

An Infrastructure Development model to make travel, food and shelter practically free to all!

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The author is a First Class First with Distinction Engineering graduate and an M.Tech from IIT/Kharagpur. Having served a decade in railway open line in various capacities, another decade in Railway research at RDSO & IIT, worked abroad as consultant till 1990. He was involved with the Konkan railway project from the beginning of construction (1990) as a Chief Engineer, Director (Projects) and finally as the Managing Director till Jan 2005. He has original contributions of new theories in rail-wheel and track-vehicle interactions in railway technologies recognized and published in the world forums. He holds

several patents abroad and in India for his inventions. His inventions cover railway technologies, Anti-collision Devices, Sky Bus Metro- in all 17 patents are assigned by him to the President through Konkan Railway Corporation, the royalty streams valued (by PwC) at over Rs 8000 cr (NPV), if nurtured over next three years. He believes it is in the realm of reality to make food, travel, communication and dwelling virtually free to all humans on the planet through bold application of science and technology to infrastructure development.

Abstract

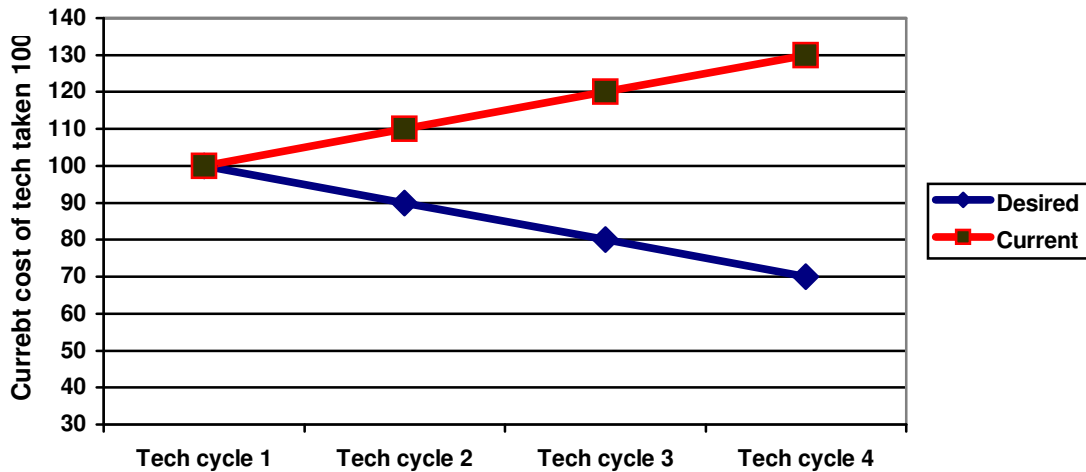
It is cosmic reality that humans are a part and parcel of the universe. They neither own exclusively the resources, nor create any, on their own. A trustee at best, but localised in time and space frame, we cause distortions in access rights causing unequal distribution of wealth. Infrastructure development is the instrument through which the humans address the improvement of quality of life, and knowledge in action is the technology, which forms the driving engine to deliver the infrastructure. Intellect is the precious gift to humans, which used properly, can yield development model, which progressively improves quality of life while reducing the costs of services, thus becoming a wealth generator- wrong approaches currently prevailing, lead to financially unviable models, effectively eroding value and wealth of one community to enrich another exploitative community, which in long term is unsustainable and makes all poorer. Through application of knowledge embedded devices and re-engineering known technologies, it is demonstrated how we can change the pace of infrastructure development to create a win-win strategy of self-sustaining & wealth generating infrastructure, ultimately leading to a situation of virtually free travel, food and dwellings! A real life case of development of the Sky Bus Metro technology in our country is shown to be capable of making the urban transport virtually free with vastly improved quality of service! Such paradigm shift in infrastructure-development is unbelievable, but true!

1. **Introduction:** The most precious gift given to us, humans, is intellect. The way we make use of the same with proper attitude makes all the difference to the prevailing quality of life in terms of food, shelter, transport and communications. Intellect has no barriers, nor limits – it is an eternally renewable resource. From generation to generations, since the human species have learnt to pass on the results in the form of knowledge of their experiences from grandfather to grandchild, the cycle of intellect

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improvement is endless and continuously progresses on an upward curve. However, greed and desire to prevail over others is a constant ingredient amongst humans. The distortion in the societal development and again, amongst societies is visible in terms of disparities in living styles and access to and use of resources – and the spectrum covers extremely poor people to extremely rich people with means of controlling the very processes of distribution and allocation of the resources. Exploitative mechanisms always rear their heads and history has shown cycles of transformation in our societies. Countries moving from peaks of achievements to downs, and those down and exploited, fight back and strive to reach the peaks.

