VISION 2020

With Particular Reference To

Rural Development and Technology Management

Where the poor command all basic needs

And everyone is willing to experiment with change

So, the country develops rapidly and wisely

Alternately,

The fastest feasible growth that will push

Quality of Life Index beyond the world average.

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VISION 2020

Sweet are the uses of adversity,
Which like the toad, ugly and venomous
Wears yet a precious jewel in its head

William Shakespeare

Vision is not the pot of gold at the end of the rainbow
Nor a prediction of what will be
It is a signpost of where society can go
Not necessarily where it will go

Every vision remains a fancy
Until the status quo becomes unbearable
And people agree that change is desirable
Then, and only then, does any vision become a reality

Vision seeks inspiration in impediments, opportunities in obstacles
It converts Impedances into Driving Forces

An Irish Fable Worth Remembering: A sailor shipwrecked on an uninhabited island prays to his guardian angel to let him have at least a baby for a companion. Much impressed at that unusual thought, the angel leaves a baby by his side in a sack while he was asleep. The sailor wakes up; sees something wriggling in the sack, ***suspicious of anything new***, and as a matter of abundant caution, he drives a knife into the sack before opening it.

Look into the mirror. Do we see that sailor in there?

VISION 2020

SYNOPSIS

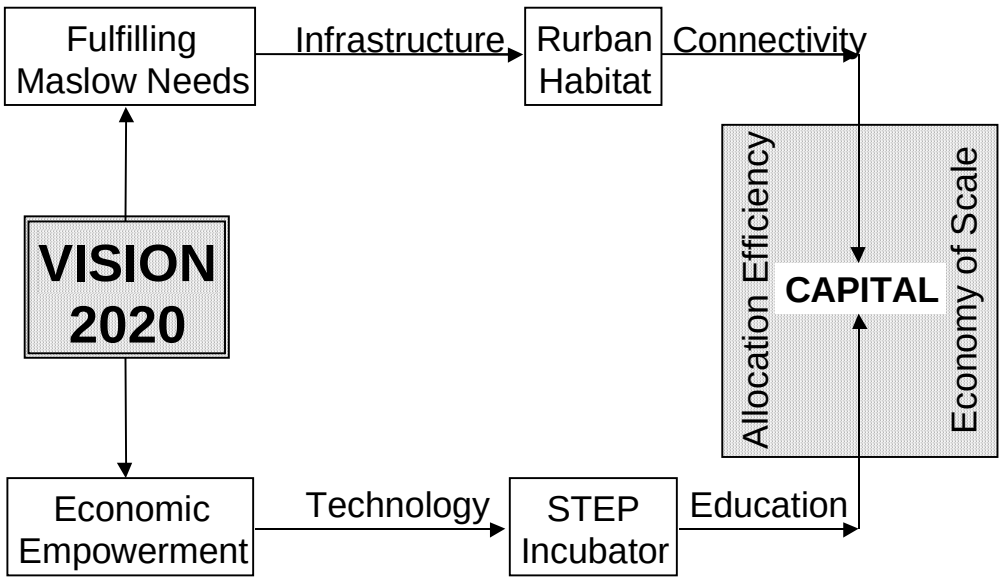
It is usual to plan for growth, as rapid a growth as possible. That is incremental thinking. Visionary thinking is different. It starts not from what is but from what should be, at any rate, can be. It works backwards from the end and not from now on to the end.

India is likely to attain a stationary population of 1.7-1.8 billion. It may never reach the current prosperity of the United States; may be it should not with all its attendant extravagance. Can it reach at least the average level of world's prosperity with per capita incomes of about US $ 5-6000 per year? That much is indeed necessary. That is the minimum needed to avoid being looked down in the comity of nations. More than that runs the risk of evoking jealousy and inviting unwanted migration too.

The Planning Commission has targeted 8 per cent growth rate, but agriculture (the mainstay of rural areas) cannot grow much faster than 2 per cent. So, either rural areas recede 6 per cent a year relative to cities, or there is 6 per cent rural-urban migration or rural areas are empowered to grow at 8 per cent with non-agricultural development making rural-urban migration unnecessary. The last option is best and feasible. Then, the objective should be to enrich rural areas by employing around 80 per cent of 1.3 to 1.5 billion rural residents (out of ultimate population of 1.7-1.8 billion) in non-agricultural occupations.

Two aspects of VISION 2020 have been addressed in this presentation – ensuring the fulfilment of Maslow Needs socially and Empowering the Economy to face global competition. The approach to the VISION is best done by working backwards as shown in the diagram. For instance, fulfilling Maslow Needs socially requires infrastructure and that is best done by a process called Rurbanisation that combines rural ambience with the capability of cities to supply a full range of services. Like wise, Empowering the economy to face global competition requires technology development and that may be generated in Science and Technology Parks (STEP) and technology Incubators. Connectivity is the primary input to Rurbanisation and education the one for STEPs and incubators. Both connectivity and education require

Fig. S. 1. Deriving Driving Forces of Development By Working Backwards from Vision



capital and optimum utilisation of capital depends on (a) the choice made or allocation efficiency and the level chosen or optimum economy of scale. Or, primary level Driving Forces are infrastructure and technology, and at the secondary level, they are connectivity and education level respectively. Capital is only tertiary and it has been shown that its importance to growth and development is relatively minor.

Rural areas can be empowered to compete with cities. They can be reorganised to support 80 per cent of their population in non-agricultural occupations. Rural-urban migration can be halted. All that is not only possible, that is also more economical than expanding cities without limit.

The ultimate Vision is a nation dominated by Rurban habitats, several thousand of them, virtually one for every rural development block and supporting 70-80 per cent of the total population and offering a full range of urban amenities in a rural ambience; a nation neither too rich nor too poor but one that follows the Middle Path, deploys technology extensively but wisely where talented people are respected and ordinary people are secure.

1. TARGETS OF VISION: FULFILMENT OF MASLOW NEEDS

1.1. Maslow Needs

Thanks to Amartya Sen, UNDP has shifted emphasis from outputs to entitlements, from quantity to quality, from money to what money actually buys. As a result, UNDP has introduced this year a new measure called Human Poverty Index (HPI) to highlight more forcefully shortcomings in any economy. HPI does not replace the more orthodox Human Development Index but supplements the same. HPI is a composite of three variables:

a. Percentage of people not expected to live beyond 40 years of age;
b. Illiteracy rate and
c. Lack of access to safe drinking water, health services and sanitation.

Defined in this manner, it is possible for communities that have high per capita incomes and even a high HDI, to have relatively poor HPI. Both HDI and HPI indicate what should be done, or what the priorities should be, but not how to achieve such goals. Further, both HDI and HPI are limited to essentially economic factors whereas, ideally, a vision should take into account social, cultural, political factors too.

Maslow's postulate of hierarchy of "basic needs" offers a systematic and analytic basis for defining a Vision[1]. VISION 2020 may be interpreted as the Vision for the year 2020, or better still as a formulation of perfect vision. Maslow postulated that people hhave a hierarchy of five needs, namely, physical, security, status, autonomy and self-actualisation needs (to which ecology needs may also be added and placed between autonomy and self-actualisation). One may then define the ideal VISION 2020 as transforming the present disgruntled society into a happy one in which one and all are empowered to enjoy all six Maslow needs.

Food, water and energy constitute the first level of physical needs. Food can be further sub-divided into its components like proteins, vitamins and the like. We could branch off still more, say, into types of vitamins. Quality too needs to be specified.

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[1] A Maslow, *Motivation and Personality, 1952*

Similarly, appropriate inputs can be identified for other levels of Maslow Needs. Table 1.1 suggests a possible set of inputs to match each level of Maslow Need

Table 1.1. Maslow Needs and Matching Inputs

Need	Type of Input	Typical Examples
Physical	Income	Food, water, clothing, energy, employment
Security	Wealth	Health care, house, vocational skill, secure employment
Status	Perquisite	Quality habitat, career, education
Autonomy	Freedom to act	Authority, connectivity
Ecology	Freedom from squalor	Waste disposal, non-congestion
Self-actualization	Culture	Higher education, leisure

1.2. The Iron Law of Economic Justice

Just as it is not obvious that the earth does go round the sun, it is not directly obvious that luxury consumption helps the poor. Strange as it may appear *the one and only way the poor can get their basic needs is to let others enjoy luxuries! Unless and until the rich enjoy luxuries, the poor cannot get their basic needs.* These are necessary (but not sufficient) conditions, yet so strict are they that this stipulation may be described as the Iron Law of Economic Justice.

For decades, the policy has been to target the poor and to target them directly. As a practical observation, *everybody cannot have identical incomes; some will always be richer than others*. So, disparities are a fact of life. In such a practical but non-ideal situation where income disparities cannot be reduced to zero, the question arises: “How small can those disparities be made?” To make an estimate of minimum practicable income disparity, let us start with Scandinavian countries that are reputed to be the most egalitarian ones in the world. Those countries are also among the richest. Hence, there is no doubt about their ability

to get results. So, we will not be far wrong if we assume that they have reached the practicable limits in minimising disparity. In their case, the bottom ten per cent of the population gets 3 per cent of national income while the top ten per cent command 21 per cent, a ratio of 1:7. For most other countries, the variation is between 2.5 per cent and 25 per cent. Others, like Brazil, are far worse. Then, we may reasonably assume that, in practice, the ratio of incomes between the bottom and top deciles cannot be made significantly lower than 1:7, and will generally be about 1:10. By the same token, we may assume that the bottom decile will usually get no more than 25 per cent of the national average.

Let us consider the significance of this practical reality. For the sake of argument, let us assume that the average income of a country is 100 units with the bottom decile getting 25 units. Further, let us suppose that, even with an income of only 25 units, the poor are able to command all basic needs. That will happen only when the price of all basic needs is not more than 25 units. However, the average income is 100 units. Then, where can the remaining 75 units go? That can be spent only on, non-basic needs, on luxuries! In other words, if the poor get all their needs, 75 per cent of national income and expenditure must be spent on luxuries! On the other hand, if luxuries amount to less than 75 units, the cost of basic needs will be more than 25 units – more than what the poor can afford. That will make the poor destitute! In this example, we have assumed that the bottom decile of the population gets 25 per cent of the national average. If it gets less, say, only 20 per cent, luxury consumption should rise to 80 per cent to avoid deprivation.

In India, we have treated only food items as necessities. Many non-food items also are essential needs, not luxuries. If entitlement to those needs too are included, the proportion of the poor will be much more than the official figure of 30 per cent. India can remedy the situation in two ways: Increase luxury consumption to 75-80 per cent of the total or *raise the income share of the poorest to 50-60 per cent of the average.* No country in the world has ever achieved that degree of equality. So, the only practical way of eliminating poverty is to raise the share of luxury consumption to 75-80 per cent of the total.

Unfortunately, this Iron Law of Economic Justice describes only a necessary condition but not a sufficient one. Hence, substantial luxury consumption is

necessary for the poor to enjoy the basic amenities of life but there is no guarantee that, in that case, the poor will actually enjoy all basic needs.

1.3. Issues in Implementation

1.3.1. The Problem of Inverted Precedence

Physical needs, like food and water, are the most basic. Consider the case where a person ensures that the family gets enough to eat by becoming a bonded laborer. That may solve the problem of physical needs but, at the same time, it precludes any hope of satisfying any higher need. Or, one may get a well paid job in a city and lose all hope of enjoying an unpolluted environment. Thus, faulty processing of a lower need can block, at least impede the fulfillment of higher ones. That is a precaution that is often overlooked in designing schemes to help the poor.

Problems arise also when higher needs are allocated out of turn. For instance, lower staff in government establishments often rent out their staff quarters and remain in the slum where they came from. Here is a case where the allocation of a higher order need becomes infructuous because it preceded the full satisfaction of a lower need – in this case, income. Likewise, sophisticated instruments gifted to universities often remain idle because they were offered before establishing a culture of research. Such instances may be multiplied. Evidently, there is no point in fulfilling a higher order Need until the beneficiaries are ready for the same and also till they are in a position to utilise it effectively. Many government schemes do not make allowance for this feature.

These two kinds of problems result from the hierarchical nature of Maslow Needs. These needs are not only felt in a hierarchical sequence, they cannot even be fulfilled effectively out of sequence. Neglecting that characteristic leads to waste of national resources.

1.3.2.Public Goods and Geographic Socialism

A poor servant maid in Delhi (some “middle class” families too) has no other option but live in a slum. Even then, she will almost definitely have electricity in her house if not a gas stove, refrigerator, TV or even a telephone. Her child may attend an English medium school. In several respects, she and her family will

command a Quality of Life, and enjoy future prospects that are better than what "rich" landlords and their children command in India's villages. This contrast demonstrates the oft-ignored fact that poor people in a rich economy can be better off than rich people in a poor economy do. The maid and her family enjoy all they do because Delhi has a wealthy economy where electricity is readily available, telephones can be had for the asking, gas supply is well laid out, English medium schools are plenty and public transport too is extensive. In villages, practically none of these can be had however wealthy one may be.

Typically, the state determines the allocation of 20 to 30 per cent of the national product, the single largest component in any economy. The importance of the geographical distribution of government goods is often under-estimated. For instance, good schools are located only in cities like Delhi, therefore the son of a menial employee in Delhi has better chances of education and better prospects of the future than the scion of a wealthy landlord in a village. Thus, because of government's policy in the distribution of its goods – in this case that of high quality schools – every person's future is determined by where he or she resides and is quite independent of personal income or wealth. Here it is not a question of affordability, but of entitlement. The village landlord could have afforded the same kind of education as the maid if English medium schools had been nearby.

Some goods like water, kindergarten schools are of little value unless available close by. They may be called tele-ineffective goods, the kind that have little value when moved some distance away. Such goods, in particular, should be made available in the immediate vicinity of everybody. The equitable geographical distribution of all such goods is a major component of distributive justice and might be described as "Geographical Socialism"[2]. That form of justice is conspicuous by its absence in India. For example, over Rs. 1000 has been spent per capita to augment the water supply of Chennai. In Mumbai, it has cost Rs. 800 per capita merely to cart garbage. No rural area can dream of attracting that kind of allocation for such basic needs. Far less would have been adequate but even that little is denied by the state. Denial of minimum degree of Geographical Socialism is a major act of social injustice.

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[2] P. V. Indiresan, *Managing Development: Geographical Socialism, Decentralisation and Urban Replication,* New Delhi, Sage, 1990.

The government has a variety of job creation schemes for the village poor but few jobs of any kind to be had, let alone well-paid ones. On the other hand, there are next to no employment generation schemes for cities; yet, there are plenty of jobs and high-paying ones too. This anomaly is the result of government's policy of investing in the macroeconomy of cities and tackling rural poverty at the microeconomic level. Villagers cannot get rich so long as villages remain poor, too poor to attract modern industry and commerce. Conversely, if villages are enriched, there will be little need to target individual villagers.

1.3.3. Risks s of Rapid Economic Development

The Planning Commission has targeted 8 per cent growth for the Tenth Five-Year Plan. However, agriculture, the mainstay of villages, cannot grow faster than 2 per cent on an average. So, it is inevitable that either, (a) villages get relatively impoverished, or (b) massive rural-urban migration results. The probability is that both will happen. Hence, if no corrective steps are taken, over the next five years, (a) a third of the rural population will have to either migrate to cities, or (b) suffer a similar relative decline in incomes. Alternately, rural areas may be so developed that, over the next five years, a third of the population will be diverted to non-agricultural occupations. If this issue is not faced squarely and if rural development is not diverted away from agriculture (and handicrafts) rural incomes will be reduced to one-eighth of urban ones by year 2020, or urban slum populations will go up by an order of magnitude.

1.3.4. The Problem of Spatial Development

As matters stand, in our crowded cities, there is not enough space to provide basic amenities such as water, electricity, shelter and a healthy environment. Their congestion is such that it is physically impossible for most cities to offer these amenities. In rural areas, there is no such physical constraint (as there is in cities) but absence of investment prevents people to enjoy basic amenities there too. So, the problem in cities is physical and insurmountable; in villages, the impedance is economical but curable – provided sufficient investment is diverted to rural areas.

The Iron Law of Economic Justice is nowhere more dominant than in the field of housing – unless the wealthy enjoy spacious houses, the poor cannot hope to get a basic minimum of shelter. Consider, for instance, the designs adopted by

the Delhi Development Authority (DDA). The DDA builds flats for the well to do under, what is known as, the Self-Financing Scheme. These flats are built on modules of 100 sq.m. of land area, which is shared by four flats on four floors. That is, effectively, each flat gets only 25 sq. m.of space as its share. Even then, the DDA constructs so few of these flats and thereby has made them so scarce, that their market price is over Rs. 50 lakhs – so expensive that even those who occupy the highest positions in the government find it difficult to acquire them. If even such rich people can afford (with much difficulty) barely 25 sq.m. of space, what can the poor hope for? At current market prices, they cannot afford even one sq.m. of land. In effect, the government treats the poor the way Kauravas treated Pandavas – deny them land the size of a cow's foot even. The Kauravas triggered the Mahabharata war. Our urban planners are fuelling an even greater disaster. Bereft of all hope, slum dwellers steal other people's land. Injustice has made criminals out of basically decent people.

The model of urban development adopted by India involves (a) non-allocation of living space to the poor, (b) expansion without planning, (c) sub-standard allocation of services of each and every type, (d) concentration of capital investment, (e) adoption of expensive technology that offers no economic return.

The existing paradigm of urban development based on unbridled expansion of slums is deadly. Also, rural development that depends solely on agriculture/ cottage industries will breed only poverty and not wealth. In any case, the government should tackle the poverty of villages rather than the poverty of villagers. In Germany, 80 per cent of the rural population is engaged in non-agricultural occupations. That is a useful model for India too to emulate.

