

History of Electric Rickshaws at NARI

(Chapter from the book [“Romance of Innovation”](#))

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When I was growing up in Lucknow during the 1960s, I used to regularly ride on the cycle rickshaw. Anytime the rickshaw went uphill I would get off and push it! To my young mind the idea of one human being engaging in hard physical labor to transport another was quite shocking and horrifying. Yet, that was the only mode of transport available in those days and, whether we liked it or not, we had to use it.

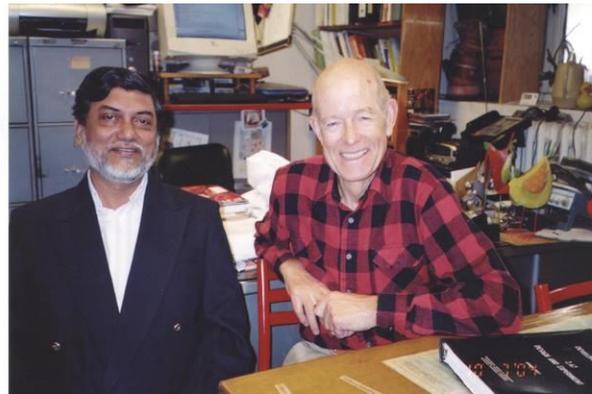
When I was [studying at IIT Kanpur](#) none of the professors ever challenged us to improve the cycle rickshaw – the projects in the late 1960s were focused mostly on U.S.-centric problems! So, after [my return from the U.S. in late 1981](#) I decided to take up the challenge of improving the cycle rickshaw. Such improvement had no significance in Western Maharashtra where these vehicles were banned on humanitarian grounds in the 1960s by Mr. Morarji Desai, who was at that time the Chief Minister of Greater Bombay.

However, I was keen to improve the cycle rickshaw for another reason. Starting in 1981, every day for almost two years, my wife [Nandini](#) and I would cycle back and forth from our home to our Institute two times a day for a total distance of 12 km. The bicycle was my only vehicle till my younger brother took pity on me and donated his scooter in 1983. The tarred road on which we cycled was lined on both sides by thorny *Acacia* and *Prosopis* trees. Not only did these trees provide shade to the road but also thorns, which regularly punctured the tires!

Data collected from our staff members (all of them came to work on bicycles in those days) and our own experience showed that 73% of the total maintenance cost of a bicycle was tire related. Besides, it was difficult to go uphill and against the wind on a bicycle. I therefore started to think about how to improve the cycle and felt that any improvement in bicycle design will have bearing on the rickshaw design as well.

Literature on bicycles revealed that one Dr. David Wilson, a professor of Mechanical Engineering at MIT, Boston had written [a bible on bicycle science](#) and was the [originator of the recumbent bicycle](#). This is the type of cycle where the driver sits in a reclining position and uses his leg muscles efficiently like that used while rowing. I corresponded with him, and we became good friends. In 2004 when I was invited to give a talk at MIT, Dr. Wilson came to my lecture, and I spent quality time visiting his office and lab.

I thought of incorporating some of David's ideas on recumbent bicycle design into rickshaws. Data on energy use in various transportation systems also revealed that pedal power was the most efficient mode, consuming the lowest energy per unit mass transported.



AKR with David Wilson in his MIT office

In 1983 I put all these ideas [together in a note on the strategy for improving the cycle rickshaw](#) and sent it to [Mr. H. N. Bahuguna](#), who was the former Chief Minister of U.P. and an active Member of Parliament. He had started his political career as a leader of the rickshaw-pullers' union in Allahabad, and the cause of the rickshaw was very close to his heart. He immediately put up a non-starred question in Parliament, asking the Government of India (GOI) about the status of rickshaw improvement in India and whether the GOI was aware of the work being done at NARI. Naturally, the Ministry

of Transport wrote that quite a lot of work was being done by various GOI organizations; but this was not true.

Since no cycle rickshaw was available for study in western Maharashtra and I also got involved in setting up the lab at NARI for work in [solar distillation](#) and [gasifier development](#), the work on rickshaw improvement took a back seat.

However, in 1995 (almost 11 years after I had written the note), I decided to attack the problem seriously. The incentive to do so came from the desire to develop electric cycle rickshaws. New developments in battery-powered vehicles world over gave us an opportunity to use that technology for cycle rickshaws. I also thought that since rickshaws provide last mile connectivity, are small enough to go into small lanes and provide huge employment opportunities for rural and urban poor, an environmentally sound electric cycle rickshaw will be a boon for the cities and small towns.

In 1993 I had gone to Atlanta, U.S.A. to present few papers at the International Energy Conversion Engineering Conference (IECEC). There I met [Henry Oman](#), a [distinguished electrical engineer](#) who had retired from Boeing Corporation. He presented some interesting work on electric bicycles, which I believed could have implications for cycle rickshaws.