Tech. Development Cycles



2. Intellect & Infrastructure: The intellect is the running common thread in all these activities and infrastructure is the medium through which we draw benefits of resources delivering benefits to the society.

The backbone is infrastructure for humans to provide for their basic needs in an efficient manner conserving energy resources efforts and resources. The development in science and knowledge is put into action, which manifests as technology, which in turn controls the basic infrastructure of a community. A society's core strength, hence arises from the basic capability to generate newer concepts and newer technologies, which progressively meet the most important critical requirement of reducing input efforts, while increasing quantitatively and qualitatively the output in terms service or product. Alternatively to deliver the same level of service, the costs should progressively reduce.

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3. Innovation: If the society is unable to innovate to find such technologies, which, progressively reduce costs and add value, then what happens is, we end up losing the basic wealth and burn our future for our current comforts. Obviously we cannot sustain such development model for long- the planet has a way of correcting the imbalance sooner than later.

3.1 In the matter of tele-voice communication, we are already seeing a revolution taking place within last 5 years! The prices have been steadily falling and those who adopt the competitive edge technologies are able to survive the crashing unit prices, and scales of massive utilization make the difference. The more expensive legacy wired systems charging phenomenal amounts have given away to virtually free conversation across continents!

3.2 The revolution is on. The digital revolution has similar impacts on other areas of traditional human endeavours- provided we open up our minds and adopt as well as adapt.

4. Knowledge embedded devices: It is time to now consider designing systems based on knowledge embedded devices, widely distributed and networked to handle multiple tasks, which otherwise normally handled by groups humans. The advantages are obvious.

- ♦ Productivity levels soar beyond our expectations of old legacy development models
- ♦ Quality levels get re-defined
- ♦ A paradigm shift in the way we think and work is caused
- ♦ All the rule based working is built in and fault tolerance and recovery processes built into the network

4.1 Production systems, agricultural activities, road constructions, shelters, transport systems linking the material transportation covering movement of raw materials to production centers, finished items to consumers, city house keeping functions- all community services can be progressively managed by the knowledge embedded devices inter-connected to mutually consult, analyse and take actions based on consensus.

With no additional productivity-linked heightened expectations to be fulfilled as time progresses, in such economy driven by the knowledge embedded devices, the initial capital cost gets recovered in the initial years at current economic prices, and from then

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on the services will progressively cost less and less, in comparative economic terms, as proportion of the earning capacity of the community.

Transport: can we make an urbanite travel free virtually?

Ports: Can we make port operations cost less and less – bringing down the costs to virtually drop by more than 80%?

Can we make agricultural produce reach markets/consumers at progressively lowered costs?

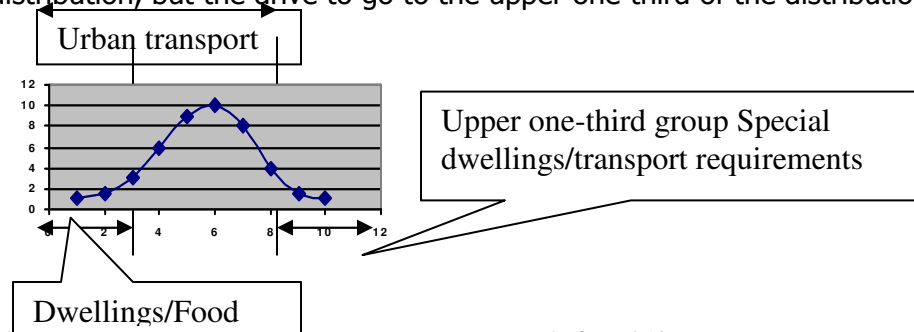
The cost of production of energy –can we make to fall continuously over a period?

General mass scale dwellings: can we make them with falling unit costs with application of known technologies?

5. Approach: The stress will be to make use of as much as possible known proven technologies, re-engineer and adopt cross-discipline developments, breaking compartmental thinking, thinking afresh the basic requirements and produce non-conventional but actually workable combination of technologies. This mode of thinking can produce tremendous boost to value-engineer cost-effective solutions, adding continuously to the wealth of the community.

6. Cardinal principle: It is time for engineers and technologists to impose upon themselves the cardinal requirement that their actions should pass the test that in creation and operation of assets forming the infrastructure for societal sustenance, should be such as to truly add value and wealth to the community, and not an instrument to transfer wealth out of the community.

7. Postulation-differences remain: One should not confuse that by the above approach we are creating a society of “no-needs, hence no motivation to excel”. The postulation here is that, whatever we do the bell-curve of distribution of wealth and driving people to reach the better zone of the curve remains. To amplify, the above steps only addresses the populations at the lower one-third of the zone of the bell curve distribution, but the drive to go to the upper one-third of the distribution continues.