1.3.5. Supplying Public Goods

The components of Human Poverty Index (life expectation, literacy and access to safe drinking water, health services and sanitation) are all largely a function of public goods. Governments in poor countries are unable to provide these services either in quantity or in quality. In contrast, the supply of public goods in "company towns" is usually of a high order. Here, these goods are paid for, not by taxes, but by the employer and provided as perquisites to the employees. Essentially, in this case, the employee remuneration is in two parts; a wage component *w* for private goods and a perquisite component *p* for the public goods allotted making a total of

w+p in all. When the cost of public goods is met directly by the employer, there will be constant pressure from the employees to maximise *p*, that is, to maximise the allocation of public goods. On the other hand, when the entire remuneration *w+p* is paid in cash, the same employees will balk at spending the original share *p* on public goods. They will all try to be "free riders". In effect, the people are willing to pay a higher local tax when the remuneration is split partly in cash and the rest is given away as a perquisite in the form of public goods.

Suppose, as an alternative to providing perquisites, the employer is asked to pay the same amount *p* as tax to the government. Then, the employer will now turn into a free rider and the tax collected will be much less than *p.* Out of that reduced collection, the cost of collection will have to be deducted. For both reasons, the net amount available for public goods becomes significantly less. Further, municipal bodies are not known to be very efficient. That is a third reason why the actual delivery of public goods will be worse than in private campuses.

Thus, there are three options, with the cost of public goods met by (a) the consumer as a tax, (b) by the state as a subsidised service, and (c) by the employer providing the same as a perquisite. As we know, the consumer will not pay enough, and the employer too will evade paying the full amount of tax. Neither can the government make up the shortfall fully nor spend it efficiently.

In the past, the state has "primed the pump" by raising the supply of public goods and stimulated demand. Perquisites too work in an identical fashion and stimulate growth with the added advantage that when employers provide public goods as perquisites, they will utilise resources more efficiently than municipal bodies do. For three reasons, giving away public goods as perquisites is better than raising wages and leaving it to the discretion of individual citizens how much they will contribute for public goods. (a) They may not spend all that money and hence, curtail demand; (b) they may spend it on imported luxuries, which may not be ideal and (c), the time lag between accretion of income and actual expenditure will create inflationary pressures.

Before, employers can supply public goods as perquisites, they will have to house their employees in campuses of their own. Few employers can do so. There is also the objection that few employers would be altruistic enough to accept the responsibility of supplying public goods. Instances of such altruism are not

unknown; in many cities of India, open spaces at the intersections of major roads are maintained by individual firms and very well too – much better than what the local government could have done. As a reward, the company is allowed to place a small board indicating that it is maintaining the flowerbeds. Evidently, this small recognition materially changes the attitude of the employer. As Schumpeter (1961) has explained, entrepreneurs have two strong desires: (a) Social recognition and (b) getting things done. Encouraging employers to supply public goods will cater to both these psychological needs of entrepreneurs.

1.4. Factors in Visionary Development

Targets do not make a vision but are derived from it. Vision is qualitative, but targets are quantitative. "Freedom from Hunger" is one expression of Vision. Providing 3000 calories a day to farm labour is a target, a target that can change to barely 2000 calories a day for sedentary office workers. Thus, targets vary from one situation to another but Visions like "Freedom from Hunger" are invariant. Targets are convenient and necessary too for implementing a Vision. Unfortunately, the tendency is to treat the target and not the Vision as the final objective. For that reason, some of the boundary conditions of development, such as the following, tend to be overlooked.

a. *The Iron Law of Economic Justice*: Unless the rich have their luxuries, the poor cannot have their needs. Unfortunately, this is only a necessary condition, not a sufficient one. Offering luxuries to the rich does not guarantee welfare of the poor.

b. *Hierarchical Nature of Maslow Needs*: In fulfilling the hierarchy of Maslow Needs two precautions should be observed: One, no lower order need should be so provided that it impedes the supply of a higher one. Two, higher ones should be offered only when lower levels are reasonably well satisfied and there is no risk of the facility being diverted.

c. *Limits to Agricultural Expansion*: Agriculture cannot keep pace with industry or services. Hence, rural areas should be empowered to shift from an agrarian economy to an industry and service oriented economy. Or else, large-scale rural-urban migration and consequent social dislocation will be unavoidable.

d. *Equitable Distribution of Public Goods between Cities and Villages*: Both inefficiency and injustice are rooted in the policy of not allocating public good investment equitably (on a per capita basis) in rural areas. Geographical Socialism is still valid even if other forms of socialism are not.

e. *Public Goods and The Free Rider Syndrome*: Encouraging employers to provide municipal goods, as perquisites to their employees, is an efficient way of getting round this pernicious human frailty.

1.5. Formulating A Vision

The Prime Minister's aspiration of 9 per cent GDP growth is the closest to a Vision that we have heard in a long time from our political leadership. The actual rate, whether it should be 9 per cent or 8 per cent or any other is not the issue; it could be anything provided it is the fastest growth that is possible under the prevailing conditions. Hence, the economic Vision for the Indian economy may be defined to be "*the fastest possible GDP growth,* or better still *"the fastest growth in per capita incomes".*

Growth cannot go on forever. So, there is a school of thought that aims at *sustainable growth* along with its counterpart *sustainable consumption.* Up to what level growth can be sustained is a matter of guesswork. In the past there have been extreme pessimists like Malthus who predicted that however prosperous an economy may be in the short run, ultimately, the wages will dwindle to subsistence levels. That is still true for economies that practice subsistence agriculture and have no population control, e.g. several areas in BIMARU states.

With modern technology and population stabilisation, per capita incomes can, and do, rise above subsistence levels. Theoretically, there seems to be no limit to technological advance, and hence no limit to per capita incomes. However, where there is free migration of people, rich countries cannot avoid in-migration from poorer ones. So, if immigration were free, the entire world would stabilise at a common per capita income. In the real world, due to economic, social and political costs of migration, that equalisation will not be exact but few countries can remain much richer than the average. That is why, compared to the world average, even the US is only about five times richer but poor countries are 30

times poorer. Then, for a poor country like India, one realistic definition of sustainable Vision can be:

> *The fastest feasible growth that will push per capita income, the Quality of Life Index and the Human Poverty Index too reasonably beyond the world average.*

In that case, the country will not invite contempt as being too poor nor invoke much jealousy for being "sinfully rich". On that basis, India may plan to raise per capita income five times on a Purchasing Power Parity basis. However, that is not enough. Disparities between the rich and the poor too should be taken into account. According to World Bank estimates, the bottom twenty per cent of India's population get a fifth of what the top twenty percent get. That ratio of 5:1 between the top and bottom quintiles is comparable with most egalitarian countries. Then, assuming that (a) this ratio of 5:1 between the top and bottom quintiles is acceptable, (b) that India should grow five times richer to reach the world average, the socially conscious Vision 2020 may be set as

> *The living standards of the bottom quintile of India's population should be raised to the level of the top quintile today by year 2020.*

There is now a willingness to admit errors committed in the past. That is truly a Cultural Revolution. However, realisation of past mistakes is only half the battle. The task of finding better solutions remains. Better solutions can be discovered only through experimentation. For that reason, experiments will have to be conducted on alternative processes of development. Every such experiment involves risks. So, risk-taking will have to be encouraged and safety nets erected for unavoidable failures. Before we can reach the goal of building an economy where the poor will command all basic needs, we should induce everyone (particularly administrators and entrepreneurs) to experiment with change. That is the best way to make the country develop not only rapidly but wisely too.

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2. DRIVING FORCES OF DEVELOPMENT

2.1. The Importance of Technology

There is a widespread belief that it is capital that drives the economy. Annual budgets, Five-year Plans, company reports make a great play about capital investment. While money is critical, it is not the most important contributor to a nation's growth. Denison has calculated (Table 2.1) the factors that contributed to the growth of the United States between 1929 and 1982. He found that as much as 64 per cent of that growth was attributable to advances in knowledge (that is, to R&D). Education came next with 30 per cent whereas the direct contribution of finance and capital was barely ten per cent. Management and economies of scale too contributed more than capital did. Similar conclusions were arrived at by Solow too.

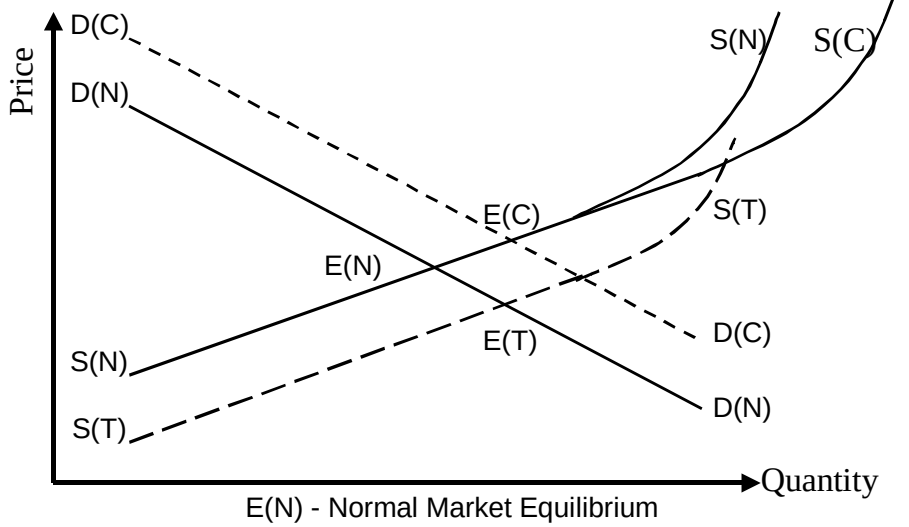
Table 2.1. Components of GNP Growth in United States: 1929-82

Type	Share
Labour input except education	- 23
Education per worker	30
Capital	10
Advances in knowledge (R&D)	64
Better resource allocation (management)	19
Economies of scale	20
Land	- 4
Other determinants	- 20

In the 1920s, the situation of United States was not much different from that of India today. For instance, she was a late entrant with other countries like Britain and Germany already well entrenched each in their own market niche. Further, she too had relatively a large population. So, the 1929-1982 experiences of United States offer a useful lesson for India today. Hence, India would be wise to lay stress on R&D and education and make them the Driving Forces of future economic development.

Businessmen too would be well advised to take the same cue and concentrate more on educating workers (or recruiting educated workers) than in buying machinery, and invest more on R&D than on buying know-how. Unfortunately, Indian businessmen, and planners too, have an ineradicable conviction that money is all. They and the labour leadership too have a morbid fear of technology change. For instance, as late as 1985, the Government of Kerala banned outright the use of computers in any of its establishments.

Fig. 2.1. How Technology promotes growth and lower prices and capital stimulates demand but increases prices



E(N) - Normal Market Equilibrium
E(C) - Capital infusion increases output and prices too
E(T) - Improved technology too increases output but with reduced prices

Indian businessmen feel that they are too poor to support education and R&D. It is more than likely that they are poor only because they do NOT support

education and R&D. Incidentally, according to Denison, economies of scale accounted for 20 per cent of American growth. It appears possible that India's ideological support to small-scale industries and the government's aversion to economies of scale have impeded the country's development substantially.

At the rate India is progressing, it will take 100 years to attain the per capita GNP South Korea reached by 1995. Evidently there is something wrong with our economic policies. The mistake is our policy makers worship Lakshmi instead of Saraswati. Both deities do contribute to economic growth but with a difference.

As Fig. 2.1 indicates, the money pumped in by capital increases demand and shifts the demand curve upwards, but the position of the supply curve will not change, only the limit at which the supply will saturate will be extended from S(N) to S(C). So, pumping more capital increases output but at the cost of higher prices and consequent inflation. In contrast, when technology is adopted as the growth engine, improvements in technology reduces costs all round – it reduces consumption of labour, of material and quite often even that of capital. So, it pushes the supply curve downward, generates growth and actually reduces prices too. That is why technology is a better Driving Force than money.

2.2. The East Asian Model

East Asian countries are by far the most successful practitioners of capital-led growth. Paul Krugman has explained that the East Asian Model depends on increasing the inputs of labour and capital; the Western one on increasing the efficiency of utilisation of those two inputs – through technology innovation. According to Krugman (Box 2.1), the East Asian Model is liable to get saturated on the labour front once the entire population is put to work. Similarly on the capital side, saturation will be the result when savings and foreign investment reach their peak. Further, as foreign investment is notoriously fickle, the risk is not merely saturation but instability – as demonstrated already by East Asian countries. In contrast, innovation-led development is relatively autonomous, and hence, more stable. In particular, so long as there is worthwhile innovation, there is little risk of recession. So long as a nation is building better and better mousetraps, there is little risk of shortage of customers! (However, it must be said to the credit of East Asian countries that after a foundation of capital-led growth, they are now investing heavily in R&D and in higher education too.)

Box. 2.1. Limitations of the East Asian Model

Long before the East Asian meltdown, Paul Krugman correctly predicted that the East Asians were merely paper tigers. Writing in 1994 in the journal *Foreign Affairs,* he said:

Consider in particular the case of Singapore. Between 1966 and 1980, the Singaporean economy grew a remarkable 8.5 per cent per annum, three times as fast as the United States; per capita income grew at a 6.6 per cent, roughly doubling every decade. This achievement appears to be a kind of economic miracle. But the miracle turns out to have been based on perspiration than inspiration: Singapore grew through a mobilisation of resources that would have done Stalin proud. The employed share of the population grew from 27 per cent to 51 per cent. The educational standards of that workforce were dramatically upgraded: while in 1966, half the workers had no formal education at all, by 1990, two-thirds had completed secondary education. Above all, the country had made an awesome investment in physical capital: investment as a share of output rose from 11 to more than 40 per cent.

. . . these numbers should make it obvious that Singapore's growth has been based largely on one-time changes in behaviour that cannot be repeated. Over the past generation, the percentage of people employed has almost doubled; it cannot double again. A half-educated workforce has been replaced by one in which the bulk of workers has high school diplomas; it is unlikely that a generation from now most Singaporeans will have Ph.D.s. And an investment share of 40 per cent is high by any standard; a share of 70 per cent will be ridiculous. So, one can immediately conclude that Singapore is unlikely to achieve future growth rates comparable to those of the past.

But it is only when one actually does the quantitative accounting that the astonishing result emerges: all of Singapore's growth can be explained by increases in measured inputs. There is no sign at all of increased efficiency. . . . .once one allows for their rapid growth of inputs, the productivity performance of the "Tigers" falls from "the heights of Olympus to the plains of Thessaly"

There is a critical reason why India may not succeed in adopting the East Asian model. Small countries – Singapore, or at the most Malaysia – can prosper through capital-driven growth. For a large population like India's, *similar level of per capita* foreign direct investment is next to impossible. Even if such massive foreign investment materialises, that capital may be used only for the kind of goods that have been discarded by developed countries, and hence have low profit margins – television sets, for instance. Further, whatever niche there was for a large country appears to have been captured already by China.

Imported technology is like a banana peel, the fruit from which all value has been extracted, and which can yield only a marginal profit. Small countries can prosper by selling a million TV sets at comparatively low profit margins. Taking that route, India will have to export hundreds of million sets for which a market is just not available. So, being a large country, India can prosper only by exporting products with large profit margins – that means, innovative products that will emerge only from high quality education and innovative R&D.

There is an incorrect view that India has a large manpower base in science and technology. As Table 2.2. shows, how poor India really is in this respect.

2.2. A Comparison of S&T Manpower in India and Other Countries

Country	Scientists and Technicians per 1000 of population	R&D Scientists per 10,000 of population
China	4	
Germany	86	47
Israel	76	59
Japan	110	60
Korea	61	22
USA	55	
India	1.2	2.5

2.3. The Swadeshi Issue

Though the Indian government's economic policy has been strongly in favour of self-reliance, its technology policy has been equally strongly in favour of importing technology. Currently, in several ministries, it is the official policy not to accept any technology unless it has been in use for two years. That rules out indigenous innovation altogether and actually kills it because why should a foreigner accept any Indian technology if that is not acceptable in India itself? Thus, technology infanticide is the practice in India though the country won Independence on the basis of swadeshi.

In two articles entitled "Who Is Us?" and "Who Is Them?"[3] Robert B. Reich, the former US Labour Secretary argues that the labour force is always "Us" but the owners may or, may not be – even if they are citizens. According to Reich, the Corporation is "profoundly less relevant to . . . economic future than the skills, the training and knowledge commanded by . . . workers". He adds that control and ownership of corporations is NOT important. "What is crucial is how much corporations invest in the future capability of the workers, and how far they employ local scientists, engineers and technicians in R&D. A corporation which invests in the training and upgrading of human capital is "Ours" even if it is owned by foreigners; a corporation which does not invest in human capital is not "Ours" even if owned by our own citizens."

According to Reich, financial capital is fluid; international capital movements are far simpler and easier than international movements of human capital. So, human capital is reliable; financial capital is ephemeral and untrustworthy. Further, as a rule, financial capital chases human capital – that is why so many software firms are coming to India. Or, if we have human capital, we need not worry about financial capital. The converse is not true. That makes skilled work force a more reliable asset than financial capital. Development based on human capital is dependable; that based on financial capital is undependable. As he says:

> *"well-trained workers attract global corporations, which invest and give the workers good jobs; the good jobs, in turn, generate additional training and experience. As skills move upward and skill*

accumulates, a nation's citizens add more and more value to the world ––and command greater and greater compensation from the world, improving the country's standard of living."

Then, an Indian owned firm, even if it is a Public Sector Undertaking is NOT one of "ours" if it is wedded to imported technology. In contrast, any foreign firm that brings in new technology, new management, new skills and invests in R and D employing Indian scientists, engineers and technicians, is truly one of "ours"!

Culture Receptive to Technology: *All these are cultural factors, the fact emphasised by Olson. Mokyr[4] (pp. 11-12) has analysed this particular aspect, and explains that the following three conditions should be satisfied before any national culture will support innovation and development:*

a. A cadre of ingenious and resourceful innovators who are both willing and able to challenge their physical environment should be available.
b. Economic and social, institutions have to encourage potential innovators by presenting them with the right incentive structure.
c. Diversity and tolerance should prevail in the society to enable technological creativity overcome entrenched vested interests that might incur losses if innovations are introduced.

In other words, innovation and technological progress are unlikely in a society in which people are intellectually malnourished, are superstitious, or are extremely traditional. In brief, what any country needs most is scientific spirit. Thus, quality education is the prerequisite without which technology innovation and development will not flourish.

