. What this pattern is is most quickly described by sketching out the innovative features, in our region, of the programme of the institute.

First, we remark the innovative policy of formally training both middle-level and high-level manpower in the same institution. This aims at dealing a death-blow at the public devoting of the

prestige of middle-level cadres despite these being the lynch-pins of modern industry - the workshop supervisors, foremen and master craftsmen without whom quality factory production is impossible and industrial power therefore next to nothing. The cooperative arrangement envisaged here by the Institute is with the polytechnic processing of diplomas and higher diplomas. The aptitude-tested diplomate, invariably with a specific minimum of experiential qualification, is transferred to the finishing courses in the Institute or in appropriate country centres of excellence, to specialize in a particular industrial technique, process or discipline.

By this innovation we also remove the artificial barrier to technicians, no matter how gifted, of the so-called higher diploma, and open unreservedly the prestige-boosting channels for upward mobility for technicians as for engineers. A third strong argument for this innovation is the improved cost-effectiveness of equipment that have so far had to be duplicated in the dichotomous training of these cadres within a profession that is already among the most capital-intensive.

It is informative also to call attention here to the complementarity of the Institute's programmes to those of national institutions. Two training scenarios are available, according to the Institute's Constitution: the regional for manpower needs identified as common to a number of countries, and the country-oriented in fields requested by the individual country. In either case the training may obtain in any regional or sub-regional campus of the Institute or by arrangement in any national campus, according to where the relevant special resources are most conveniently located. In either scenario we note that the origination of individual programmes is country-based, thus ensuring a maximum of national collaboration. Given this setting, the Institute then secures the necessary support funding from its own or other sources.

A second main element of innovation is the multi-disciplinarity of the curricula to match the needs of the design and production industry. Simply listing the nomenclatures of the Centres shows the pattern - and "Centres" stand in place of "Faculties" because their activities encompass more than teaching and research, to include equipment prototype design and development, technology adaptation and diffusion including publications production, technology packaging and professional consulting, equipment marketing and engineering management and collaboration with the central Clearing Bureau in information research and field work for which each Centre should ideally support a Field Unit. The ten Centres* are, according to the prioritisation in the Lagos Plan Agricultural Engineering and Food and Drugs Technology; Technical Trainer Training (Instructors, Teachers Electromechanical Engineering and Educators);

*See philosophy planning and the structure of AIHTTR/PAMM/
AIHTTR/GS/2-/S/9/80 ECA 1980

Interdisciplinary Industrial Production (Teaching Electronics and Factory); Electronics and Communications; Business and Social Studies; Energy and Natural Resources; Non-metalliferrous and Minerals Technologies; Basic Sciences; Environmental and Infra-structural Engineering. The order of priorities is not necessarily the same as the chronology of the starting up of activities. For purposes of comparison I quote some usual disciplinary combinations in well-known Institutes of Technology of the orientation of the AIHTTR. Japan's Institutes of Technology in Tokyo and Nagoya have the Departments of Precision Machinery and Electronics, Materials Technology and Nuclear Power; the Asian Institute of Technology in Bangkok specializes in Gestechnical Engineering including Clearing House and Directory services relevant thereto; Poland, a country of some 37 million people supports nine "polytechnika" specialising in Five Mechanics (Warsaw), Working Machinery and Vehicles Engineering (Poznan), Chemistry of Foodstuffs and of Textiles (Lodz), etc; and Brazil's Institute of Technological Research physically separates basic courses such as basic sciences and electrotechnics into other institutions.

The single most important innovation in the AIHTTR Programme is the process for ensuring its applications-orientation in a way to make up for the already identified lacuna in the entire background of our technical cadres. The central processor here is the Production Centre or teaching factory earlier mentioned, supplemented appropriately by other modes of acquiring industrial experience, such as the traditional extra-mural attachment which offers a wide variety of practice if not as effective a processing. But the main innovative processing is from the Production Centre itself which services all teaching Centres, and from individual Centre Project Workshops where out-and-out plant overhaul drilling on real-life or life-scale engineering systems of the kind common in factory maintenance yards of the research and development type, replace the much less effective laboratory-scale tests of parts and components characteristics common in present engineering course-work curricula.