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It is the upper one-third group in the society who create the bench mark levels to be attained by others and motivation levels remain to shift from lower levels. The bell curve distribution remains and the shift as a whole takes place in time. By addressing the transport requirements, we can see we today take care of two-third of the urban population's requirement.

8. A practical application: We will now deal with a few areas of our infrastructure to demonstrate the above, mentioned concepts:

Sky Bus Metro – a paradigm shift in urban transportation:

The model shows how over 5 to 7 years an urban habitat can virtually have free transportation within their community.

Transport requirements of new economy emerging in the new millennium- Improve quality of life while reducing costs:

- ◆History shows when technologies are outdated they actually become economically un-affordable, typical financial disasters!

- ◆A society which forces their future progeny to pay for today's comfort is not sustainable

- ◆Today's transport solutions based on last century's technologies like elevated/underground rail based systems are violating this cardinal principle-we should not rob wealth of our grand children!

- ◆Human life and quality improvement at reducing costs should be perceived as the focus of the new millennium

- ◆Infrastructure therefore has to cost less but deliver more to be a value generator: technology innovation alone can help

- ◆Sky Bus Metro technology is the break-through in transport technology from our country to cause such paradigm shift to make transport costs to fall while quality of life improves for all including handling cargo – providing a holistic transport solution.

9. The Challenge

- ◆ Urban space remains frozen
- ◆ Populations are shifting to urban habitats
- ◆ Mass transit capacity
 - occupying less and less urban space,

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- while being pollution-free
- affordable by common users
- with point to point connectivity
- Be integrated, avoiding inter-modal transfers
- Safer than existing systems-value human life
- Better quality of travel
 - ◆ Air-conditioned
 - ◆ Noise-free
 - ◆ Virtually no-wait service

9. Sky Bus technology as offered by Konkan Railway meets the above requirements, and helps us re-define the thinking and planning for urban transport.

9.1 Description: Heavy 52/60 kg /m rails placed at standard gauge floating in elastic medium and damped by inertia of measured mass held in a 8 mX 2m box enclosure, supported over a 1m dia. columns spaced at 15 m and located at 15 m distance from each other, in the divider space in between lanes on a road- way, at a height of 8m above road surface- provides the support and guidance for powered bogies which can run at 100 kmph, with the coach shells suspended below , carry passengers in air conditioned comfort, can follow existing road routes, while existing traffic on roads continue.

9.1 The fixed structure at 8 m height above road level is aesthetically pleasing and there is no concern of claustrophobic feeling for road users.

9.2 Aesthetic and eco-friendly, the Sky Bus can never derail, capsize nor collide- by design as well as by construction, hence is safer than existing rail-based system. At Rs 500 m or US\$12m/km in India, the system is noise-free and pollution-free with 18000pphd, scalable to 72000 pphpd as required. With no signalling and having no points and crossings, it is a unique mass-transit system, which can be put up within two years in any crowded & congested city. In addition to moving people Sky Bus system can carry standard 20ft containers, boosting its capacity utilization to double that of other existing systems.



10. Legal provisions: Sky Bus metro falls under tramway category, under Art 366(20) of Constitution of India, since it operates along existing roadways and within municipal limits, hence excluded from Railway Act. However all technologies are railway based and substantially provisions of Railway Act apply with additional provisions required to operate safely in conjunction with road users, who are sharing the

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transport zone along with the Sky Buses over-head. So a special Sky Bus metro Act has been drafted to cover the legal requirements.

11. The components of SKY BUS

- Sky way
- Sky bogies
- Sky coaches
- Sky stations
- Traverser arrangements at terminals

11.1 Sky way

- In the middle of road way pile foundations support 1 m dia column approximately 8 m high, and space at 15 m all along the roadway
- The sky way consists of a concrete box structure carried over a series of piers at a height of 8 m above existing road level
- Two rails fixed with appropriate fastenings within the concrete box support and guide the sky bogie
- There are no points & crossings-



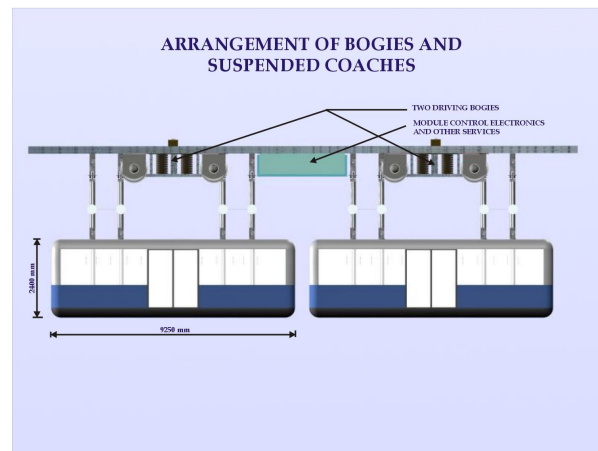
11.2 Sky Bogie

- Standard two axle bogies used in metros for speeds of 100 kmph are used (but can have higher speeds, if required up to 160 kmph)- of standard gauge.
- Linear induction motor technology is incorporated-with 4th rail driving which is above the bogie/or 3 Ph AC motors with regenerative power capability.
- Third rail is used for current collection
- Braking-bogie mounted
- Regenerative
- Disc brakes
- Emergency mechanical brakes