2.4. Education as a Driving Force

According to Denison, education contributed a massive 30 per cent to the growth of United States. Education can be classified under three categories. School, vocational and university. Contrary to popular opinion, Indian education must be quite good – or else, India would not have been able to export skilled manpower as much as it does. At any rate, many Indian schools are apparently not so bad as to destroy the native intelligence of students. At the same time, by absolute

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[3] Robert Reich, *Harvard Business Review, 1991.*
[4] Joel Mokyr, *The Lever of Riches: Technology, Creativity and Economic Progress, New York, Oxford University Press, 1990.*

standards, however, India's performance is admittedly unsatisfactory both in quantity and in quality.

2.4.1. School Education: The government has the policy of opening a school in every village, even hamlet, on the principle that no child should be far away from a primary school. That may be good quantitatively but not qualitatively. It is more important that every child has access to *good education rather than physical proximity to a school.* Single teacher schools that predominate in the rural areas do not offer, cannot offer, quality teaching, not even regular teaching.

In this era of globalisation, command over the English language is a precious asset. So, is computer literacy. Unfortunately, most state governments are lukewarm towards the teaching of English and indifferent to computer literacy. Some are actually hostile. So, only rich children who can afford private schools get the advantage depriving poor children the capability to compete on an equal footing.

It is now recognised that intelligence has many dimensions of which eight are prominent: factual, numerate, analytic, linguistic, spatial, intuitive, athletic and emotional. Most Indian schools concentrate on rote learning that stimulates factual intelligence and little else. It would be useful if students are given individual attention and encouraged to develop whichever type of intelligence they excel most.

Strictly speaking, school education is not a preparation for the job market. It takes 10-12 years of schooling for the economic benefits of education to be realised. Few poor families have the economic strength to educate their children for that many years. So, dropouts are common, particularly in poor families. Therefore, before school education to play its due role in national development, the following issues must be addressed:

a. Providing universal access to good quality schools and at affordable cost by even the poorest families.

b. All children must have the entitlement to acquire proficiency in English and in computer skills.

c. School education should address the individual strength of each student – and the society should respect and honour all skills equitably so that every kind of talent is encouraged.

d. Suitable employment opportunities should be created for those children who have no ability or inclination to study for long years.

2.4.2. Vocational Education: On the whole, unlike in Germany, vocational education has not succeeded in India. That is because it does not address several basic features of this system of education – which would be better described as training rather than education. Some critical features of vocational training are:

a. Innumerable variety
b. Needs years of practice
c. Requires costly materials to practice on
d. Skills required can change rapidly

No school system can address these issues. A school can, at the most, have instructors in two or three specialisations where as the variety required in the market is enormous. Schools cannot afford to provide long years of practice and even if they try to, they will never afford the amount of materials that may be needed – except may be in computer skills. Nor can instructors in schools keep pace with rapid changes in technology. For all these reasons, vocational training is best given in the work place and under the supervision of master technicians. Bookish learning in a school need not be excluded entirely. Conceptual aspects can still be taught there. It is like a musician learning the theory of music in a school, but practising music under a guru.

2.4.3. University Education: Sir C. V. Raman, India's only Nobel Laureate in science was strongly opposed to the concept of dedicated research laboratories like the CSIR. His argument was that the money should have gone to universities. It is no accident that virtually all Nobel Prizes have gone to universities and few to far better endowed non-academic research laboratories. The reason is simple: good research needs young research students. Hence, diverting talented researchers from academic institutions to full time research hurts both ways: Full-time researchers lose the stimulation that only young research students can give. Students too lose because the best minds are

drawn away from teaching. In particular, applied research is liable to be siphoned away completely from universities. At the same time, without the discipline of teaching, researchers are liable to lose touch with basic principles and the quality of their research is liable to suffer. So, isolation of teaching from research will hurt both research and teaching.

Some of these fears have borne fruit. Universities are starved of funds and research laboratories too are starved of talented youth. There are over 800 engineering colleges in the country and another ten thousand arts and science colleges. Yet, there are not enough well educated students to man the laboratories. Some pertinent issues to be considered are:

a. Education provided does not match job requirements in most cases.
b. Almost invariably, graduates are under-employed.
c. Education does not keep pace with rapid advances in knowledge.
d. Most teachers are of poor intellectual calibre and are yet paid very highly compared to the ability of the economy to bear.
e. The most talented migrate abroad or opt for non-technical occupations.
f. Financial and infrastructure support is meagre.

Table 2.3 compares the finances of IITs with that of the Massachusetts Institute of technology. The revealing factor is how much more expensive IIT education is and how much better their faculty is paid compared to MIT – in terms of per capita income of the two countries. University education will not become universal, and poor students will be lost to higher education, until Indian education becomes as cheap as American education is in terms of ability to pay.

Though the US has several thousand colleges, the country picks on barely a score of them for substantial support. The same kind of elitism is to be found in every advanced country without exception. Apparently, higher education is not democratic and requires extra privileges to the most talented.

The issues to be borne in mind relating to higher education are:

a. Making Indian universities globally competitive
b. Matching education to the economic needs of the country

Table 2.3. University Financing – A Comparison

Item	MIT, Cambridge, USA	IITs
Salaries	5000 perchis	30,000 perchis
R&D Income	60 %	10 %
Fees Income	13 %	20 %
Endowments	23 %	2 %
Fees Rate	600 perchis	3000 perchis

Perchi = national per capita average hourly income

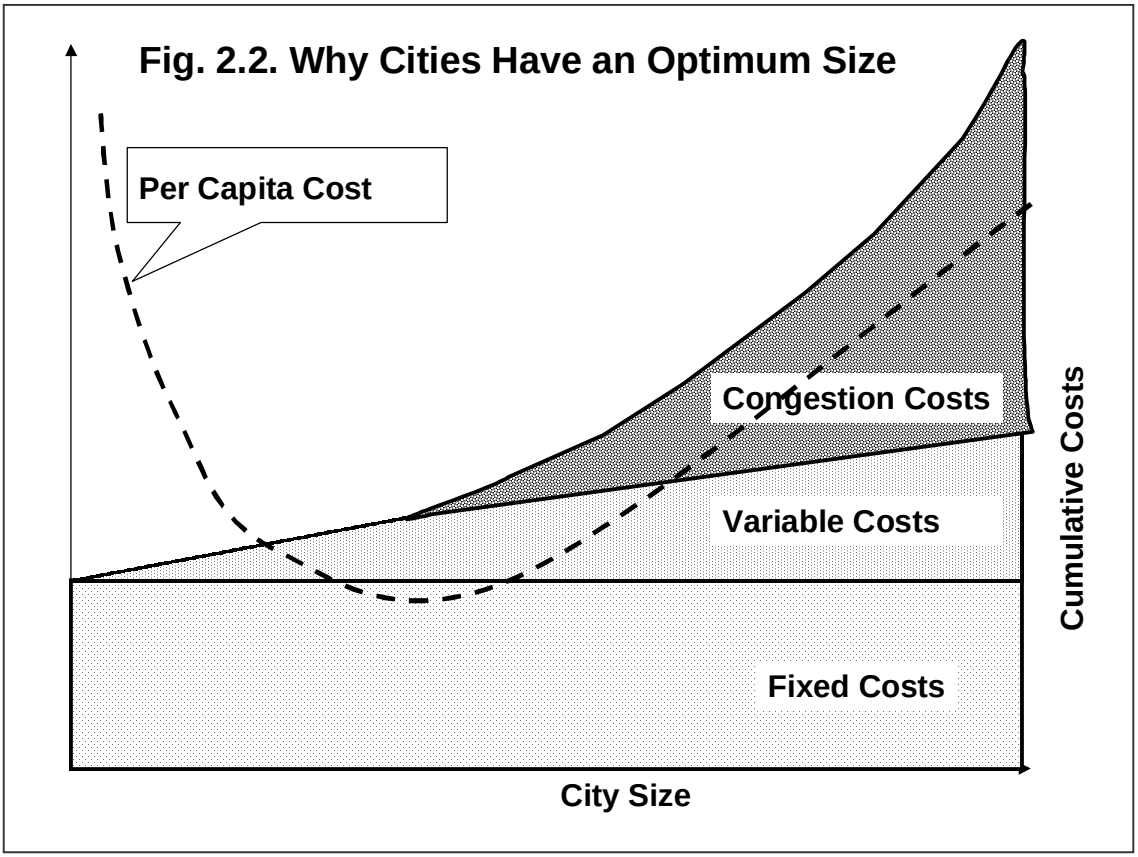
c. Attracting talented students to S&T occupations
d. Financing elite institutions at international levels.
e. Making it socially acceptable to give preference to talented students and faculty.

2.5. Urbanisation as Driving Force

It is a common observation that cities generate employment in higher numbers, and of higher value too, than the same population distributed over a number of villages. It is also a fact that rich countries are, as a rule, highly urbanised and poor ones are rural. So, urbanisation appears to be a necessity for a modern economy and hence, should be treated as a Driving Force of development.

At the same time, not all city dwellers are rich. Many cities are infested with appalling slums. In general, the world's largest cities are in the poor nations of the Third World while some of the richest cities, like Frankfurt, Edinburgh, Amsterdam, San Francisco, have all a population of a few hundred thousand only. So villages and very large cities wallow in poverty, while rich habitats are often of a modest size. So, there must be an optimum size for cities, at any rate there is a range of population size where cities prosper best.

The Central Business District (CBD) determines the economic strength of a city. If expensive metros are ruled out, access to the CBD will be mainly by bus transport whose capacity is typically 6000 persons per hour. If the CBD is located at the convergence of four arterial roads, around 25,000 people can enter or exit it during the busy hour. As a thumb rule, the CBD employs 5-10 per cent of a city's population. So, one CBD accessed by buses can support a population of about 3-500,000 population. If the city grows bigger, either more expensive rail or metro systems should be used or multiple CBDs installed. Either way, costs escalate. These are congestion costs that raise real estate prices beyond control, make it necessary to employ costly techniques like high rise buildings and fly overs, increase pollution, even crime. Hence, both theoretically and from



practical experience, city size is best limited to a few hundred thousand.

Fig. 2.2 expresses these concerns graphically. When population size is too small, the capital cost of amenities (a railway station or a college for instance) will be spread over too few people. So, per capita costs are high. When the size

becomes large, the city tends to get congested. So, congestion costs mount up raising per capita costs once again. In between, there is a broad range of population sizes where the per capita costs are low.

Population density is another critical factor in habitat design. Cities are, by definition, more crowded than villages. Yet, many Indian villages are so densely packed together that their density could be higher than that of large cities of the West. While sparsely populated villages cannot offer most services of a modern economy, crowded cities are liable to be infested by slums. So, they too deny many amenities. Hence, in this case also, there must be some in-between figure where modern services are economical and at the same time, congestion is not excessive and tolerable.

Indian cities and villages are often tightly packed. Kolkata has the dubious distinction of being the most densely populated city in the world with a density of 89,000 per sq. km. Other cities are not far behind. In contrast, New York, one of the most densely populated cities of the world has a population density of 8900. In London, the density is half as much, in Berlin a third. So, large cities need not be as crowded as Indian cities are. The fact that not one city in India is able to provide such a basic necessity as water in sufficient quantity is an indication that our urban design exceeds the carrying capacity of the soil.

In most parts of the country, average rainfall is around 70 cm per year or 2 mm per day on an average. Assuming that half of that can be harvested, local water availability can be assumed to be one mm of rainwater per day. If a modest 100 litres of water per day is allowed per head, 500 square metres of space should be available for a family of five. (That includes non-residential space too. So, average space per house will be 200-250 square metres.) Then, the upper limit will be 2000 families, or 10,000 persons per sq.km. – about the same density as New York. Similar conclusions emerge from considerations of traffic flow also.

Considering how expensive land is in Indian cities, an average allocation of 250 sq.m. space would appear a pipe dream. Actually, only 25 thousand sq.km – no more than 0.8 per cent of the land area of the country will be needed to allocate space at this rate to the entire urban population of 250 million people. So, it cannot be anyone’s case that enough land is not available to entitle people to this order of space. However, though there is enough and more of land in the

country to prevent slums, they are not available within existing cities – precisely where people want to reside. That too is not an insoluble problem.

2.6. Constrained vision, Unconstrained Vision

The problem lies with our vision, rather the lack of it. There are two kinds of vision – the Constrained Vision and the Unconstrained one. We in India have been bogged down by Constrained Vision in many ways. Constrained Vision leads to dead ends, to a state of utter helplessness and hopelessness. We have got caught in that state of mind because we have been asking the wrong kind of questions. For instance, it is usual for us to ask: "How can we accommodate the growing rural-urban migration in our already congested cities?" That pre-supposes that rural migration can take place only to congested cities and nowhere else. That is Constrained Vision. When the question is posed in that manner, the inevitable conclusion is slums are unavoidable. Suppose we pose the issue in a different manner and ask: "Our Vision 2020 includes civilised habitat. Hence, how can jobs be created for surplus rural labour in places where it is possible to guarantee a minimum quantum of dwelling space?" That is the way of Unconstrained Vision. It opens up opportunities that do not exist now. It shifts emphasis from congested cities (a case of closed option) to employment generation in rural areas where land is available in plenty for housing needs. That is an unbounded option, the approach of Unconstrained Vision.

Urbanisation is always a Driving Force for an economy but not always a good one. Only when it is implemented within a range of suitable sizes and with appropriate population densities that it becomes a desirable Driving Force. Most services, including referral hospitals and universities can be supported once a population reaches 3-4 hundred thousand. A collection of such cities located within an hour or two of travel time, can support a large airport too. That is how Frankfurt, Dusseldorf, Cologne and Bonn operate. Cities with size larger than a few hundred thousand spawn multiple business districts and inevitably get congested. So, the optimum urban habitat will be composed of several mutually connected cities each of a few hundred thousand population and all with densities not more than 10,000 per square kilometre. Urbanisation on these lines will not only be a Driving Force, it will also be a good Driving Force.

Slums are not inevitable. Top officials need not be confined in tiny flats. Even the poor can have enough space to relax provided the rich have much larger accommodation. Many developmental problems have remained unresolved only because the vision stops at the conventional. Once the vision stretches beyond the obvious, effective solutions become apparent.

Unfortunately, these days, most people in India forsake the country at the first whiff of inconvenience and at times for self interest. Some leave the country to use their talents for the benefit of others. Others stay here but siphon away profits to deposit them elsewhere, in Swiss banks and the like. The perception that India is not the best place to exploit either talent or capital is a major hurdle and a significant impedance to the country's progress. Restoring people's confidence, particularly those of the talented, should have priority in the mind of any planner or policy maker in India.

3. IMPEDANCES TO DEVELOPMENT

According to Denison, nearly two-thIrds of American growth during the mid Twentieth century was attributable to technology development. Hence, any impedance to technology innovation will be a great impediment in the path of economic progress. In India, there are plenty of such impediments, based on a variety of fears, such as:

a. Unemployment
b. Displacement of population
c. Environmental pollution

Other impedances to technology-based development include:

a. Rigidity in the labour market
b. Poor education system
c. Industry's apathy to R&D
d. Government bias in favour of technology imports
e. Reservation of many products for production by small scale industries

Behind all these impedances lies one factor – fear of change and consequent cultural suspicion of technology.

3.1. Impedances to Technology Development

According to Olson[5], there can only be two reasons why some countries are rich and others are poor: (a) differences in factor endowments (namely, land, labour, capital and technology), or (b) differences in environment. Olson concludes that, of the two, it is the environment that is crucial. Considering the vastly different economic wealth of neighbouring countries with similar endowments, (United States and Mexico, South and North Koreas, or former West and East Germany), wealth and poverty cannot be the result of differences in factor endowments but due to faults in political policies and institutions. According to Olson, economic factors like land, labour, capital and even technology are relatively unimportant, not even material. So, though poor technology is the basic reason why India is

[5] Mancur Olson Jr., *Big bills on the sidewalk: Why some countries are rich and others are poor,* The Journal of Economic Perspectives, 1996.

poor, the basic issue is not inadequate technology development but poor technology environment.

For instance, South Korea was no better than India thirty years ago. Now it is one of the advanced countries of the world. All that progress was engineered primarily by buying technology. Olson estimates that for every dollar paid out by South Korea for importing technology, the country's GDP increased by 60 dollars. So, he concludes (a) the kind of technology needed for the enrichment of a poor country is purchasable in the international market and (b) the cost of such purchase is minuscule compared to the wealth generated as a consequence. India too has purchased considerable amounts of technology but has not utilised it as productively as South Korea has done.

It may be argued that South Korea has done better because she was richer, had more capital. That is not true. In the 1960s, when South Korea set out on the growth path, she was no richer than India. Yet, South Korea progressed faster because she managed to attract foreign capital far better than India did. As Olson explains,

> "intrinsically, the more profitable avenues would have been exhausted in rich countries leaving behind only less profitable ones. On the other hand, in poor countries many profitable avenues would have remained unexploited. So, poor countries offer much better pickings for capitalists than do rich ones. Therefore, the natural flow of capital is always from rich countries to poor ones, not the other way around. . . left to the market, capital will flow across borders until the returns to capital become the same in both places – until the extra profits of poor countries equal extra costs of entering such markets. So, poor countries may have little capital of their own but should have little difficulty in attracting capital *provided their culture does not discourage inflow of foreign capital*.

That, however, is not the case in chronically poor countries like India. In India, as in all poor countries, the barrier to inflow of capital is not inside the rich countries; it lies right here at home. Or, the barrier is not the economics of rich countries but the nature of Indian culture.

It may be argued that poor countries are poor because their people are unskilled. It sounds reasonable to argue that people in developed countries are more capable, better skilled, better educated, better trained and so on. According to Olson, that argument too is not tenable. He points out that immigrants from poor countries outperform natives of rich countries. That is true whether they seek employment, or become entrepreneurs themselves. For instance, whether in United States or in Britain, the Indian immigrant community is wealthier or earns more than natives do. So, India has *a set of more talented people than United States has,* but loses them all due to brain drain. Brain drain too is not an economic problem but a cultural one. If Indian culture permitted her to pay her engineers as well as she pays vendors of soap, she would suffer no brain drain. In the words of Donald Christiansen[6]

> *A country that trains its engineers and technologists well, then rewards them with both real and psychic income, should have little trouble competing in a world economy that thrives on trading high quality, high tech products over international boundaries.*

Thus, we notice that technology is purchasable, capital is available, and the supply of high quality labour is more than the demand.