Plant overhaul project drilling as described much earlier is effectively plagiarization-proof and provides a direct path to technology adaptation and design. It constitutes half of the "total technology" training approach of the Institute when combined with the teaching factory process. Since the Institute will deal exclusively with mature students, all modes of practical work - mural attachments, workshops and laboratories, and factory - together make up about 60% of the curriculum, an unusually high degree of hands-on experience injected to attempt a compensation for the equally unusual thinness of our technological base. Practical factory-floor induction in the Production Centre will be, like projects work,

the common denominator to training for all products of the Institute.

The planning of the Centre is that of a veritable factory run commercially under realistic time drives and profit motives by a separate organization from, but a commercial subsidiary of the Institute. Not dependent for its livelihood on the vagaries of consultancy contracts only, it will establish by feasibility studies its own competitive production lines and organization. The one snag in this proposal is its considerable capitalization budget compared to a purely academic centre. But this would be a paracipitate comparison. Even taking into account the allocation of about 10% of the factory resources to training, every student clocking in for a full working day per week for this, the Centre is undisquisedly 90% a production factory, and in the remaining 10% it is not unlike the best-run factory provision for essential in-house training. Its training concept requires that this be so: otherwise it would not be processing trainees through a realistic factory environment, nor teaching them hard-headed, profit-making business practice.

Its medium of operation will be key, soft to medium technology products such as small motors, high quality tools, communications hardware, technology adaptive design and development, technical education equipment and prototypes and high quality scientific textual production. It links curricularly to the Academic Board of the Institute so as to remain in the full stream of the activities of the Institute through the two-way flow of trainers, trainees and technicians.

For an institution dedicated to raising innovative cadres and to invigorating the halting pace of industrialization in Africa, there would appear to be no better-tailored approach than a "total technology" scheme. Indeed for one overwhelming reason it is the only choice. In the MICs a choice between various modes of acquiring the requisite expertise exists because each has the back-up of the technologically rich socio-industrial milieu. Such a choice we do not have; and the final appropriateness of the approach is that it is possible now to inject any kind of practically-oriented projects designed by ourselves to correct flexibly for experiential shortcomings diagnosed, as they crop up, by indigenous educators.

Finally the capital intensity problem may be resolved by one such teaching factory servicing a number of adjacent national institutions. Indeed it is feasible to extend this to the international and inter-institutional exchange of curricula of staff and student-training in such centres and of staff themselves. My experience is that this is an important consideration for engineering professors; it is certainly for those staff of the Institute whose

background may not include up to the minimum of 5 years industrial research experience required on the average. The chief barriers to effective cooperation in this mode is the same as has to date militated against the wide-spread exchange of teachers between our existing universities, albeit this is a powerful mechanism for eeking out the severe understaffing of many of our universities, particularly in engineering; I refer to the barriers of policy, language and colonial-era prejudices. The academic heads in universities must squarely take the blame for not exploiting fully staff exchange opportunities, and perhaps need nudging from the policy-making levels in future. Both through direct involvement in its programmes and through the medium of its Clearing House the African Institute expects to provide many opportunities and to ease the channels for intra-African staff exchanges for shorter or, as during sabbaticals and vacations, longer periods.

VIII. Conclusion

This then is the kind of programme we believe is desiderated in Africa's efforts to transform her economy, and which the AIHTTR is set up to operate and to catalyse the development of in member States as required, so as to complement the performance of existing institutions with the kind of technical manpower that they are so far not set up to produce. Because of the level of capitalization and the critical masses involved it is out considered view that the majority, if not all of African States should pool resources and strongly develop this programme. Starting from its regional headquarters in Nairobi, it is proposed that branch campuses of the AIHTTR should progressively seed in each sub-region either as new developments or by strengthening existing or budding national centres of excellence. Their establishments will-be, as for the regional campus, on the pre-eminent principle of cooperation among themselves and with national institutions. The much stronger practicalization than hitherto of this principle is an imperative need that still seems to need urging within the region's higher educational institutions, and we urge that every such institution should like the AIHTTR take serious action towards the most effective regional cooperation.

In the view of the United Nations, for Africa this is the crucial Decade of Industrialization. In the view of African nations it is a long-expected challenge, and our slogan now should be All hands on deck in self-reliance and realistic patriotism. In my view this should be the call to a mission, going out individually to capable hands in each African nation or overseas in the "brain drain" diaspora presently serving in lands where they are in all likelihood less needed, and to all professionals who are concerned at the widening chasm of the technology gap and its concomitant