11.3 Design loads:

Max axle load 12 tonnes

- Weight of bogie-2 axle motor:5 t
- tare weight of coach: 6.5 t
- weight of equipment:2t
- passenger load: 9 t
- total for a bogie: 24 t
- axle load: 12 t



11.4 Sky Coaches

- Double walled light shells with wide large windows are suspended from the sky bogies

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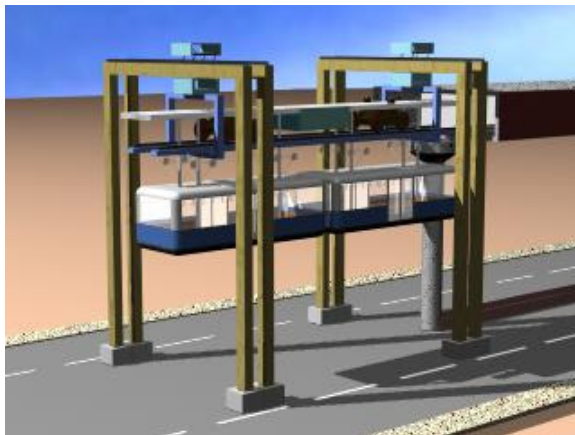
- Controlled banking on curves- 100m radius curves can be handled.
- Air conditioned and with automatic doors
- Audio visual information to passengers
- Special 4m wide sliding doors for quick entry and exit of passengers
- Each pair carries 300 persons and service every one minute or 30 seconds is possible.



11.5 Sky station description

- Unlike conventional mass transit systems, Sky Bus needs smaller stations
- Service is every 30 seconds or 1 minute that is virtually no waiting time for passengers
- Totally automated without drivers or guards-and access control is also electronic by prepaid cards being swiped in
- Stations act as only access facility, and not as passenger holding area

11.6 Traverser: There are no points and crossings. The traverser is the system which automatically shifts the sky bus units for balancing the loads/ changing routes too as well as shift units to depot lines etc.



Proven technologies and a very simple solution by merely re-engineering

the components constitute Sky Bus:

12. Sky Bus: Performance, Costs & Benefits

- ◆ Passengers per hour in peak period 40,000 to 80,000 on a route
- ◆ Service every minute

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- ◆ Grid network covers existing roads-point to point service

Financials of a typical 10km route module of a Sky Bus Metro Network in a city.											
1	Route length Double line	10	Km								
2	Cost /route km	Rs 500	m								
3	Cost of the project	Rs 5000	m								
4	Realisation	30% of designed capacity	350,000 journeys								
5	Ridership	300,000 journeys local commuters									
6	Floating	50,000 day-travellers visiting/ non-monthly									
7	Only Fare Box collections considered. No other income is assumed.										
8	Incomes not considered: Advertisement, real estate leasing , city house keeping, container service										
9	Monthly card holders travel at average 50ps per km										
	9.1	Sell monthly travel cards TWO for total km	1000 (peak 500+500 non-peak)								
	9.2	Both the cards can be used at any time travel, but charging rate depends on time									
	9.3	The TWIN cards issued to a family at total price of Rs 500									
10	Floating occasional travellers										
	10.1	Min journey charges	Rs 15								
	10.2	Day card of 50 km	Rs 100								
11	Est. revenues										
	11.1	Monthly cards	150,000 Rs 900 m								
	11.2	Daily journey trips	50000 Rs 262.5 m								
		Total Rs	1162.5 m								
12	For standard 10 km route										
	Expenses on operation and maintenance (O&M)										
	1.	Fees to KRCL for management	50 m								
	2.	Engineers+staff 150 to 200	20 m								
	3.	Energy costs major component	150 m								
	Repairs costs increased with age										
	O&M expenses increased with annual 1% increase in volume of traffic for energy.										
13	Assumptions to work out IRR										
	No inflation in unit rates for fares considered.										
	Volume increase in traffic by annual 1%.										
14	Project IRR (20yrs)	18%									
15	Tax & depreciation:		It is assumed that we should be able to maintain debt without redemption at 15% /annum comfortably over the 20 years.								
	Depreciation at 5%	25 cr									
	Then net taxable income after interest and depreciation will be taxed at 30%										
16	Return on Equity :	24%	<table border="1"> <tr> <td>Equity</td> <td>30%</td> <td>Debt</td> <td>70%</td> </tr> <tr> <td>Equity</td> <td>1500 m</td> <td>Debt</td> <td>3500 m</td> </tr> </table>	Equity	30%	Debt	70%	Equity	1500 m	Debt	3500 m
Equity	30%	Debt	70%								
Equity	1500 m	Debt	3500 m								

- ◆ Rs 500 m per route km of double line capital cost for 40,000 passengers/hour capacity during peak
- ◆ Two years construction period after financial closure.
- ◆ Capital can be recovered in 5 to 7 years
- ◆ Full private funding possible, being financially viable.