That leaves only one more factor of production, namely, land and mineral wealth. It is true that there is greater pressure on land in India than in the USA. But many other countries like Japan, Holland, Belgium, England have even higher population densities. Yet they are all much richer than we are. In any case, land accounts for no more than 2-3 per cent of a nation's wealth. So differences in endowment in land, even arable land is not crucial. In any case, the cost of potato chips in the market is twenty-fifty times the cost of cultivating potatoes. Weight for weight, even a spoon costs tens of times more than the iron ore from which it is made. Hence, wealth is derived not so much from agriculture or from minerals but by processing them into high value products. Or, land is a predominant wealth only in an agricultural society and not in a modern one. That is why Singapore is wealthy in spite of having no source of raw materials and India is poor even though she has resources in plenty.

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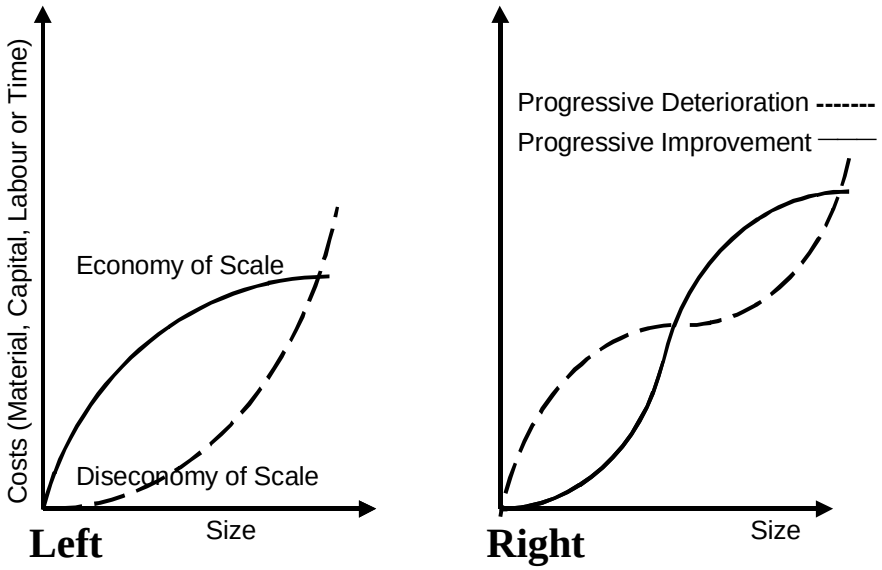
[6] Christiansen, Donald, Engineering Excellence: Cultural and Organisational Factors, New York, 1987, IEEE Press.

3.2. Economies of Scale and Bottlenecks

In his analysis of the growth of the United States, Denison estimates that Economies of Scale contributed towards 19 per cent of the total. That was twice as much as capital did. Evidently, the managerial ability to handle larger and larger system is an important factor in economic growth. That is an area where India is indeed weak.

Fig. 3.1. Economy of Scale, Diseconomy of Scale



India is a large country and large scale is inherent to all its activities. Yet, the pace is slow, much slower than that of much smaller countries. The excuse is given that the pace cannot but be slow because the large size inevitably introduces inertia. Hence, instead of being an advantage, large scale has turned out to be a disadvantage in India. Fig. 3.1 explains these phenomena graphically. As the curves on the left panel show, economy of scale results when the cost increases less rapidly than size does – the curve is then convex towards the upper side. Diseconomies of scale result when cost increases faster than size; the curve is then convex towards the bottom side. Often, the situation is as shown on the right panel – a combination of both diseconomy of scale and economy of scale. That combination too is of two types. Initially, the cost can increase rapidly and economy of scale establishes itself later on. That is the

American achievement. They think big; they are willing to wait till the market builds up to an economic size. State policy makes the opposite happen in India. Small scale industries get so many tax incentives and are allowed to evade so many taxes, that it is NOT profitable for them to expand to a globally competitive size. As a corollary, there is no incentive to invest in R&D and keep pace with global advances in technology. That is a double jeopardy – the country loses out both by poor technology and lack of economies of scale.

When a system is expanded, the addition could act either as a bottleneck or as a lubricant. In small systems, bottlenecks get identified fast but not so in large complex bureaucracies where there are so many points of delay and obstruction that one more does not get noticed, nor appear unusual. Cost conscious private industry is sensitive to delays and impediments; unwieldy bureaucracies are not. In their case, delay is actually an addiction – most bureaucrats would be unhappy if the power to impede and delay is taken away from them.

This is a cultural issue. In India, there is insufficient awareness that growth has two elements, material increase and the time taken to achieve it. If time of implementation is halved, for the same increase, growth will be doubled. In India, delays and impedances are seen as a source of power, not as a loss of face. Indian officials see both monetary or psychological profit in impedance. So diseconomy of scale prevails. Or, economy of scale will take root in India if the penalties are so imposed that they cause either monetary or psychological injury on those who impede, and act as bottlenecks and not as lubricants and rewards are granted on those who act like lubricants. In India, there is currently so much fascination for impedance that few people are consciously aware of the extent they practice it, or how it erupts in every kind of transactions. That is particularly true in any issue that concerns technology innovation – the most critical factor in economic growth.

3.3. Fear of Technology Induced Unemployment

Fear of unemployment is a major impediment to acceptance of technology change. As a rule, technology reduces employment in three ways:

a. Technology reduces labour per unit of product.
b. Technology increases wages, and hence cuts the demand for labour
c. Technology makes skills obsolete.

At the same time, technology opens out new opportunities, and more rewarding ones too. However, dislocation is unavoidable. It requires considerable grit to accept the attendant risk of not finding alternative employment. Dictatorships can force people to accept the resultant hardships but not democracies. That is the argument frequently given to justify India's slow pace of progress compared to that of China and other East Asian Tigers.

It might be recalled that in Denison's analysis, better allocation of resources accounted for a significant 19 per cent of US growth. It is not unlikely that India too will grow significantly faster if employers are allowed the freedom to allocate human resources efficiently. Unfortunately, state policy is fashioned otherwise in India. The government goes to great lengths to help the less competent and employ them in superior positions and does so at the expense of the talented. That policy is a direct impediment in so far as it prevents optimum allocation of human resource. Indirectly, it impedes both education and the application of technology, the two major Driving Forces of economic growth. Until a solution is found to this problem, the country will not be able to grow fast.

As the late J. R. D. Tata used to say, it is easier in India to get rid of a wife than an employee. It is a fundamental principle of fluid mechanics that there can be no flow where there is no exit. Therefore, rigid labour laws that prevent removal of unwanted labour are an impediment to progress.

It is not an accident that in the profession of computers, selection by merit prevails, the policy of hire and fire is accepted without demur, and even with enthusiasm while, in traditional fields, labour clings to the concept of permanent employment with promotions based on seniority rather than on merit. It may therefore be worthwhile to divide the economy into two sections – a traditional non-competitive part and a modern, globally competitive section. Instead of having the same rule for every case, the law may be framed differently for these two sections of the economy.

Employment in the field of computers is much more remunerative than elsewhere and rightly so. That excess remuneration has two components – compensation for the risk of sudden loss of employment and the market premium for relatively rare skills. In all government agencies, the policy is exactly the opposite. Those that are engaged on a temporary basis, and hence, suffer from insecurity, are

actually paid less and are denied most perquisites too. Those with seniority but no skills are remunerated better than those who are skilled and competent. There is a lesson here for formulating a national income's policy. If the culture of computer industry spreads all over, a major impediment to rapid growth will be removed.

3.4. A Law for Employment Growth

The problem of employment guarantee becomes manageable and organised labour's resistance to efficient allocation of human resources can be minimised if both wages and the labour demand increase simultaneously. Wages will increase automatically when (a) new technologies are inducted because of inevitable shortage of labour with new skills and (b) there is economic growth.

Then, Number employed = Total wage bill divided by wage rate

Growth rate of employment = Growth rate of GNP – Growth rate of wages

The first is a tautology; the second one too is also essentially a tautology because, in general, the total wage bill of a nation is very nearly a constant proportion of the GNP. Therefore, the numbers employed will increase, if and only if, GNP increases faster than wage rate. Employment shrinks because this simple arithmetic is often overlooked, and organised labour extracts wage increases faster than the growth rate of the economy. That indeed was the error committed by the last Pay Commission: Because wage increases exceeded the growth rate of government finances, downsizing of the government has now become necessary.

3.5. Wage Policy and Employment Growth

There are two Indias – the India of the organised sector and the India of the informal sector. Relative to the organised sector, government employees are probably under paid, but taking the country's economy as a whole, they (and every one else in the organised sector) are grossly over paid as the following comparison will make it clear. In the US, the Chairman of the Federal Reserve Board – a position at times described as more powerful than that of the President even – is paid $130,000 a year, about four times the country's per capita income. India's per capita income is, currently, around Rs. 25,000 a year. Even petty clerks in the government earn more than Rs. 100,000 a year and hence, in terms

of the country's capacity to pay are better paid than the America's Federal Board Chairman. Thus, In India, even lowly government jobs catapult a person to the top of the economic ladder. Obviously, many cannot have that privilege and hence, few new jobs can be created. That situation is unavoidable so long as such jobs are overpaid in terms of the country's per capita income. That is another reason why technology change, and consequent loss of employment, is viewed with horror in India. That is why, organised labour insists that jobs be protected at all costs.

It is not an accident that the Planning Commission is talking of downsizing the government while at the same time holding out hope for a momentous 8 per cent growth rate. Rapid growth and downsizing are self-contradictory. That anomaly is the consequence of having a salary structure out of step with Indian realities, with Indian per capita incomes. So long as this disparity persists, employment will not grow, and economic growth will get stunted.

3.6. Limitations in Technology Management

3.6.1. Appropriate Technology: True to the Gandhian spirit, many people in the country favour Appropriate technology, more accurately described as traditional craft technology. While it has its uses, it has its limitations too. For instance,

a. A bullock cart: cannot provide the same quantity or quality of service as a motorised vehicle.
b. It does also pollute – relative to the quantity of service provided, its biological pollution is high, overall more polluting than a motor vehicle
c. Relative to quantity of service, its capital/ running costs are high.
d. It cannot generate high incomes

3.6.2. Social Actvism: A particularly severe controversy concerns irrigation by dams. A study conducted by the National Council of Applied Economic Research has shown that small dams, irrigating 2000 hectares and less, cost about six times more per hectare than large dams irrigating excess of 100,000 hectares. As a thumb rule, to store a given amount of water, a 100 metre high dam will submerge ten times less land than a 10 metre high one. The taller dam is therefore likely to displace ten times less number of people, destroy ten times less forest and cause ten times less environmental stress. There is a romantic view that water harvesting is a good substitute for dams. That may supplement

but not supplant dams. Also, dams would better be as high as possible. For instance, Bhakra dam has been built so high that it takes nearly three years in-flow to fill it. There are three reasons why such large storages are preferred. Firstly, our monsoons are so fickle that storage of several years flow is needed as an insurance against monsoon failure. Second, in our tropical climate, evaporation losses alone account for 1.2-1.5 metres per year. Hence, deeper storage reduces effectively the *proportion of water* lost due to evaporation. Thirdly, dams have a finite life due to siltation. Obviously, a deeper one will have a larger life than a shallow one. Our great-grandchildren's great-grandchildren will thank the designers of Bhakra for their foresight in building such a tall dam.

Table 3. 1. The Adversarial Relationship Between Social Activists and Technologists

Social Activists	Engineers and Administrators
Insist on zero-cost solutions	There is no free lunch
Single issue activity	Should consider all ramifications
Not responsible for resultant problems	Responsible for all consequences
No hesitation to break the law	Constrained to act within the law
Offer impractical solutions	Must make their designs work
Opposed to innovation	Experiment with technology
Seek to avoid poverty	Try to generate wealth
Have high communications skills	No communication skills

Table 3.1 depicts the contrarian views of social activists and technologists. Without in any way belittling the concerns advocated by social activists, it must be stated that social activists are among the most significant impediments to rational development. If ecologists had been active at the time Bhakra was being built, and most of Bilaspur town was submerged, that dam would never have been built, there would have been no Green Revolution, and millions would have perished of malnutrition if not by outright starvation. It is even debatable whether

their methods will bring prosperity to the people whose cause they claim to espouse – they are more likely to perpetuate their present dismal poverty.

3.6.3. Preference for Imports: Except where it is entirely unavoidable, Indian administrators (whether in the public or in the private sector) fear to try local designs. They consider that well-worn imported designs alone are risk free. As a result, Indian designs face a Catch-22 situation: They will not be accepted unless they have been in use, and they cannot be in use until they are tried out! So, except when foreign technology is not available at all (as in defence, atomic energy and space), Indian designs do not get a chance to prove their worth. Private industry too is no different. They want swadeshi *only for manufacturing operations but not for technology*. For several reasons, that is a bad bargain. First, there is an opportunity cost – the Indian design might be superior. Second, imported designs too bear considerable risk. Precisely because they are well worn, they are liable to be obsolete, and not saleable in competitive foreign markets. Third, the policy gives ample scope for foreign firms to form cartels and overcharge. Fourth, there is a strategic risk. Several times in the past, United States (and other Western countries) have denied valuable spares for equipment already sold and have even reneged on committed contracts.

3.6.4. Resistance to Innovation: A peculiarity of technology is that, like vegetables, it must *always* be fresh; otherwise, it is unprofitable. If Indian manufacturers had attempted to *improve their technology continuously*, their technology needs would probably have been within the capability of the Indian scientific community. In any case, over a period of years, the needed expertise would have been built up. As Indian industrialists flog every know-how purchase to its death, there is a long time gap between technology renewals. So, the technology gap becomes too wide to bridge even if talented engineers are available. In other words, India offers little or no scope for Sam Pitrodas because Indian administrators have little interest in improving on imported technology.

The Ambassador car is still ubiquitous in India. It started as the 1958 model of Morris Oxford. In forty years, the vehicle has not changed in essentials even though automobile technology has gone through several revolutions in the meanwhile. In post-war Japan, the story was different. Datsun of Japan procured the identical technology from Morris Motors and at the same time too. Unlike in India, Datsun modified the received design step by step. Over the

years, the changes accumulated to such an extent that the vehicle became unrecognisably new one with no remnant of the original Morris Oxford left. In contrast, the Indian model has remained frozen for forty years. Advances that have been occurred in the mean time have been so substantial that the gap between the Ambassador and a modern car is unbridgeable. So, the company has had no option but go shopping abroad once again for new technology. Such repetitive import is a bane of Indian technology.

3.6.5. Overcharging by Foreign Suppliers:Predatory MNCs often trade on India's weakness for imports and attempt to destroy any Indian technology that can prove a threat to their own hegemony. Such predatory tactics are not rare; they are, in fact, quite common[7]. At the same time, MNCs are known to dump their goods at throwaway prices to under cut Indian technology with a view to kill competition. While it would be unfair to tar all foreign firms, it would be unwise not to protect the country from such threats.

In spite of such experiences, it is the official policy in the Department of Telecommunications (and in others too) not to procure any equipment unless it has been used for a minimum of two years. In this connection, the following Irish folk tale about a sailor shipwrecked on a desert island is worth recounting.

> *A sailor shipwrecked on an uninhabited island prays to his guardian angel to let him have at least a baby for a companion. Much impressed at that unusual thought, the angel leaves a baby by his side in a sack while he was asleep. The sailor wakes up, sees*

[7] The following three examples illustrate the point.

- In 1991, several European suppliers demanded around Rs. 1500 million to supply a communication system for the Indian Navy. At this stage, the navy approached US manufacturers with whom, for political reasons, India had had no contacts at all for years. Apparently, never expecting the Indian government to go to Americans, the French neglected to prime the US manufacturers about the deal. Hence, unlike European manufacturers, the Americans quoted a fair price – Rs. 150 million.
- In another instance, India's aircraft carrier, INS Vikrant was in need of a re-fit for a guidance equipment for landing aircraft. The price quoted by a French firm was Rs. 9.5 million. Finally, IIT Delhi developed the same at a cost Rs. one million only.
- Recently, an American firm quoted Rs. 7.5 million for a piece of railway electronic equipment, but when IIT Delhi succeeded in developing a local version, the price was brought down nearly 80 per cent to Rs. 1.7 million.

*something wriggling in the sack, **suspicious of anything new**, and as a matter of abundant caution, drives a knife into the sack before opening it.*

Look into the mirror. Do we see that sailor in there?

3.7. Lack of Scientific Spirit

Few people in the country, even among scientists and technologists have any clear conception of the nature of the scientific spirit and the discipline and techniques that go with it. That lacuna is particularly acute among the teaching community and is the cause of misdirecting students. That is yet another reason, why India is unable to exploit its technical capabilities to the full.

Thomas Kuhn[8] has explained how Western science has remained ahead of all others, and has maintained that lead successfully for several centuries. That success he attributes to certain features of Western intellectual culture. Just like scholars the world over, Western scientists too believe in received wisdom. They too accept certain theories to be absolutely true. But unlike other, they do not stop there. As Karl Popper[9] has explained, they consider the purpose of science is to disprove – not prove – theories. That they do by pushing the frontiers of the accepted paradigm farther and farther. For that purpose, they set, and attempt to solve, newer and newer puzzles. In that process, sooner or later, anomalies occur where the paradigm fails to predict results accurately. When it becomes impossible to explain such anomalies, a second process takes over. A concerted attempt is made to discover a new paradigm that performs more satisfactorily than the old one. When a better paradigm is found, a third step follows. The old paradigm is consigned to the dustbin, and the new one becomes the received wisdom. This third step is therefore a scientific revolution, a revolution that is no less ruthless than any political one. For instance, no one uses Newton's laws of motion in space science and has been completely replaced by the Theory of relativity. Likewise, valve radio is dead as dodo. In Western science, once a paradigm fails to deliver, it is discarded without pity. That is the essence of scientific spirit.

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[8] Thomas S. Kuhn, *Structure of Scientific Revolutions,* University of Chicago Press, 1970.
[9] Karl R. Popper, *The Nature of Scientific Discovery,* New York, 1959.

For the scientist one flaw is enough to reject the paradigm for all time. To the person of faith one incident is enough to confirm that belief for ever. The true scientist is ever engaged in finding what is wrong with received wisdom, and discards received knowledge the moment it is found to be flawed. The person of faith is ever trying to reinforce the faith, and discards any evidence that goes contrary to the beliefs handed down from the past. The scientist has no compunction to sacrifice one's own faith, even to kill one's own brain-child the moment something better becomes available. The essence of faith is continued devotion irrespective of evidence to the contrary. The education system in India has not as yet rid the country of the culture of faith, nor inculcated that of science.

3.8. Impedance to Rational Education

India has a number of world class institutions, like the IITs and the IIMs for instance. It has also the largest number of world's illiterates. There is much educated unemployment and large-scale under-employment. Though there are 800 or more engineering colleges (nobody knows how many), youngsters of adequate calibre are not available. The really outstanding ones migrate and are lost to the country forever. Vocational education has not taken off at all and that shows up in the poor quality of engineering products produced in the country. Much remains to be done to improve both the quality and quantity of education in the country and at all levels and there are many obstacles to be faced at each step.

3.8.1. School Education: In terms of per capita income, Indian teachers are among the best paid in the world and in many cases, the most pampered too. Salaries are so high relative to available resources that, in many states, as much as 98 per cent of the school budget is spent on salaries. So, there is a gross mismatch between the allocation of finance between wages and academic activities. Single-teacher primary schools are predominant. For various reasons, many teachers are suspected to be chronic absentees. Rote learning is the rule rather than the exception. Many students dropout within a year or two to remain illiterate for life. Schools and school teachers are highly politicised. Major obstacles to the rectification of these errors are:

a. Resource allocation policy is a deterrent. Distributing teachers to every hamlet, even if that means single-teacher school, prevents most rural children from having access to quality education. Financial allocation is skewed

grossly on the side of wages and next to nothing for other academic expenses. Finance is not the constraint – its maldistribution is

b. The negative policy concerning the teaching of English are driving everyone, who can afford it, to go to private schools thereby increasing the disparity between the rich and the poor.
c. Remote control from state capitals, and non-allocation of authority to govern local schools to panchayats has resulted in poor discipline.
d. There is next to no investment on modern tools of education technology.

3.8.2. Vocational Education: Vocational education is the step-child of the education system. The situation is unlikely to improve because:

a. The responsibility is distributed between the Ministries of Education and of Labour but there is no competition between the two.
b. Industries are lukewarm to the idea of supporting this kind of education.
c. At the lucrative end (computer training for instance), vocational education is dominated by expensive commercial institutions precluding the possibility of poor children acquiring such skills.
d. There is little social recognition for the value of vocational skills. As the experience of computer training shows, that is because of relatively poor career prospects and emoluments for vocational skills.
e. Academic institutions are NOT geared to provide quality vocational training in all its myriad forms.

3.8.3. University Education: Irrelevance is the major problem at this level. In the middle of the Nineteenth century, cardinal Newman espoused the idea that the purpose of the university was to produce gentlemen – not productive citizens. In the Twentieth century, Nobel Prize winner Henri Bergson propounded the idea that the highest knowledge was the one that had no practical use whatever. Such concepts still rule the academia and there is uneasiness about the demand for profitable education. On the other hand, the Finance Ministry has concluded that the private benefit from university education is so high that it is a “non-merit” good not deserving of much public support. University education in India is quantitatively low by Indian standards, and often of poor quality. Progress is probelematical for the following reasons:

a. University education is highly politicised. Teachers form a powerful lobby. Colleges are started and run on commercial lines by powerful local politicians and the government is helpless against the depradations of both.

b. There is no contact whatever between the employers and the academia.

c. Recruitment and promotion are both politicised and caste-based. Both ways, quality suffers.

d. Admission by entrance tests does not select the most deserving candidates.

e. Seniority rule largely precludes recognition of merit.

f. University bureaucracy and policy making are both painfully slow, too slow to keep pace with rapid advancements of knowledge.

g. There is no system of winding down outdated courses..

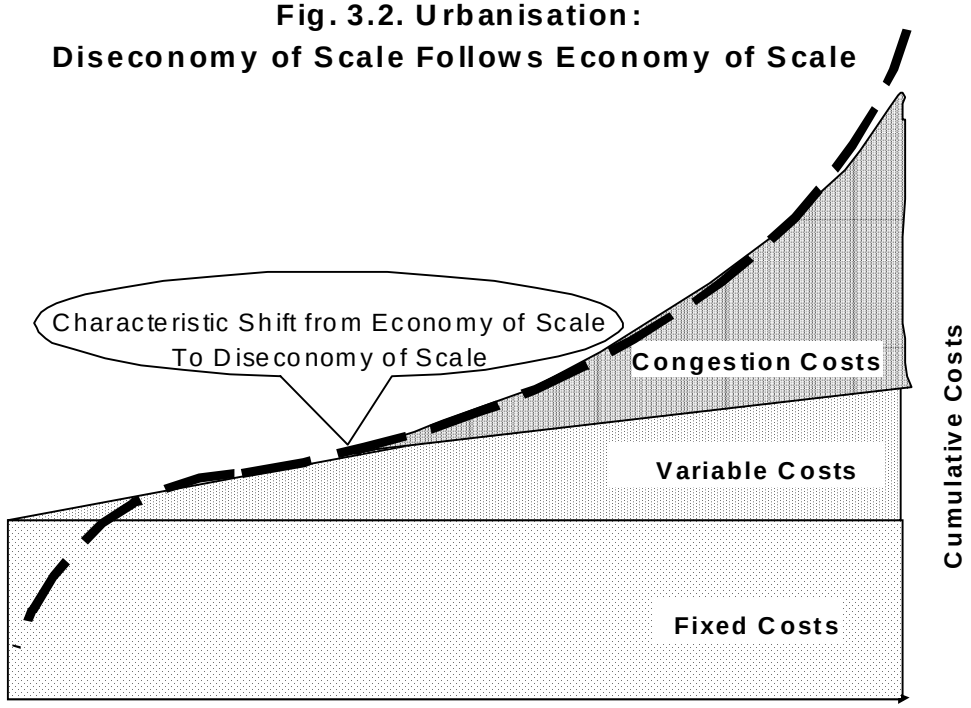
h. Heavy diversion of research funds towards government laboratories has denuded universities of research funds.

i. Research has ceased to be an attraction for bright students.

j. Brain drain has denuded the nation of high quality talent.

All these problems are well known; there is nothing new. They are being repeated ad nauseum in every gathering of academics. So, the real obstacle is the inability of the system to accept the inevitable cost associated with viable solutions or even experiment with them. Absence of seriousness and integrity are the two major obstacles to improving education in the country.

Fig. 3.2. Urbanisation:
Diseconomy of Scale Follows Economy of Scale



3.2. Slums and Rural-Urban Migration

Slum infested urbanisation is another example of this phenomenon and a major impediment to both rapid growth and Quality of Life. Fig. 3.2 compares the variation of cost of urbanisation with city size (indicated in Fig. 2.2) with the curve of Fig. 3.1, which depicts how economy of scale can turn into diseconomy of scale when size increases. That feature of deteriorating economies of scale with increase in size is typical of most construction in the country, whether that be the construction of roads, buildings or any other.

Typically, 25-30 per cent of investment for growth is accounted by construction. So, any diseconomy of scale will seriously impede growth prospects. Many countries have built attractive cities; we are unable to do so. Even Delhi the richest, and the most pampered city in the country, has nearly 40 per cent of the population condemned to live in appalling slums. The problem is NOT financial – it would cost far less to house them elsewhere. The problem is cultural – the insistence of concentrating investment in congested, expensive megacities to the exclusion of more economical locations, the insensitivity to human degradation and the unwillingness to do anything about it. That is a major hindrance, impedance to both rapid growth and rational development..

Who imposed these constraints? We imposed them ourselves! These three constraints cannot be basic because there are many beautiful uncongested cities in Europe and elsewhere. So, it should be possible to develop cities without taking recourse to slums. Paraphrasing Sherlock Holmes, once the impossible is eliminated, whatever remains, however improbable, must be the solution. So, when the option of cities is eliminated as impossible, the choice that remains is the improbable one of shifting development to rural areas. That is the only location where land is cheap enough to be affordable even for the poor.

According to current wisdom, slum clearance is an impossibility. That is why even the World Bank has reconciled itself to funding merely “slum improvement” schemes. That pessimism results from the constrained vision that looks only inside congested cities but not beyond. In that scenario, rural-urban migration and natural increase of population will combine to accelerate urban growth beyond control. It is the prevailing view, that as the space in and around cities is

limited, and cities are bound to expand, slums are not only unavoidable but will also increase inexorably.

There are three self-imposed constraints here.

a. Rural-urban migration is necessary.
b. Space must be found only inside congested cities.
c. Reverse urban-rural migration is impossible.

Table 3.1. Two Views About Slums

Conventional Wisdom	Visionary Alternative
Slums are natural, they are inevitable	Slums are created artificially, needlessly
Space is scarce; so, only a minimal space should be allowed even for the rich	Only when the rich get large spaces can the poor hope to get their due
Rural-urban migration is inevitable	Rural-urban migration is unnecessary
Capital creates jobs	Employers create jobs
Rural poor will migrate to cities only	Rural poor follow wherever employers go
Employers like only CBDs	Basically, employers seek connectivity only
Cities alone can supply large connectivity	Dedicated bus lanes linking a loop of villages can provide similar connectivity
Business must be at the city centre and residences far off at the periphery	Businesses can be distributed around the loop and located close to residences
Space is scarce, hence expensive. So, poor can have slums only	Space is in surplus; so, land prices can be made low enough for the poor to afford

Rural-migration results because the poor need jobs and can get them only in large congested cities. When employment becomes available locally, few

villagers will migrate and rural-urban migration will come under control. People may even drift away from cities when job prospects become better in rural areas. So, the cure for cancerous growth of cities lies in generating employment in rural areas.

3.8. The Democratic Challenge

There is a feeling that democracy is a threat to the discipline needed for rapid growth. According to Alexis de Tocqueville, United States has managed to have it both ways, by making patriotism a matter of self-interest. He says:

> The Americans are fond of explaining all the actions of their lives by the principle of self-interest rightly understood; they show with complacency how an enlightened regard for themselves constantly prompts them to assist one another and inclines them willingly to sacrifice a portion of their time and property to the welfare of the state[10].

Unfortunately, these days, most people in India forsake the country at the first whiff of inconvenience and at tines for self interest. Some leave the country to use their talents for the benefit of others. Others stay here but siphon away profits to deposit them elsewhere, in Swiss banks and the like. The perception that India is not the best place to exploit either talent or capital is a major hurdle and a significant impedance to the country's progress. Talented persons have a feeling that they have no voice in the management of the polity. Restoring people's confidence, particularly those of the talented, should have priority in the mind of any planner or policy maker in India.

a. NRF (National Renewal Fund) comes into operation after a person's skills are found to be obsolete, not before.

b. VRS (Voluntary Retirement Scheme) is not restricted to those whose services are redundant.

c. Both NRF and VRS are implemented on an ad Hoc and are by no means a permanent feature of organisation policy.

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[10] Alexis de Tocqueville, *Democracy in America,* F. Bowen, 1862, Bk. II, Ch. 8.

4. REALISING TECHNOLOGY VISION

Vision, as already explained is quantitative, not qualitative. We have identified our Vision in terms of Quality of Life that will be decidedly better than the world average. In the light of Denison's analysis, we may conclude that (a) technology, (b) education, (c) economies of scale and (d) efficient allocation of resources as the main factors in maximising economic growth. Capital is deliberately excluded because once these four elements are well developed, capital will naturally get attracted. In any case, the contribution made by capital to a modern economy is but a small fraction of what these four factors do.

4.1. Objectives of Technology Development

As shown in table 4.1, management of technology and administration of a government department call for entirely different, at times, contradictory cultures.

Table 4.1. A Comparison of Administrators and Technology Managers

Government Administrators	Technology Managers
Must follow rules/ precedence strictly	Expected to innovate all the time.
Hierarchical; authority is determined by the position held	Culture of peer system; professional reputation determines influence
Adequate if nationally competitive	Must be globally competitive
Command little value abroad	Command a world market for expertise
Seniority, experience paramount	Productive mainly in young age
Subservient to the organisation	Individualistic; elitist
Good administrators are extroverts	Good scientists are often introverts
Personality critical for success	Scholarship critical for success
Tasks are specific, must be done and persons may be interchanged	Task matched to personal expertise; technology can be exchanged
Transfers are routine; deemed useful	Transfers rare deemed harmful

Indian technology output is less than its potential because these differences are not appreciated nor addressed adequately. In the light of these differences, and earlier discussions, a set of objectives of managing technology are listed in Box 4.1. The issues identified are brain drain, import bias, career insecurity, competitiveness, economic justice, and ecology. The first three require correctives. The others can be expected to materialise when the first three issues are tackled.

4.2. Remedying Defects

4.2.1. Brain Drain: Brain drain can be treated as the consequence of Ricardo's

Box 4.1. Vision Objectives of Technology Development

Brain Drain: India will generate such attractive career opportunities that the country will import, not export, talented engineers.

Import Bias: Self-reliance will be realised not by rejecting foreign technology but by trading technologies, acquiring them through exchange with indigenous ones and not by outright purchase.

Career Insecurity: The natural displacement of labour by technology will be remedied not by reducing productivity but by stimulating employment multiplication.

Competitiveness: Indian technology will be so competitive internationally that there will be no need to protect Indian goods and services.

Economic Justice: The threat of increasing income disparities will be met by minimising poverty, not by reducing wealth.

Ecology: In all cases, technology will be developed or acquired in keeping with the requirements of good ecology

Law of Comparative Advantage. The situation is best explained in terms of an example. In India, it costs about Rs. 400,000 to produce an engineer in an IIT and about Rs. 50,000 for a PC system. So, one IIT engineer equals 8 PCs. In the US, training an engineer, costs a $120,000 while a PC can be had for about $1000. So, an engineer there is worth a 120 PCs. Then, in a trade between the two countries, it would be *mutually profitable* to exchange one Indian engineer for

30 PCs. That is because, India will then get in place of one engineer 30 PCs, whereas producing it locally, only 8 PCs would have been produced for the same price – a nearly 4 times price advantage. It is four times advantageous for the US also because, they will now have to pay only 30 PCs to get one engineer whereas to produce one themselves it would have cost them the equivalent of 120 PCs. Thus it appears there is a mutual advantage for both countries if India exports engineers to the US in exchange for PCs. Unfortunately, the lifetime productivity of an IIT engineer far exceeds that of a PC. So, it is ultimately a bad bargain for India. However, such brain drain will remain unavoidable so long as India places a low value on engineers and a relatively high value on machines.

Although this explanation of Comparative Advantage has been couched in financial terms, in reality, the fulfilment of all Maslow Needs must be taken into account. R&D and technology innovation operate at the highest Maslow level of self-actualisation. That will not be realised until all lower order needs are properly fulfilled. In the Indian situation, salaries are relatively high and so is security. The Indian government is commendably generous in funding projects too. However, it is utterly niggardly in rewarding people psychically. It has a blind spot particularly when it comes to professional travel – an important consideration for all R&D specialists. So, the lower physical and security needs pose are quite well looked after, but the higher order status and autonomy needs are not addressed at all in the Indian milieu.

For scientists, status is determined by the recognition given by world-renowned scholars. Even in olden days, a pundit was respected only when his ability was acknowledged by experts in Banaras. These days, researchers and designers need similar recognition by experts gathered in international conferences. Attending such conferences is considered so important that the National Science Foundation is known to return a project proposal if too little had been budgeted for travel. Its philosophy is that a work worth doing is worth disseminating and that it is best judged by a gathering of experts. In India, such travel is considered a waste and provided only under humiliating conditions.

Teachers' reputations are made by their students. At present, few youngsters are willing to take up research. That will be remedied only when research becomes as attractive a career as jobs in industry.

Administrators, including lowly clerical staff, rule scientists with an iron hand and allow next to no autonomy. Lack of opportunities for social intercourse with reputed researchers the world over, absence of autonomy and poor remuneration are the three major causes of brain drain. The following reforms are likely to reverse the trend.

a. Every time a scientist has a paper accepted in a reputed, refereed international journal, a travel grant will be given as a reward to attend an international conference.
b. R&D project investigators will have the powers of a Head of Department to authorise expenditure out of those project funds without seeking approval from any other authority.
c. Research assistantships should be instituted in large numbers with remuneration competitive with industry but only on contracts for a period of 5-6 years.

All these are intrinsically performance-based rewards. They are not permanent. Incidentally, in the 1980s, when Mr Pickering was US Ambassador to India, a proposal was considered to establish a placement system for Indian academics and scientists for summer jobs in American industry. That would have given regular opportunities for competent Indian researchers to gain real world experience and would have been a help to United States too. Such an arrangement would have given competent Indian youth the best of both worlds. Unfortunately, for political reasons, the Ministry of Education rejected the proposal. As the relationship between the two countries has improved, such a scheme may now be acceptable. That could be another way of retaining talented youth within the country – at any rate for nine months in the year.

4.2.2. Import Bias: In India, when an official's work is evaluated, errors of commission and not errors of omission are questioned. There is no audit of opportunity costs – profits lost due to "risks not taken". So, whenever an Indian comes up with a new idea, the cautious reaction is to ask, "Who has used it before?" and "If the idea is so good why is it nobody abroad has tried it out before?" As a corollary, officials search for current limitations, not look for future prospects. This culture breeds "Technology Checkers", not "Technology

Acceptors" as a matter of course. Table 4.2 brings out the difference between these technology acceptors and technology checkers. It is self-explanatory.