12.1 Free travel for life to those who own flats/assets in the city after 7 years:

Once the capital is recovered over 5 to 7 years, the residents/occupants, will be entitled for free life-time free travel, for one time payment of Rs 15000.

For a 10km route approximately, 2 lac users , when they pay, funds collected amount to Rs 3000 m. This is used as equity to expand raising debt of twice the amount, which means Rs 10 b worth additional network, providing annual 15% returns. Floating populations continue to be charged, which will be sufficient to pay for the operating expenses. The result is the urban travel becomes virtually free for life at a mere one time payment of 1% of value of his flat!

13. Network of Sky Bus Metro Mumbai city

- ◆ Any metro can be sufficiently served by a grid network of 100km route length

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- Two routes of 20km length : 40 km
- Four routes across of 10km : 40 km
- Four routes feeders of 5km : 20 km
- ♦ About 200 sq.km area can be served!
- ♦ The system can move 100,000 to 200,000 passengers per hour in either direction- with flexible transport transfer capacity
- ♦ At average lead of 7 km , the system can handle more than 6 m commuters every day assuming utilisation of 50% of capacity!
- ♦ The investment is of the order of Rs 600 b for this system and can be up and ready within 3 years! Provides integrated solution, handles cargo too!
- ♦ For such service, the current elevated/underground metro systems while being comparatively less safe, cost Rs 1200 b to 2500 b, and also will take not less than 7 to 8 years to construct. Still requires inter-modal transfer costs to be incurred additionally. Pollution of trucks continues in all other transport solutions.

14. Time Scale of developments

- ♦ The innovative concept paper was presented by Mr B. Rajaram at a World Congress on railways at Bolgna University, in the year 1989 titled as ` Sky Wheels`.
- ♦ After due engineering, the Sky Bus Metro technology was presented by Mr. B. Rajaram as MD Konkan Railway, to the Government of India in the year 2000-2001.
- ♦ **Dr APJ Abdul Kalam, Scientists like Dr Anil Kakodkar** as well as a working Commissioner of Railway Safety affirm technically the system to be feasible and safer than existing systems. (Year-2001)
- ♦ Independent consultants like ICRA/ PwC confirm IRR of 14 to 15% (Yr 2001-02)
- ♦ Private industries expressed confidence by investing their own funds to put up Rs 7 cr worth Sky Bus prototypes- a miracle by itself!(Yr.2003)
- ♦ Then Ministry of Railways authorised Konkan Railway to spend Rs 50 cr to put up 1.6 km test track at Margao-getting ready within the cost to be operated in August 2004.

15. World Potential

- ◆ Market exists all over the world for the financially viable urban transport
- Even as on date expression of interest cases add up to Rs 500 b- simply based on the concept itself!

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- Our country stands to gain from this market as more than 95% is indigenously manufactured.

16. Implications for India

♦Polluted cities causing wasteful fossil fuel consumption being congested lowering average speeds of vehicles, will become wonderful healthy places to attract more investments

♦Investment of Rs 500 b over next 5 years covering 1000km of Sky Bus metro in 10 cities can save wasted fossil fuel worth Rs 50 b per annum and improve quality of life for all at affordable price.

♦This funding could be fully outside Government resources- private funding possible being financially viable!

16.1 Industries benefit:

- Cement : 5,500,000 MT Steel:2,800,000 MT
- Construction : Rs 150 b Manufacture: Rs 50 b
- Employment :20000 permanent & 200,000 temporary/annum
- Financial services: Rs 15 b Software/devices:Rs 20 b
- Consultancy/design supervisory services: Rs 30 b

♦With international market the above figures will be doubled, in 5 years!

This investment of Rs 500 b in India adds annually a surplus cashflow of Rs 100 b recurring only from the fare box collections!

17. Skycon, Skyjet & Skyrail technologies

- ♦ Sky Bus Metro technologies lead to other transport applications
- ♦ Skycon is the application in Ports- the container handling and the Port operations get quantum jump in productivity almost five fold- causes a paradigm shift in designing and operating Ports.
- ♦ Skyjet is another application linking major metros bringing the metropolitan cities at 1000 km within travel times of 7 hours! Delivers containers too with the same speed! Hence high speed travel becomes financially viable in our country at affordable prices.
- ♦ Skyrail is an application for mountainous areas allowing almost vertical lifts and radius of turning less than 20m, with capability to deliver any defence equipment, free from climatic conditions.
- ♦ The scope of all these applications has not been factored in.

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18. Safety Certification:

♦ Basically the Skybus Metro System is a modified railway improving the safety parameters: the center of gravity of mass carried by wheels is brought closer to the railway wheel-rail guidance support point as compared to railway. Since we use the same railway bogie on the same railway track used for metros in the world, the same rules for dynamic safety will apply while the system is in motion- that is:

♦ The peak accelerations in vertical/lateral/longitudinal directions should not exceed the norms fixed for the metro rail systems in the world.

♦ The ride index values used by Indian railways for their suburban systems used as the upper limits for performance

♦ Since this is coaching stock with 8 wheel configuration, and limits are based on human comfort, automatically the safety requirement of Derailment Coefficient being within safe limits is assured.

♦ The above position is confirmed by the Chief Commissioner of Safety for Railways in India.

♦ The same rules for opening railways can be effectively used in this case too.

♦ The fixed structure dimensions and the moving dimensions permissible are derived by using the existing clearances provided for rolling stock in our own country. Further from the test track these values can be re-confirmed and validated.

♦ The principles used for operating and controlling the railways in metro suburban system are used for Skybus too. The apprehension that this may not give through-put , by some railway experts is unfounded. The secret is “train” here is 20m long and because of superior electrical braking the braking distances are of the order of 150 to less than 200m as compared to 5 to 10 times in conventional railway working and hence conventional railway experience of the fearing experts does not have technical basis. Also we carry 300 to 430 persons within 20m length in Skybus, which is not so for conventional railway, which is the Metro rail.

♦ Now “Certification” is a legally based document which can be issued by a person / or commission so authorized under the law of the land. If Railway Act is applied, then Commissioner for Railway safety can issue the same, once the laid down norms are satisfied. A third party independent agency takes the measurements for the performance norms, which are compared with standards prescribed by the rules made under the Act , and after completing the work only before opening for public the certificate is issued. Since Ministry of Railways do not want to classify Skybus under Railway Act, then center

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has no authority on the safety issue- tramway act under the constitution applies and State Govt becomes the rule making authority, even though all the rules are similar to the railway rules only, for the Skybus too- because it is a 100% railway technology based system- only improved to avoid derailments/ and collisions which routinely occur on conventional railway systems.

♦Obligation from State Govt:

♦The old central Act but, transferred to States to operate after Independence, the Tramway Act 18XX existing, can be straightaway adopted by the State or The Skybus Metro Act has to be passed, since Ministry of Railway has categorized the Skybus Metro System as “not railway” under Railway Act 1989.

♦Since the test results satisfy the international norms, once the Act is passed by a state, it becomes a state subject , the safety commissioner under the Act will certify to the same norms used for the railway vehicles, either by India or by Europe, with third party test results.

♦Right of Way has to be granted to the BOT operator under the Act- The draft is already prepared by an experienced Supreme court advocate and a former Member law commission.

♦Invitation to discuss and finalise a concession agreement with the BOT operator.

♦It is there for your asking, the Skybus Metro system- this new millennium’s gift of our country to the world, in the words of Bharat Ratna Dr Abdul Kalam.

♦It will be a historic day when the Skybus Metro gets commissioned within 24 months of financial closure, expected to happen in 4 months, and open the new Metro for public use in 2007- touching lives of hundreds thousands of ordinary common struggling people, who will eternally be grateful to the Government!

Konkan Railway Corporation Ltd., a Government of India Company, the BOT operator who are funding and the State will have to execute a MOU to make the above a reality.

□

19. Sky Bus Metro – new millennium’s transport solution: affordable by all common citizens on the planet- a gift from India to the world!

♦ Sky Bus is the first non-invasive rapid mass transit system giving benefits of rail and flexibility to follow roads.

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- ◆ Unlike existing ones, **Sky Bus technology carries cargo for city and eliminates trucks too!**
- ◆ Urban transport is made financially viable and affordable by the common man today to be within his living means.
- ◆ The utilization of infrastructure created for urban transport of commuters, is doubled because the Sky Bus technology allows cargo also to be handled, providing house keeping functions also to the city- which existing metro technologies cannot render.
- ◆ The perennial financial burden that the current urban transport solutions are, will now become history, with the advent of Sky Bus Metro technology. The public administrations will gain and the common citizen is benefited.
- ◆ Skycon will revolutionise the Port working all over the world and the Skyjet systems will redefine the working lifestyles of people and cargo delivery time cycles will be influenced not only for industry but also for agriculture.
- ◆ The automated systems progressively bring down the costs of transport in the goods and services availability.
- ◆ Extensive use of knowledge embedded systems in a network configuration in the technology, lays the foundation for a future of falling costs, as is already happening in the tele-communication sector. The quality of service improves many-fold.