This policy creates a no-win situation for indigenous innovation and is an open sesame for imported technology. The bias against indigenous development is now official. Many government departments have a rule that no equipment may be procured unless it has been used elsewhere for two years.

Table 4.2. A Comparison of Technology Checkers with Acceptors

Technology Checker	***Technology Acceptor***
Authorised to procure only that which is currently the best.	Will procure what will ultimately be the best.
Buys off the shelf products; does not support technology development.	Tries out new designs; offers feedback to improve product performance.
Has to live with it even if it proves unsatisfactory.	Gets products on trial; returns them cost free if unsatisfactory.
Pays full price up-front.	Pays only after the product is proved satisfactory.
Career in jeopardy if product proves unsatisfactory.	Career in jeopardy if an opportunity to induct a novel product is overlooked.
Cautious. Will take no risks and buy only proven products even if the technology is old.	Adventurous. Will experiment with new technology.
Will resist change	Will welcome change.

4.2.3. Career Insecurity: Rapid changes in technology continuously make obsolete skills and expertise causing enormous tension and resistance to technology innovation. Fortunately, unlike in the case of scientific discoveries, technology developments can normally be anticipated several years ahead – far

better than economic trends can be predicted. So, there is scope to train a person in anticipation of technological change and not wait till the person actually becomes obsolete. Such retraining can be a fundamental right of an employee and not a discretionary favour of the employer.

At times, there is no option but to take recourse to Voluntary Retirement Schemes. At present, VRS schemes make no distinction between those that are still needed by the organisation and those that are redundant. So, the administration uses its own discretion to accept or reject any offer for VRS causing considerable bitterness and ill will. The following rule-based system may avoid these difficulties:

a. Every organisation is bound to state at the beginning of each year the areas of expected technological obsolescence and the nature of the new skills required to match the technology change.

b. The organisation is also bound to name the employees that are under threat of technological change.

c. All affected employees will have the option to acquire the prescribed new skills at no cost to themselves, or alternately, opt for VRS.

d. Further, any employee who is overlooked for promotion, or even denied a posting of his choice in preference to a person junior in service, will have the right to opt for VRS.

e. No other person will have the right to opt for VRS.

f. Once these regulations come into force, all organisations are free to allocate their personnel as best as they think fit.

While these rules may solve technology-induced obsolescence and the problem of long-term economic downsizing, it may not work equally well for unpredictable market fluctuations in the demand for the workforce.

4.3. Technical Education

Next to technology, education is the most potent force of economic and social development and for technology development too. In India, there are currently over 800 engineering colleges and many more are being added. Most of them are expensive but the quality is poor. Table 4. 3 compares some features of IITs with those of the MIT, United States. The main difference between the two lies in endowments – MIT is rich and can afford to subsidise education for needy students. Indian institutions have no such resource, not even IITs. In brief:

Table. 4.3 University Financing – A Comparison

Item	MIT, Cambridge, USA	IITs
Salaries	5000 perchis	30,000 perchis
R&D Income	60%	10%
Fees Income	13%	20%
Endowments	23%	2%
Fees Rate	600 perchis	3000 perchis

perchi = National Per Capita average hourly income

a. Technical education is costly and affordable only by the very rich unless heavily subsidised.
b. Such subsidies may not be available from the government, or it may be inadvisable to be dependent on the state.
c. That leaves no option but to depend on business to secure enough endowments to make education widely affordable.
d. Business will offer such endowments only when it sees value in it. Hence, universities should tune the education they proffer to business needs.
e. Such attunement will benefit universities too because that will ground their theoretical studies to the actual state of the physical world.

4.3.1. Science and Technology Entrepreneur Parks: In this connection, the idea of land-grant universities may be considered. In the nineteenth century, United States established a number of "land grant" universities with large land grants. The produce from that land supported agricultural research and education. Similarly, engineering universities may now be established with land granted for Science and Technology Entrepreneur Parks the rent from which may meet most of the cost of technical education. That is one way of bringing down student fees to 15 per cent of the total.

The Department of Science and Technology, Government of India has established Science and Technology Entrepreneurship Parks (STEP) in a number of engineering colleges. Funds are provided jointly by the DST and by Financial Institutions (IDBI, ICICI & IFCI) with the aim of (a) nurturing innovation and S&T based entrepreneurship and (b) fostering linkages between academic institutions and industry. The STEPs provide basic services and offer guidance to budding as well as existing entrepreneurs. So far, 13 STEPs have been established in and around academic institutions of excellence spread all over the country. The programme has so far resulted in setting up of more than 600 new enterprises employing a capital of about Rs. 50 crores. These units have a turnover of nearly 88 crores and provide direct employment for about 5000 persons. Further, skill development and other programmes have generated employment for another 6000 persons.

These are impressive results. However, they fade into insignificance compared to experience elsewhere – Tsinghua University in Beijing claims to generates all by itself US$ 200 million a year.

As an alternative to STEP, several electronics parks have come up in recent years. Unlike STEP, which is linked to an academic institution, the Electronics Parks (at times called Hi-Tec Cities) are independent systems and cost a hundred times more. They are also much closer to industry. They emulate international standards of construction, total commercial orientation. They are located in expensive congested cities. So, their costs are high. So far, they have shown little interest in basic research or on education in its true sense.

Box 4.2 describes the features of one major park of the Rensselaer Polytechnic Institute (RPI) in the United States for comparison. The RPI lays as much

emphasis on the environment as on technological services. It is as much a case of habitat development as one of establishing industrial services. It seeks to attract very small entrepreneurs with fewer than ten employees as zealously as it pursues large multi-nationals. Few STEPs in India can claim to have a Master Plan let alone a vision for an environmentally attractive habitat. The Technology Parks in RPI and other universities are huge; Indian attempts are puny in comparison and are unlikely to be commercially viable.

BOX 4.2. THE RENSSELAER TECHNOLOGY PARK

The Rensselaer Technology Park (Rensselaer Polytechnic Institute) is the owner/developer/operator of multi-tenant rental space in the Park which extends over 1250 contiguous acres with 450 acres of commercial space, 150 acres for housing, 150 acres of river frontage for parks and conference facilities and remaining 500 acres left as nature reserve. The Park has a road network built to highway specifications and all underground utility services, including: fibre-optic cabling, power from two separate sources internally looped, telephone, natural gas, public water and sanitary and storm sewers. Buildings have been designed as one story, highly flexible/adaptable space to accommodate technology enterprises ranging from the sophisticated needs of computer environments and research labs to the provision of conventional office and manufacturing space. Development of the Park is guided by a Master Plan and regulated by Covenants and Development Standards. The intention is to assure standards of development that are characterised by quality and consistency without imposing cumbersome bureaucracy. The standards address such things as density and open space requirements, building setbacks, parking requirements, drainage, waste disposal, noise, air quality, landscaping, building design and materials specifications, etc. It is the policy of the university that *parcels will only be available on a land lease basis. Land will not be sold.*

There is also an Incubator Program designed to help launch new ventures, which will typically "graduate" in two to three years. Rentals progressively increase with duration of occupation to deter lessees from overstaying

As the Box item tells, the RPI is highly concerned about a pleasant, garden environment. That may appear an unwarranted luxury for a poor country like

India. There are two reasons why that view is wrong. During a visit to Delhi, the Lord Mayor of London was asked by Indian businessmen how the City of London manages to attract investment as well as it does. His reply was that it was because the streets in London are cleaned six times a day! Modern investors are put off by dirt and squalour. When they can enjoy a high Quality of Life elsewhere, investors and technologists see no reason to come to places that are at best untidy and at worst repulsive. So, for a STEP to attract business and particularly foreign investment, it must pay as much attention to aesthetics as to technical services.

4,3,2. Incubators: ***RPI has made a provision for both STEP and for Technology Incubators. Basically, STEP supports new technology industries that may or may not be based on innovation. STEP is a for-profit commercial venture as far as the university is concerned even if those profits are used only for the advancement of education. Incubators are different. They are meant to support innovations and nurse them till they become commercially viable. An industry established in a STEP may continue indefinitely, but the lease in an Incubator is for short periods only, typically not more than three years, rarely if ever, more than five years. So, there is a planned turnover in Incubators that is absent in STEPs. The Mission statement adopted recently by the Department of Science and technology and the Asia-Pacific Centre for Transfer of Technology (an arm of the UNDP) is given in Box 4.3.***

4.4. Education in Support of Technology Development

The true raw material of technology development is talented human resource. Much of national talent is lost to the country because that is not identified early enough and is not properly nurtured in a conducive and, even more critically, in a *competitive* environment. Further, success in any field, particularly in science and technology requires innate talent, matched to the requirements of each case. Obviously, with the best will in the world, one cannot make Lata Mangeshkar a tennis champion nor Tendulkar into a Tagore nor teach Arundhati Roy elementary principles of hydrology.

BOX 4.3. MISSION STATEMENT FOR INCUBATORS

Establishing Technology Business Incubators either independently or in reputed academic institutions and R&D centres,

Instituting policy frameworks, administrative systems and statutes to promote innovation and knowledge-driven businesses,

Networking knowledge centres, industries and governments, both nationally and internationally, to promote entrepreneurs,

Obtaining appropriate financial support from governments, private investors and from multi-lateral agencies,

Creating awareness of incubation concepts among the community, the state and business organisations,

Sponsoring appropriate programmes for exchange of experiences among experts on Incubators from various countries,

And ensuring equity for all stakeholders as also rapid improvement in the Quality of Life for humanity at large.

Empowering poor children to enter universities is a difficult problem. The issues and remedies may be illustrated by taking the case of Dr. A. P. J. Kalam. He started in life with every possible handicap imaginable. Though not illiterate, his parents were unschooled and poor. They belonged to a community of artisans that did not set much store on bookish learning and on any type of formal education. They also lived in a remote corner of the country with next to no educational facilities. At the same time, Dr. Kalam did enjoy several advantages:

a. He was intelligent with mathematical skills far above his peers.
b. Though not educated, his parents were wise and inculcated in him high cultural values.
c. His family was willing even to pawn jewels to support his education.
d. He had an outstanding teacher in Sri Shivasubramania Iyer who recognised his talents *at the elementary stage itself*, and went out of his way to persuade his parents to sacrifice their short-term gain to let him study in the middle school.
e. He had in him a desire to excel, to succeed.
f. He had the opportunity to work in ISRO where the work was of the highest quality and where everyone was driven to excel and succeed.

These advantages outweighed his handicaps. Similar factors will be found to be the case with many others who achieved great success against odds. The state should take special steps to help such talented children – right from childhood stage. For that purpose, the following policy may be considered:

a. Provide good quality nutrition to mothers and children.
b. Identify talent in a tender age (That is the main reason for the phenomenal success of the Chinese in all endeavours).
c. Provide a competitive environment to help such talented people hone each other's skills to the sharpest possible level of brilliance.
d. Select the best available teachers, the best intellectually, emotionally and culturally. (Teachers have to be the best because they are the intellectual seed of the next generation.)
e. Make school education affordable[11].

Some may object to selection of teachers on merit and not on the basis of caste and the like. Such persons will do well to consider "Which will help the poor more – teachers like Sri Shivasubramania Iyer or the kind that is being appointed on political grounds? More than the rich, the poor require, and deserve, the most outstanding teachers.

4.4.1. Identifying Talented Children: Talent requires competition to excel. That is why, all over the world, every country provides special support to a few, select institutions. For instance, Britain has Oxford and Cambridge, Japan Tokyo University, France Ecole Polytechnics, and in the US, of the several thousand university institutions, barely twenty are nationally prestigious. Likewise India too should have a clear-cut policy of identifying and supporting a few select institutions of national importance. That is, a special provision should be made to identify the most talented 10-20,000 students each year. That should account for virtually all outstanding youngsters in the country.

[11] Dr. S. Radhakrishnan, in his Education Commission Report, has suggested compensating poor parents for the pecuniary loss they suffer when they send their children to school. On that basis, one adult member in the family may be given daily wage employment for each day the child attends school at, say, two-thirds the minimal wage – the reminder being treated as fees. It is estimated that this will cost the exchequer no more than Rs. 10-20,000 crores a year.

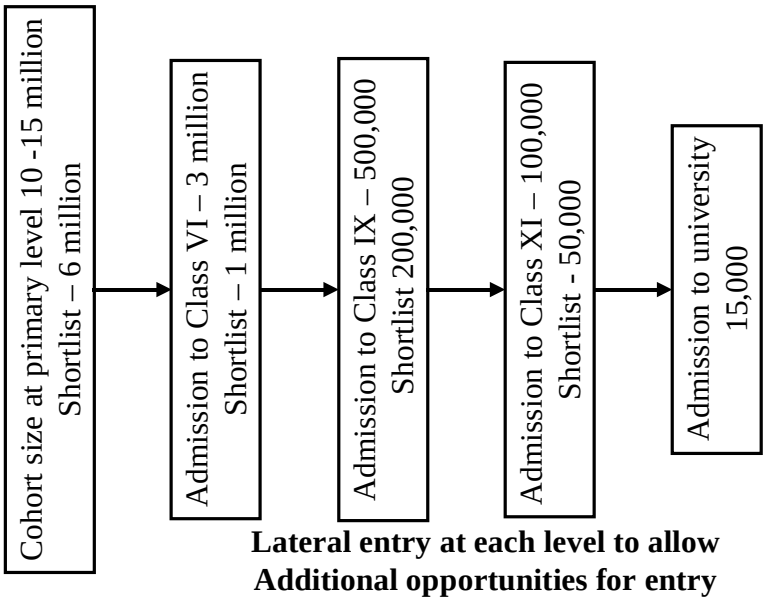
In India, it is a common practice to hold centrally conducted written examinations to admit students to prestigious institutions. Written tests with secret question papers, and open to all, have several disadvantages. They cannot match the large variety of backgrounds the children come from. However well the questions are designed, somebody or other will complain that the questions were either too difficult or out of syllabus or inappropriate. Physical management, distribution of question papers, collecting answer books, valuing them, and maintaining secrecy are all difficult, if not impossible. Above all, secrecy is threatening.

Admission rate in centrally conducted entrance examination can be as little as one in fifty or even one in hundred. That way error rate (both Type I and Type II) will be unavoidably high. Multi-stage selection will minimise such errors. Hence, it should be worth making selections to university level courses in several stages as below:

a. All selection examinations will have *open questions disclosed beforehand (no secrecy!)* and set at a level only talented minds can answer.
b. Students' own teachers will conduct a preliminary test and **shortlist** a number depending on the numbers that qualified in earlier years.
c. The tests will be held at four stages – at the end of the primary, the middle, the secondary and the higher secondary levels for admission to ***select prestigious institutions*** at the next higher level.
d. In order to help late developers, lateral entry will be made available at each level.
e. The admitting institution will test the knowledge of the shortlisted candidates in depth and not in breadth – in the field of their own choice, as in the case of the Mastermind quiz on the BBC.

f. Each admitting institution will admit students only out of the shortlist, which will be no more than two-three times the numbers admitted.

Fig. 4.1.Proposed Multi-stage Talent Search



This system empowers those who have taught the children to make the shortlist. That will increase seriousness down the line. It also ensures they select the best because, if they play favourites, the number they can shortlist in the future will get reduced. At the preliminary selection level, questions are open; so the tension is minimum. At the final selection stage, questions are both open and open-ended but the tension is still low because the candidates themselves choose the area where they like to be tested. That will separate those who think from those who mug up – the kind that come on top these days and are of little use for technology innovation.

The administrative and financial burdens will be very low under this scheme. As the examinations are highly decentralised, students from backward regions will have as good a chance as those from cities. Multi-stage selection ensures that the numbers taper off gradually and not abruptly as in the current system of one-shot entrance examinations. Lateral entry offers extra opportunities for those who miss out at any stage for any reason whatever.

4.4.2. Empowering the R&D Laboratories and Academic Institutions

Professor C. V. Raman, India's only Nobel Laureate in science used to be much concerned about the diversion of resources from universities to government research laboratories. As matters stand, it is not possible to undo what has already happened. However, there should be no objection to treat those laboratories as Deemed University and empower them to teach graduate courses. That is not ideal, as they may not like to take on undergraduate students. Yet, as Deemed Universities, they will be able to offer technical facilities and instruction far better than most university institutions.

One further reform is needed to empower these institutions. Status is very important for teachers and researchers. They cannot have a high status unless the institutions in which they work are prestigious. Those institutions will have prestige only when they are autonomous and free from political and other outside interference and control. The IITs are as good as they are mainly because they enjoy considerable autonomy. We need to institutionalise such and even more autonomy for all educational and research institutions.

For that purpose, we may consider installing two autonomous boards for each institution. One will be the Board of Trustees composed of those who provide the capital. They oversee the future development of the institution, operate the capital budget, and will also select the CEO, COO and the CFO of the institution. A second body, the Board of Governors will be composed of reputed academics headed by the CEO and assisted by the COO and the CFO. This Board will have autonomous jurisdiction over academic and research affairs and operate the recurring budget. Such an arrangement has worked well elsewhere. It is the best way of satisfying the autonomy needs of the academic and research staff without the fund providers losing managerial control.

4.5. Vocational Education

Usually, the ratio between engineers and technicians is 1:3 but in India, the two are almost equal. That forces many engineers to perform tasks that can be done better by technicians. The problem lies with the poor state of vocational training in the country. As a remedy to the problems of vocational education listed in Section 3.8.2, the following programme may be attempted.

a. Vocational education is split into two parts and offered as a sandwich of (i) hands-on three-year apprenticeship training under master craftsmen in industry and (ii) academic courses after the elementary school stage.
b. Employers asked to offer at least one apprenticeship for every ten employees with a stipend equal to, say, half the minimum wage or pay the equivalent as a cess.
c. Master Craftsmen identified and empowered to impart vocational training with suitable incentives.

This system will be better than formal vocational schools where it is quite impossible to get adequate trainers nor materials for students to work with. This also inherently matches the skill output to the strength and specific needs of all businesses.

In engineering and medicine, it is common for specialists to have several assistants who provide vocational support. For that reason, those who undergo vocational training should be several times more in numbers than those who undergo purely academic education. In India, the ratio is reversed. In Germany, even those who clean windows and walls get at least a week's training before they are put on the job. In India, persons start off as vice-chancellors without even a day's training. Vocational training does not command much respect, does not have a high status. This situation may be remedied to a certain extent if advanced technician-training courses were eligible for a degree, like say, Bachelor of Technical Arts. At the same time, it is true that computer courses are vocational in nature and yet are highly popular – even if they do not lead to a degree. That is because they lead not only to well-paid jobs but white collar ones too. That is another cultural inhibition – inordinately high value attached to white collar jobs. Until that bias goes, vocational education will not be valued as much as it is valuable to the economy.

4.5. Elementary Education

All progress starts with elementary education, one of the most poorly managed sections of Indian economy. That is the result of a basic conceptual flaw – the policy is to take schools to where children reside and not take children to where quality schools can be located. That has led to proliferation of single teacher schools, which are neither properly equipped nor monitored. It is better to take

children some distance to good schools rather than take bad schools to the neighbourhood of each and every child.

Every village can be imagined to have eight neighbouring villages in the eight directions of the compass. These eight villages and the one in the middle form a cluster of nine villages, and one school in the middle can serve children from all nine villages if only arrangements are made for children to travel no farther than the next village. In such a case, we can have around 60,000 large schools with as many as nine teachers each instead of the present system of over 500,000 schools, mostly single teacher ones. Such consolidation offers substantial economies of scale in terms of cost of management and cost of delivery of quality. (At any rate, there could be one Hi-Q central school per panchayat.)

The second flaw concerns allocation of resources – over 98 per cent on salaries. A rule that every time teacher's salaries are raised, half that increase will be statutorily made available for educational infrastructure will make a significant difference to quality of education.

We have had earlier food-for-work schemes. Professor Radhakrishnan's suggestion is the opposite: work-for-educating the child. It is an idea worth exploring and may work if it is decentralised and managed through the schools themselves. As suggested in the previous section, a family member is guaranteed employment at, say, two thirds of the minimum daily wage every day the child attends school. The remaining one third may be retained by the school to meet its non-wage costs. In effect, the government gives work contracts to schools. If the work is not done up to specifications or child does not perform satisfactorily, the school is bound to return what it has taken. This is a tightly performance-controlled scheme that could help both the school and the maintenance of civil works of the community. Conceptually, it is similar to an engineering college managing a STEP and earning an income out of it.

There is enormous interest in the learning of English. That is opposed not only on academic grounds but for political reasons too. Most existing teachers are not qualified to teach English and they fear for their careers if English is given importance. As a consequence, the rich-poor divide is widening. Rich children learn English and monopolise high paid jobs and the poor are condemned to low paid ones. If the government does not want to antagonise existing teachers, it

can at least encourage private initiative to provide supplementary courses in English and support it to the extent that they will be affordable by poor families.

Computer literacy too is a matter of importance, particularly for a nation that hopes to earn foreign exchange mainly in that field. Unless, a school has a minimum of ten-twenty PCs, the computer laboratory will not be economical to maintain and sustain. That is another reason why it is best to concentrate elementary education in 50-60,000 big schools. In order to make such a change palatable, existing schools may not be closed down, but future expansion may be concentrated in select schools where both English teaching and computer training of high quality will be made available.

In Section 4.4.1, it was suggested that bright children might be streamed and educated in special schools, the way Chinese do with much success. That will be objected on principles of socialism. That is a deeply flawed argument. Whatever happens, only 2000 children can join the IITs. At present, the selection is made in one stroke. Poor children are suddenly confronted by rich well-trained children and get hopelessly outclassed because only those who can afford private coaching can get to IITs. In a multi-stage screening system, they will start competing among their own peers and gradually hone their skills and have a fair chance to succeed on merits. The government too can help and offer high quality training because the numbers become manageable. So, the so-called social justice argument against streaming actually does irremediable harm to the poor.

This idea is similar to the Navodaya school concept but will benefit many more. It will need one quality school (not necessarily residential) for, say, every 100,000 population and need not necessarily be run by the government.

4.6. Realising the Technology Vision

The ideas suggested here are indicated in Fig. 4.2 and may be summarised as:

The government's contributions are:

a. empowering poor parents to afford to educate children

b. clustering schools to obtain economies of scale

c. improving allocation of resources by linking budget for academic infrastructure to salary budget

d. offering substantial psychic income to talented scientists and engineers, and

e. Establishing a safety net to cope with unavoidable technological obsolescence.

In this visionary set-up, reputed engineering colleges will establish Science and Technology Parks, large enough in size and equipped well enough to attract business to be economically viable. The STEP will not only be a link with industry, it will be a source of income too. Incubators too will be co-located but largely subsidised by the state. Likewise, businesses will offer infrastructure support and the services of their master craftsmen to raise the level of vocational education. Above all, the government will reform its rewards and penalties system to recognise those who help technology innovation and penalise those who obstruct technology change.

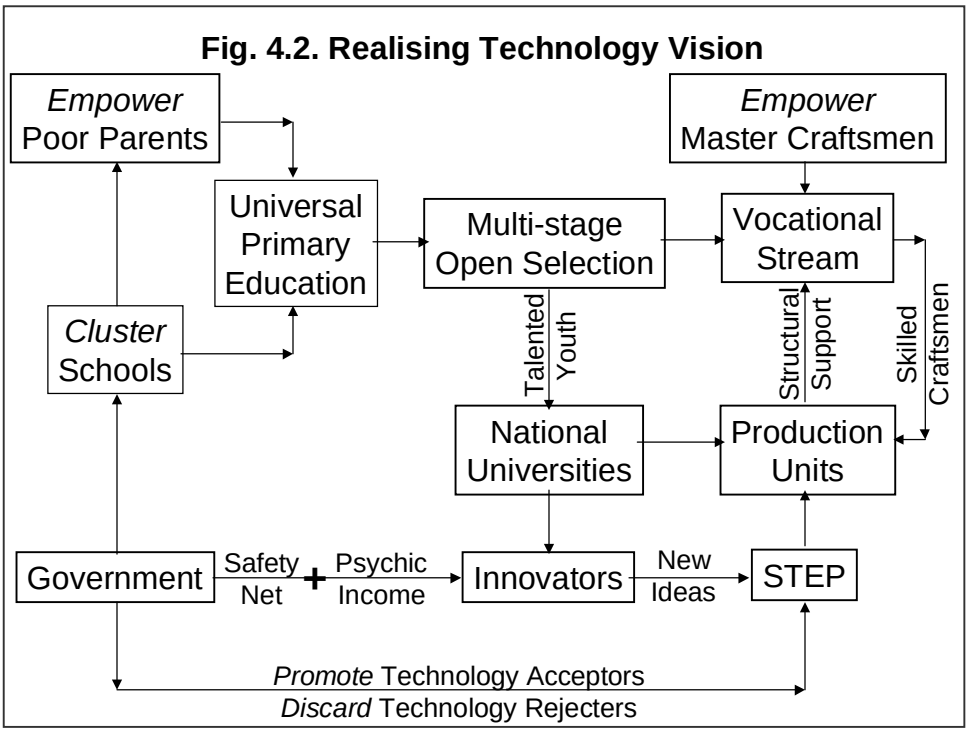


Fig. 4.2. Realising Technology Vision

5. VISIONARY INFRASTRUCTURE

It is now widely accepted that infrastructure has become the Achilles Heel of India's development. Poor technology practices, concentration of resources in expensive and non-optimum locations and non-utilisation of optimum economies of scale are the reasons why the country appears so poor even though the people are relatively better off – slum dwellers have colour TV and two-wheelers but no toilets and no water.

As for the infrastructure inputs needed for fulfilling Maslow Needs the following eight stand out:

> Reliable water supply, domestic fuel, space for shelter, connectivity, waste disposal and transport/ telecom connectivity, social services health and education), markets.

Incidentally, when these services are installed, a large amount of employment gets created both directly and indirectly. Directly, because these are all labour intensive services; indirectly because, the presence of these services will attract industry and commerce. In other words, these are employment multipliers. All these are dependent also on the way the habitat is designed and managed. A new habitat holds promise when:

a. The location has already a population of viable size
b. There is ample space for expansion
c. There are no bottlenecks to choke further development
d. There is a large city in the vicinity

As Fig. 2.2 explains, there is an optimum range of sizes for habitat – costs are high both when the size is too small and when it is excessive. It is practically infeasible to make large cities small. Hence, for the future, it is best to select some small habitations and expand them to an optimum size.

Expanding small towns is problematic. A habitat does not take off unless it has a minimum quantity and quality of infrastructure, but that is not economically viable until the habitat has already grown to a fairly large size. In that Catch 22 situation, the Indian practice is to wait till the demand picks up some how, and

then add the infrastructure. By that time, it is usually too late. Irrepairable damage would have been done already. Too little free space would be available for much needed additions to infrastructure, and even if there is space, encroachments would have eaten them up beyond cure.

Several attempts have been made to develop satellite towns and to create Growth Centres by acquiring large chunks of land in the vicinity of large cities and preparing a layout that would be an improvement on the old city. That top-down approach with little participation from intended stakeholders has rarely succeeded. In those developments, the aim has usually been to maximise profit right at the outset by sale of land, not to maximise the revenue yield of the development. As a rule, investors hesitate to risk going to such new towns where few infrastructure facilities would be available. Consequent delays eat away expected profits leaving little scope for further expansion. Little money too will be available for maintenance, making the city less ttractive than what it could have been.

If large cities and towns are ruled out as being overcrowded already, and even small towns are damaged already, investing urban infrastructure in rural areas remains the only possibility. However, rural areas are handicapped by their small size even more than the towns are. However, they have plenty of land; in particular, nearly 15 per cent of the rural land is uncultivable and hence has little commercial value. In most parts of the country, space available is large enough also to make the habitat self sufficient in water through local rainwater harvesting – an important consideration for a country where few habitations boast of a adequate drinking water. Local waste recycling and disposal is also a technical possibility – yet another worthy consideration because there is practically no town or city in the country which is clean and free of filth. However, small population size remains a critical problem.

5.1. The Rurban Plan

Suppose a loop of villages is linked by ring road with a high-speed bus lane on which frequent services are run. That is a simple artifice, yet powerful enough to integrate the tiny markets of individual villages into one large one connecting tens of thousands of people immediately with potential to connect several hundred thousand ultimately, and thereby, transform that loop of villages into a virtual city.

Left to themselves, villages are more likely to shrink than to grow. The moment the loop of villages is provided transport connectivity (and as a corollary, telecom connectivity too), they acquire a growth potential like any city in the country. Then, with little or no prodding, the population around the loop is likely to grow four-five times within a generation. Such a habitat that combines rural ambience with the connectivity of a medium sized town may be called a Rurban habitat.

Most “growth centres” and satellite towns remain moribund only because they were afflicted with a peculiar vicious circle syndrome: They could not grow economically until they had reached a minimum threshold level of infrastructure, and they could not attain that threshold until the economy grew! Establishing transport connectivity with a ring road linking a loop of villages neatly breaks that vicious circle at a comparatively lower cost. The circular bus lane is a viable solution to a the otherwise intractable problem of attracting entrepreneurs to rural areas.

5.2. Empowering Rural Areas to Compete with Cities

Urban amenities come in the form of four types of services.

a. Domestic services – residential space, piped water, electricity, telecommunications, and sanitation. They should be available within each dwelling.

b. Primary services like bus stops, grocery shops, dispensaries, children’s playgrounds. They may be described as tele-ineffective services because they are of little use if they are not within walking distance.

c. Secondary services like schools, police stations, fault repair services, railway stations, fire-fighting services, hospitals for medical emergencies. They are needed only rarely but when needed are always required urgently. They may be called security services. These need not be close at hand (the infrequency of demand (and its regularity too) makes it impossible (or unnecessary) to locate them in every neighbourhood) but must be accessible immediately as and when demanded. That means high quality local transport and telecommunication links.

d. Tertiary services like airports, referral hospitals, wholesale markets, international gateways. These are even more rarely demanded than

security services are. Further, unlike security services, it is unusual for them to be needed urgently. In general, they can be planned well in advance. If access times are measured in tens of minutes for secondary services, that can be in hours for tertiary services. So, they need not be located in every city. Several adjacent cities can share these services, the way Frankfurt, Dusseldorf and Bonn do. Hence, while security services need rapid local transport, tertiary services require high-speed inter-city links.

Zero net rural-urban migration is a mark of completed development. That will happen if villages provide access to a full range of services as listed above the way cities do. I*t is not important for a village to have every service inside, not even a primary school is critical, but the village must provide access – it must be well connected to a complete range of good quality services, at all four levels indicated in the previous section. That is what a Rurban habitat seeks to do.*

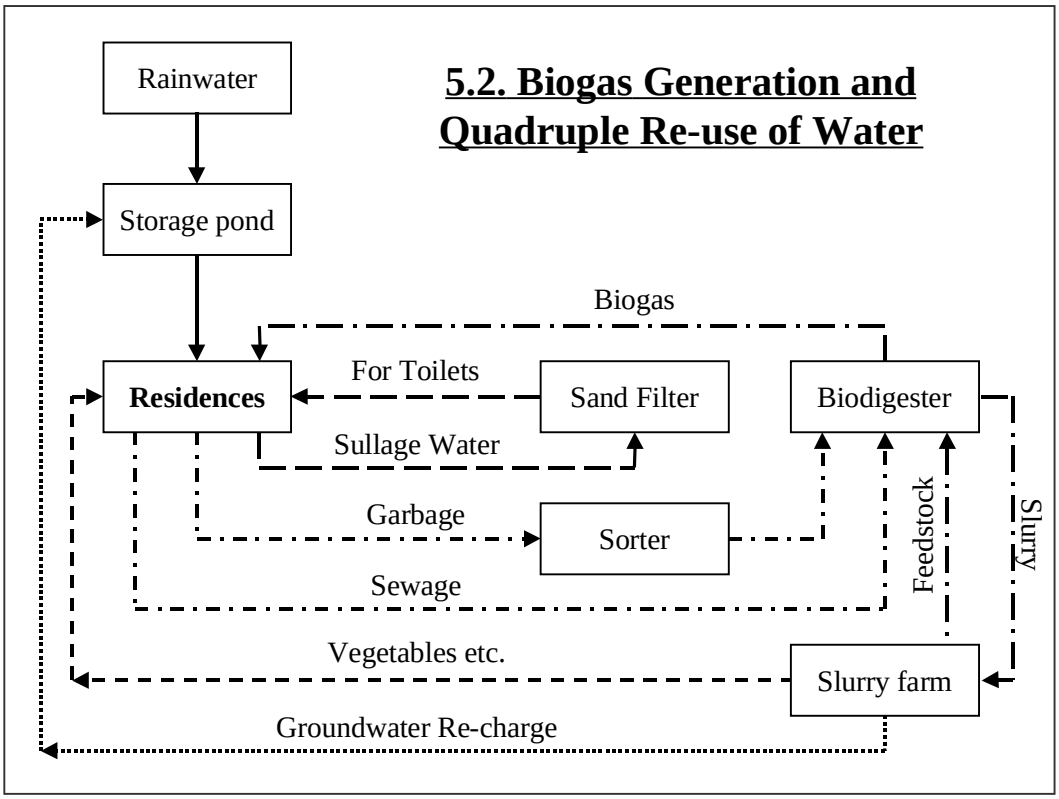
Rural ambience has its own advantages particularly the following three:

a. Dwellings with ample open space either in the form of a courtyard or as a garden and hence a low Floor Space Ratio.
b. Public spaces are relatively large, that is, proportion of open space is high.
c. Work place located within walking distance from the home.

Rural ambience offers high quality environment but little capacity for services. Cities offer a wide range of services but at the cost of poor ecology. The *Rurban* habitat can offer both good ecology and a full range of services.

5.3. Features of the Rurban Habitat

It may be argued that the same result could have been obtained by connecting together a group of villages in a star fashion or by a rectangular grid of bus lanes. That is no doubt a possibility but not an efficient one. Fig. 5.1 explains why. In the diagram, two alternatives are shown. One is a rectangular grid of main roads spaced two kilometres apart and representing an idealised city of size 10 km by 6 km, that is a city 60 sq. km in area. The other is a circular loop two kilometres wide and having the same area of 60 km as before. In both cases, no point is



more than a km away from an arterial road. As the figures show, the rectangular pattern requires eight main roads 60 km long but the circular one needs only one single road 30 km in length.

That is, the length of the main roads, and therefore all other infrastructure like water lines, telecommunication cables, power lines, drains are also halved in length. That is substantial economy. There is much more. In the rectangular grid pattern (that goes for the star pattern too), the *central region is the only location* that can be efficiently connected to all parts of the city. That naturally leads to the evolution of a Central Business District (CBD). The CBD can grow only by making the central region more and more congested and by forcing employees who work there to reside farther and farther away along the periphery of the city. That forces hundreds of thousands to commute to work every day imposing a heavy load on transport infrastructure. In course of time, expensive road re-development involving flyovers, metros and the like become necessary.

The circular loop is very different in character. *All points along the loop are equally well connected to one another.* In the rectangular or radial city, the

central region alone is the best option for the business district. In the loop arrangement, all points are equally good. That makes it possible for the business district to distribute itself all around. That alone will eliminate congestion with all its attendant problems.

There is yet another incidental benefit. It is now possible to offer each and every employer a package deal where space is provided both for business and for housing employees within walking distance of each other. Ideally, that will eliminate all commuting; realistically, commuting can be expected to be reduced to a fraction of what it would be otherwise.

There is a bonus on top of these benefits. In the conventional pattern, commuting is highly asymmetrical. In the mornings, almost all movement is towards the city centre and in the evenings the other way. In the circular design, there is no preferred direction any time; the traffic load is evenly distributed between clockwise or anti-clockwise movement. That virtually doubles the capacity of both roads and of buses too. Combined with the halving of road length and the intrinsic reduction in the need to commute, the traffic load can be reduced to a tenth of what it is currently to serve the same size of population That is no mean benefit because almost all urban problems – whether they are economic, social or even political or cultural, have at their root the financial cost of maintaining high capacity transport, and the stress and strain of daily commuting.