20. Map of Mumbai routes

table with financials

21. Expansion of metro areas- the suburbs will have access to CBD with high speed 160kmph run Skybus trains, in nominated time blocks to travel distances of 50 km in 20 to 25 minutes.

22. A Skyjet service between Pune to Mumbai following the express highway can give a travel time of less than one hour travel time linking Mumbai CBD to Pune CBD! Additionally the entire truck movements can be handled by the same system, with a capacity of 3000 trucks a day each way- Ro-Ro type service. The travel time for the truck is reduced to less than 1hour 30 min.

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22 Summary of benefits to Mumbai :

1. Within city CBD, capacity to handle more than 6 m journeys , at 50% capacity utilization-
2. A capacity to handle 5000 trucks each way utilizing the spare capacity- significant reduction in pollution
3. Creates 9000 sq.m \times 100=900,000 sq.m of additional urban space as Skytop
4. Scalable to handle more than 12 m passenger journeys a day
5. No more investments needed for flyovers or road based solutions-
6. The population of buses/autos/taxis will get reduced by estimated 50% - to serve as feeder to nearest Skystation
7. Roads will be decongested significantly and also get better maintained because of house keeping functions handled by the Skybus routes supporting automated cleaning systems.
8. Entire Mumbai Port traffic will be dispersed using Skycon, out of Mumbai without needing the road network- further releasing port lands for creating breathing space and high quality strolling gardens.
9. Gives a highly sophisticated natural infrastructure to handle disasters more effectively- being free from any adverse influence of climatic factors
10. Intermodal transfer problems and resultant investments are eliminated.
11. Populations can now seek to spread out with lowered costs for high speed and comfortable travel facility linking habitats.
12. All this without demanding precious urban land nor seeking to displace humans and without needing Government financial support, makes it too good to believe!
But that is the power of technology break through in the mode of transport!

22. Improving the present Suburban Railway system:

1. Current system is inhuman. Losing more than 3000 human lives annually is the price we are paying and the society is conditioned to believe still, it is the best for Mumbai!
2. In monsoons the service simply breaks down- tracks become unfit.
3. Current train control system are legacy systems and there is need to improve the same using technology break through , and not by more and more capital infusion.

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4. The turn round times and the headway have to be improved by combination of innovative operating modifications as well as train control systems so that congestion at station platforms is controlled- it is now a case of a major disaster waiting to happen , if we observe the way the platform fully jam-packed with crowds- one shove in the face of an approaching train can be disastrous.
5. The track geometry conditions are almost at marginal levels- both track infrastructure and maintenance blocks are concerns- this in turn has a cascading effect of increased maintenance requirement for the rolling stock.

23. Having identified some core problems, solutions are detailed for the same now. The solution is based on use of knowledge embedded devices. So may look too much of a radical solution to the conventional "follow-the beaten-path" railway brothers of mine.

1. The Anti-collision device invented(by B. Rajaram) and developed in our country = the first generation net-working thinking device- has been finally implemented now in Konkan railway and North-Frontier railway. This has an advanced application of controlling the speed of train automatically to match the braking distance required to stop short of an obstruction ahead. In Skybus we are going to use the advanced feature to create moving block train control system- free from fixed signals.
2. The train length comprising of 12 coaches or 10 coaches will be reduced to half-length that is 5 or 6 coaches, and the turn round time is reduced to 50 to 60 seconds. That means under just under 60 seconds, we provide a service.
3. We try matching the service in such a way that rate of arrival of commuters is matched with rate of dispersal- this removes the sudden spurts of disgorging commuters. By the above restructuring of operations, the congestion at stations will be reduced by half.
4. The track structure will be converted into self-stabilising (invented B. Rajaram), which gives twin advantage of substantially making the track maintenance-free as well as remain safe even when the track is submerged under water. This further gives better maintained track geometry.
5. The use of networked Anti-collision devices apart from improving safety, also help in triggering off passenger friendly communication systems to make the trains to intelligently communicate with commuters.

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6. The increased frequency of trains at 60 second running on tracks, probably discourages people from trying to cross the tracks at unauthorized locations- may save lives.

Intellect, Inspiration & Infrastructure: The driving engine for cost reductions in the various services can be provided by developing infrastructure as demonstrated above utilizing the technologies in an innovative manner. The intellect is the most precious asset given humans, to manage the cosmic resources in a sustained manner to create win-win strategy of application of knowledge to develop technologies to add value and not erode wealth with wrong technologies.