The reduction in congestion that is inherent to the Circularly Distributed Business District (CDBD) offers yet another advantage. Congestion imposes a premium on space, raises land prices to astronomical levels. That leads to a vicious circle: As prices are high, highly congested high rise buildings become necessary. When such buildings sprout up, congestion increases even further leading to a vicious circle of congestion, high prices, even more congestion and so on and on. On the other hand, where there is no congestion, land prices are low. So, the circular loop with its distributed business district eliminates that vicious circle too.

Thus, the *Rurban Habitat* not only combines rural ambience with urban services but also minimises costs in a number of ways, and not merely financially but socially, ecologically too.

5.3.1. The Connectivity Issue: Connectivity has two elements: One, the numbers that are connected; two, how quickly they get connected. Typically, in large cities, it can take upwards of an hour to reach the CBD. So, let us define connectivity as the number of people that can reach the CBD within an hour's time. Then, consider a loop of villages linked together by a circular road having dedicated bus lanes so that buses can travel unimpeded at high speeds. Then, every point on this circle is connected to every other on the route. Typically, that will connect nearly a hundred thousand people immediately and many more in due course of time. If the round trip takes no more than an hour, no two points on the route will be more than 30 minutes apart – an acceptable length of time to connect physically. Or, each and every point on this circular route becomes a possible location for a market with a connectivity of several hundred thousand. In other words, merely by connecting a loop of villages by a fast bus lane, we have sown the seed for a virtual city.

Thus, a well connected loop of villages becomes a *Rurban Habitat,* that not only combines rural ambience with urban services but also minimises costs in a number of ways, and not merely financially but socially, ecologically too.

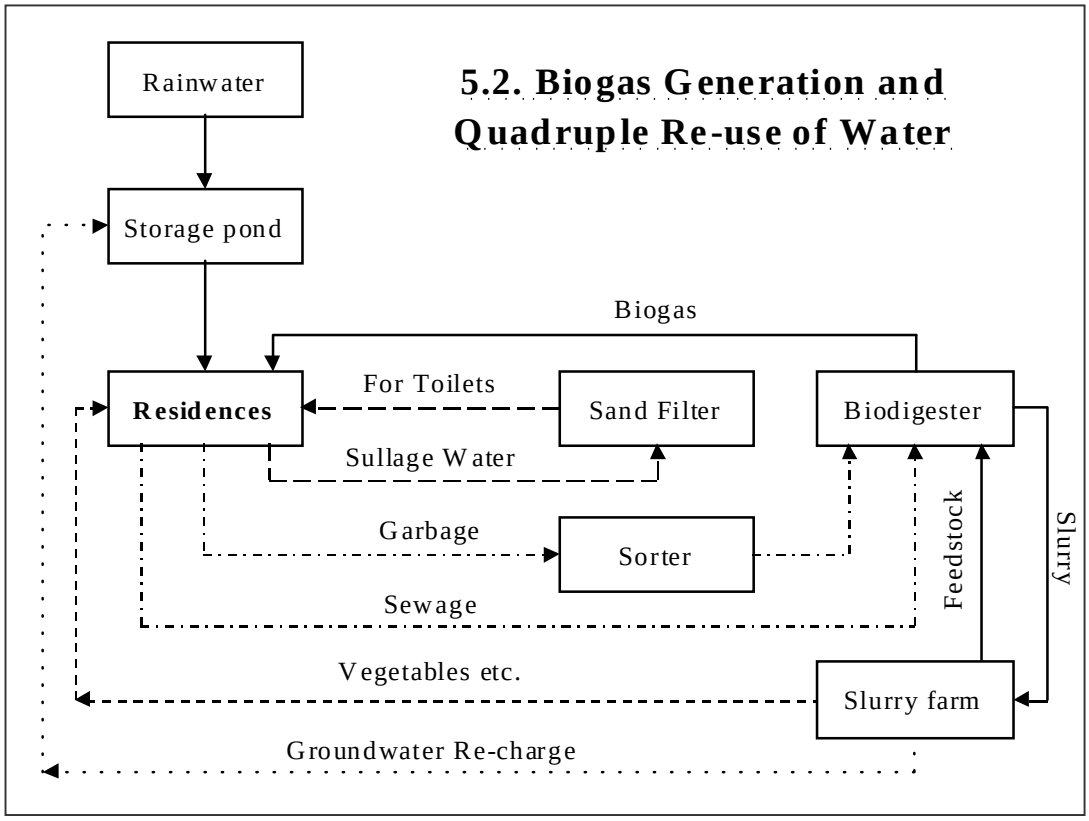
5.4. Implementing the Rurban Habitat

5.4.1. Acquiring Land: Availability of land is probably the greatest Comparative Advantage of rural areas. However, land acquisition is always a painful and politically hazardous process. The cash compensation that is offered is always a matter for dispute and discontent too. That problem can be virtually eliminated by offering farmers compensation not in a lump sum but as an annuity, an annuity equal to twice the current price of whatever they grow. That will give them grain price-indexed income, which after accounting for costs of cultivation, will be three times what they get at present. In addition, they can be given a share in the prosperity that will result from Rurbanisation by offering them 10-20 square metres of shopping space for each hectare of land they surrender. Lump sum compensation suffers from two infirmities: One, large amounts of capital

have to be found up front and that is not easy to procure. Two, farmers have to convert that capital into regular income and they are not expert in doing so.

In effect, lump sum compensation involves two wasteful conversions – (a) the state converting farmer's regular income into an equivalent capital and (b) farmers converting that capital into regular income. Compensating farmers with an annuity obviates both types of inefficient conversions. Not surprisingly, Indian farmers have warmly welcomed this idea wherever this suggestion has been made.

5.4.2. Rurban Habitat as a Collection of Employers' Campuses:



It is a common experience that, wherever employers manage their own campuses, they do ensure exceptionally fine ambience. Apparently, a peculiar competitive pride among employers induces them to devote much of their resources (and personal attention too) to the maintenance of the space they directly control. It is worth exploiting that spirit and encourage employers to establish and maintain habitats for housing their employees (either individually or collectively).

5.4.3. Comparative Advantage of Rural Areas: Of the eight infrastructure inputs required for fulfilling Maslow needs, cities are poorly equipped to offer three of them, namely, water, space and waste disposal. On the other hand, in each of these three cases, villages have a comparative advantage. As Fig. 5.2 indicates, rural areas can combine water harvesting, water recycling, sewage treatment, biogas generation, manuring and watering of energy farms and recharging ground water in a way it would be quite impossible in congested cities.

Of the eight amenities listed above, transport connectivity is truly the only handicap of rural areas. Even in this case, though cities are effective, they are by no means efficient. Urban transport is extremely costly in money, and even more so ecologically and socially. In any case, Rurbanisation by ringing a loop of villages is a good solution for that problem. It provides villagers the same order of connectivity that urban dwellers enjoy.

Table 4,1. Seven Ways Rurbanisation Minimises Costs of Urbanisation

1. Cheaper Land
2. Virtual Elimination of Daily Commuting to Work
3. Local Rainwater Harvesting, Waste Disposal
4. Halving the Length of Roads and Other Infrastructure
5. Leasing Land minimises capital costs and eliminates wastage
6. Minimises busy hour rush
7. Habitat development can be largely left in the hands of private businessmen

5.5. Planning for the Future

In particular, connectivity (both transport and telecommunications) are the precursors of development. Unfortunately, we make no prior provision for the space needed for the required order of connectivity. We let congestion becomes unbearable and then are left with no option but attempt highly expensive solutions like flyovers and metros.

Indian planners have, in the past, failed to make provision for future growth beyond the immediate scheme under consideration. In particular, insufficient reservation of space for future expansion has been the Achilles Heel of Indian planning. The country is likely to stabilise at a population of 1.7-1.8 billion of which, ultimately, around 1.5 billion may reside in urban areas. If space for that order of urban living is not set apart here and now, we will be paying an extortionate price later on. Even after paying such a price, we can neither the habitat not the connectivity of roads may come up to mark.

So far no thought has been given for reserving adequate space for the ultimate needs of roads, railways, airports, and above all, housing and commerce has never been reserved adequately for future use. Past failure to do so has retarded current progress and made it extremely expensive. If no lessons are learnt even now, and no provision is made for the future, we may manage 8 per cent growth in nominal terms but not in Purchasing Power – particularly the Purchasing Power for infrastructure and housing.

Indian planning is also deeply flawed for the reason, it has allowed cities to grow cancerous and has made no attempt whatever to limit their size within desirable limits. As Fig. 4.1 shows, if the size becomes very large, congestion sets in, expensive solutions like flyovers, metros, high rise buildings become necessary. Commuting becomes an unbearable burden both in distances to be travelled, even more in the times to be wasted in crawling through crowded highways. It has been explained already that once a city exceeds a population of size of 3-5 hundred thousand, it needs not one but several Central Business Districts that add to cost and not necessarily to convenience. For that reason, it is best to limit the Rurban habitats to a population size of 3-5 hundred thousand. That can be managed if the ring road has a circumference of about 30 kilometres and the habitat extends no more than 5-600 metres on either side – all points within walking distance from the ring road. However, it is crucial that the ring road be kept free of all encroachments so that traffic moves freely and fast. For that reason, it must be the inescapable rule that no structure will open directly on to the ring road, and that entry to and exit from the ring road should be controlled points only, the way it is on motorways the world over.

As a thumb rule, a kilometre of 50 metre wide tract must be reserved for future highways for every 20-25 sq.km. area. Space should be reserved also for future

establishment of at least one airport capable of taking jumbo jets for every 5-10 million population. Space should even now be set apart for housing 70 per cent of the population in prospective urban habitats along with parking space at the rate of one vehicle per family. Our economic progress has been choked because these provisions have never been made.

Rural ambience is obtained through non-congestion, urban quality through good connectivity. Why not combine both and devise a *Rurban* habitat that is characterised by a mix of non-congestion and good connectivity? These two features may be quantified and specified as follows.

Non-congestion for Rural Ambience: (a) Floor Space of Ratio of buildings not more than 0.5. (b) Ratio of open spaces to total area not less than 0.5. (c) Setback of buildings from major highways roads not less than 50 metres. (d) Average occupancy in public transport not more than 0.5.

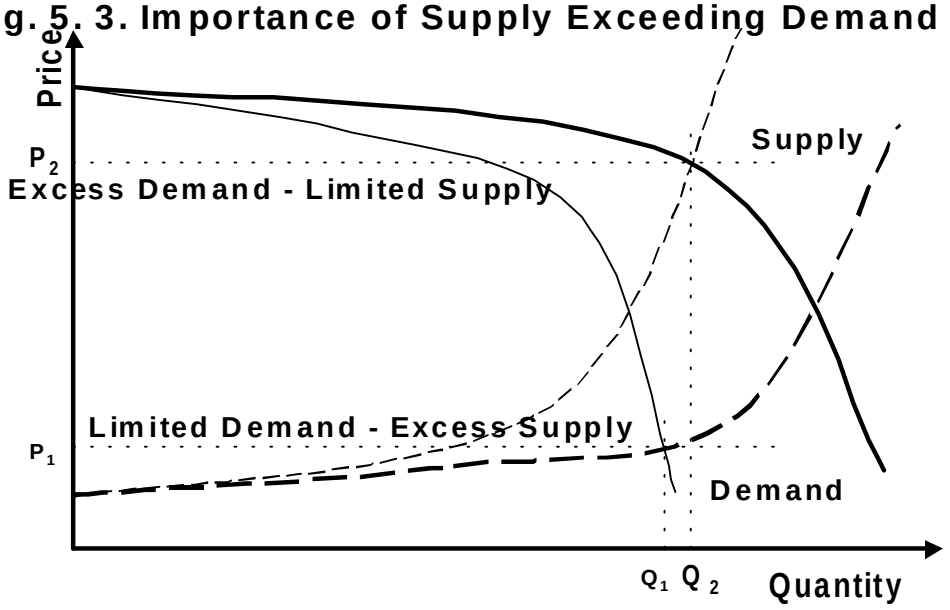
Connectivity for Urban Quality: (a) Half to one hour, or less, access time to a full range of security services by local transport. (b) A minimum of a fifty local transport services per day on any route. (c) All dwellings and commercial buildings to be within 500 metres of a bus stop or suburban railway station. (d) High speed links with adjacent cities to connect to a complete set of tertiary services.

5.6. Importance of Keeping Supply in Excess of Demand

It has been repeatedly emphasised that correct economy of scale is a critical factor in economic growth. In that respect, India's development policy has been much flawed and leading to a chronic problem. Due to financial stringency and administrative complexity, the common practice is to wait for demand to become overwhelmingly expensive before attempting any expansion. That is a self-defeating policy that, ultimately, costs much more than any savings that might have been anticipated, Fig 5.3 explains graphically what happens when supply is short of demand – prices would normally shoot up due to scarcity. Normally, when prices increase, more investment would be attracted and supply should increase. That does not happen in India because prices are controlled and are not allowed to be determined by the market. For that reason, much needed maintenance and replacement is postponed, if not given up altogether. So, a lower price is obtained at the cost of quality – and corruption too.

Only when supply is maintained in excess of supply will the prices be low. When prices are low, demand will grow automatically and will continue to do so, until supply remain in surplus and till the full potential demand is exhausted.

Fig. 5. 3. Importance of Supply Exceeding Demand



Limited Supply Can Send Price Sky-rocketing From P_1 to P2 Even When Demand Increases Marginally From Q1 to Q2

China and India exemplify two opposite approaches. China installs large infrastructure well ahead of demand. That keeps prices low, ecology high and leads to rapid growth. In India, infrastructure is kept deliberately short of supply. For instance, air travel is increasing 7 per cent a year and should double in ten years. Yet, there are no signs of the government planning the capacity of airports and other related infrastructure. They will do so only when the services get completely choked. That increases costs, stifles growth and destroys ecology.

Here is another cultural facet of India that has restricted the pace of development.

6. CONCLUSION

There are many components for a Vision. This presentation has chosen two of them: (a) empowering the economy to compete in world markets by trading on high quality, high tech products over international boundaries; (b) empowering people to access a full range of Maslow Needs.

As indicated in the Summary, it is best to plan for a Vision by working backwards. Earlier American experience shows that nearly two-thirds of its remarkable economic growth was attributable to technology. Currently, Indian industry is more or less completely dependent on imported technology. Science and Technology Entrepreneurship Parks (STEP) and Technology Incubators have been suggested as the cure for this malady. As talent is the raw material of technology innovation, and education is the means of developing talent, education gets naturally chosen as the second Driving Force.

Education has three main components: Starting with the primary level, it branches off into vocational training for one stream and education for R&D as the ultimate goal in the other stream. The latter naturally dovetails with the STEP system and hence, it is the practice world over to keep STEP as an adjunct of engineering universities. The mutual advantage between the two is not confined to technology development alone; if large enough, STEP can become such a substantial source of income for an engineering university that engineering education can be made affordable by even the poor.

Vocational education has really not taken off in India. It is suggested that such training must be adopted by industry by making it a sandwich program with students spending half the time working in industry and the other half learning basic concepts in special schools. That has several advantages including the fact that no school by itself can provide training in the myriad skills needed by industry.

The poor still shy away from educating children. DR. Radhakrishnan's proposal of offering Work for Educating Children has been commended for empowering the poor to educate their children. It has been strongly urged that single-teacher schools is a waste of both money and manpower. So, it is best to combine eight

or nine schools together into a large viable unit and in such a way that no child has to travel no farther than the next village to attend school.

Technology development needs high quality talent and training. As matters stand, the poor cannot afford the cost of such education and hence all the talent among the poor is lost to the country. The crux of the problem lies in the way engineering students are admitted – by an entrance examination that requires extensive and expensive coaching. As a remedy, multi-level selection, after the fifth, eighth, tenth and twelfth standards has been suggested. Such a system can be devised to provide the same chance to the poor as the rich have.

The hierarchy of Maslow Needs is the other face of the chosen VISION. Originally, these needs were identified as psychological, for individuals. However, there are a variety of public goods that people as a society need. For instance, water and electricity are societal services at the lowest physical Maslow level. Likewise, space for shelter and health services are components of the second security level. Education and connectivity come next for status and autonomy needs respectively. To these we can add, waste disposal and non-congested environment as an ecological need. All these are problems of infrastructure design. That makes infrastructure as the primary Driving Force for the fulfilment of Maslow Needs for the building of a modern society.

A novel proposal has been made as an economical solution to the vexed problem of infrastructure, a field in which, the country has little expertise and less money to invest. The basic problem has been identified to be the policy of expanding cities without limit, however expensive that may be ecologically, socially or even financially. Indian cities are like a tiger on which political leaders, bureaucrats and businessmen have got on – and they cannot get off. As matters stand, there is no way of converting Indian cities into a civilised habitat where the rich and poor can live together in decency. Even smaller towns offer little scope for modernisation.

For that reason, a detailed scheme has been suggested to empower rural areas to provide municipal and other services as well as cities do but at a fraction of the cost – socially, ecologically and financially too. Basically, the idea is to link a loop of villages by a modern ring road round which high speed frequent bus services are run – as the seed for future expansion. That combines the tiny

markets of individual villages into a single large one, large enough to make a variety of modern services viable. The ring road offers may advantages including the fact it cuts into half the lengths of all infrastructure thanks to a peculiar feature of its topology. Hence, the installation of high quality transport makes it possible to market the space alongside the ring road as a superior location for the future expansion of both industries and services.

Two other proposals add to the power of this kind of design, called here the Rurban habitat. One is to offer farmers who spare their land for Rurban development not lump sum compensation but an annuity linked to the value of what they have been producing. That gives them grain price-indexed income that can be three times what they earn now and yet cost barely a fee of one rupee per square foot per year to businessmen ultimately.

The second suggestion is to offer residential space and employment space in as single package within walking distance of each other. That will virtually eliminate daily commuting to work – socially, ecologically and financially the most expensive component of urban living. All in all, the Rurban concept can be expected to cut down urban infrastructure costs by 60-70 per cent.

What is presented here is an integrated approach to economic development at affordable prices.