20.1 We should be inspired to liberate our mindsets to fully realize our potential to develop such technologies to create infrastructure which synergises with forces of nature for the benefit of entire human species by making transport, food and shelter virtually free.

20.2 This is incrementally visible to us when for improved quality of service, we are able to reduce the unit cost of service, while developing infrastructure. If we constantly strive to implement this principle, we shall move gradually to a world where

- ♦ Agricultural activities are managed by knowledge-embedded-devices (KED)
- ♦ Transported automatically by KED driving the process
- ♦ Shelters mass manufacture through KED controlled processes/ transported and mass erected through substantially KED enabled processes.

20.3 It is the responsibility of those upper one-third group of human society to ensure that through the application of their intellect and technology, ensure that the lower one-third group in the society shall have the access to the basic infrastructure at affordable prices, for gradually improving quality of life at progressively reducing costs, measured in terms of their earning capacity. Every human at the lowest step of the ladder shall also become a supervisor in role of a system driven by KEDs!

21. Future: It is well within the realm of reality for the human society to build a knowledge based society, where the basic infrastructure facilities like fine quality food, shelter, travel and communications will cost very negligible portion of value of their contribution to the society. Then the society will move to the next level of knowledge enrichment, freed from currently manifest day to day struggle with natural resources for survival.

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References:

List of Patent applications:

S.No	Description	Application No.
01	Indian Patent application for Anti Collision Device	668/BOM/99 date 24/09/1999
02	Patent application for Anti Collision Device related inventions in US	10/341,338 date. 13.01.2003 with Priority date 05/04/2002
03.	Indian Patent application in respect of invention – Sky Bus (5 applications)	715/MUM/2001 to 719/MUM/2001 dt.26.07.01
04.	Indian Patent application in respect of invention of Self Stabilising Track System	900/MUM/2001 dated 18.09.2001
05.	Patent application in respect of invention of Self Stabilising Track System in European countries.	02255566.8 dt. 08.08.2002
06.	Indian Patent application in respect of invention of an intelligent signalling and transport system of KRCL	1150/MUM/2001 dated 29.11.01
07.	Patent application for Sky Bus related inventions in European countries.	02255243.4 dt. 26.07.02 & 02255244.2 dt. 26.07.02
08	Patent application in respect of invention of Rail Fastener in India	1019/MUM/2002 dated. 22.11.02

Three US Patents have been granted as under:

S.No	Description	Patent No.
01.	Patent in respect of invention of Self Stabilising Track System in US	US 6,672,515 B2 dated 6 th January 2004
02.	Patent for Sky Bus (A Novel Suspended Coach transportation System) related inventions in US	US 6,679,184 B1 dated 20 th January 2004
03.	Patent for Sky Bus (A Novel Suspended Coach transportation System) related inventions in US	US 6,688,235 B2 dated 10 th February 2004

- Click on description to see further details

List of Papers in International Rail Conferences:

- Rail International –Brussels (**English, French, Russian, Spanish, German**)
- **A simple approach to study rail wheel interaction** May 1983.
- **Theory to Predict Rail Head Failure Under Contact Stresses** Dec 1983
- **New Theory of Rail Wheel Interaction** Apr. 1984
(Listed as Reference paper for design of electric locomotives at 200 kmph speed **June '86**)
- Dynamic Response of elastic fastenings **Apr. 1986**
- **International Journal Remote Sensing: 2001**

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Synergistic use of orbital satellite image and ground-based information in environmental monitoring of railway alignment construction – a case study

International Conferences:

1. Invited for International Conference on Role of Railways in the year 2000 – “University of Bologna, “Sky Wheels – a new mass transit system” – Paper presented at Bologna Italy, as conference guest. **Apr. 1989**
2. Invited by World Congress at Florence, Italy on Railway Research **1997** to present paper on Computerisation of complete railway management-Railway Application package achieved on Konkan Railway
3. Presented paper in International Meet on Networking at IIT-Mumbai on the **KR-Net -1996**
4. Presented paper at Asia Rail Conference 98 at Singapore, “Challenges in operating new Railway”
5. Presented a paper on Invitation on FIP day at Mumbai International Conference on Bridges. Year 1999
6. Asia Pacific Rail 2002- Indian Railways in New Millennium - Konkan Railway's innovative technologies: Anti Collision Device, Raksha Kavach, Satdham Systems, Self Stabilising Track, ROSHAN, Tele-Medicine and Sky Bus Metro for Urban Mass Transportation
7. UIC Interaction Program on "Improved Maintenance Practice and Reducing Life Cycle Cost"- at New Delhi Feb, 2002. Presented a paper on “Anti Collision Device”