After the conference we corresponded and during my next visit to U.S. in 1995 Henry invited me to visit him in Seattle, Washington. There he and two other retired colleagues of his from Boeing Corporation had set up a small company to do R&D in electric bicycles. For three days we had brainstorming sessions on how their work could help in developing an electric cycle rickshaw. We also prepared a business plan for development of special electric motors for rickshaws and submitted it to the Rockefeller Foundation. Unfortunately, it was not funded because Oman and his friends were asking for too much money for their part of the project.

This visit also gave me an opportunity to visit Seattle's lovely downtown waterfront area, which is very popular with tourists. I saw a handsome blonde guy driving a cycle rickshaw (called a pedicab), which I discovered was imported from a Southeast Asian country. I befriended him and asked the cost of a ride. He said it was \$15 for a one-km ride on the waterfront. He also told me that the money he earned by riding the rickshaw helped pay for tuition at a local management school.

When I questioned him about the high cost of the ride, he replied it was \$5 for the effort and \$10 for the scenery! Very helpfully he explained that most of his passengers were females working in the IT industry, and the scenery referred to the mini shorts he wore! Being an MBA student he had figured out his strategy quite nicely!

Anyway, that gave us an idea - if we could design a good cycle rickshaw for India it could also be sold in the U.S. and Europe as a tourist vehicle! Later we did export about two dozen of our improved and electric cycle rickshaws to Europe and the U.S. where they were indeed used as tourist vehicles.

In the meantime, in 1995 we got a small project from [E & Co.](#); a New Jersey based renewable energy investment company, to do a detailed study on rickshaw improvement for India. Our work on mobility was therefore initiated by the grant from E & Co and we were grateful for their vision. Unfortunately E & Co wound up in 2011.

We did a detailed survey in Lucknow (where my parents were still living) on the problems of existing cycle rickshaws. I must have interviewed hundreds of rickshaw pullers and manufacturers for this study, and I believe that the final report in 1997 [was the first such systematic study on the whole issue of cycle rickshaws](#). I wrote a short article based on this report which appeared as an [editorial article in the Economic Times](#) and elicited tremendous response from readers. I think this was probably the first article anywhere about modernizing the cycle rickshaw.

We also purchased a few rickshaws from Lucknow in knocked-down condition and assembled them at NARI to study their performance.

NARI's improved cycle rickshaw. 1996



We then designed a [lightweight and easy-to-drive rickshaw](#) and tested it on Phaltan roads. However, converting this improved rickshaw into an electric-powered one proved to be quite difficult, since in those days (mid 1990s) small, high-torque permanent magnet D.C. (PMDC) motors and controllers were not

available in India. We hunted for these motors and controllers all over the country because the desire was to have only Indian-made components for the rickshaw.

Luckily in late 1995 we got a very rudimentary e-mail connection. We were probably the first rural organization in India to get this and were able to send and receive short emails but could not surf the web. In fact, 1995 was also the year when internet was introduced in India, so we got hooked into the internet revolution right from the beginning. This connection allowed me to send an SOS regarding PMDC motors to my friend Dave Wilson at MIT, who sent me good material on them but mostly from U.S. based companies.

Finally we were able to locate a vendor in Pune who had a small company that made PMDC motors. He expressed great interest in our work and was ready to develop the motor according to our specifications. We bought a few motors from him and tested them on our rickshaw. Based upon the feedback on the load characteristics, he modified the motor to our satisfaction. We also located a gear manufacturer in Pune to design a suitable gear for this motor.

However one of the hardest parts was the design of the controller for the rickshaw. After a fair amount of difficulty we were able to locate a party in Pune to design a simple controller based on the load characteristics. All these efforts finally resulted in the design of our first model of a motor assisted pedal rickshaw (MAPRA). The issue of a low-cost reliable controller has, however, remained unsolved and there is a need for R&D on it.

We lacked any fancy equipment to measure load characteristics of motors. So, armed with only a voltmeter and an amp-meter we measured the actual load every 10-15 seconds while the rickshaw was driven on the rural roads of Phaltan (full of potholes), and were thus able to collect very detailed real time data on load characteristics. In



fact, when I gave an invited talk in 2002 at [U.C. Davis Institute of Transportation Studies in California](#), USA they were quite amazed at the ingenuity of our data-taking device. This tradition of getting very sophisticated data from simple experiments and equipment has been a practice at our lab.

We tested these MAPRAs on Phaltan roads in the late 1990s. There was a tremendous response from the locals – hordes of onlookers would surround it whenever it went into town. The feedback however showed that very few people in Western Maharashtra wanted a motor-assisted pedal rickshaw (MAPRA); most of them preferred a completely motorized one.

With the help of funding from the Ministry of Non-conventional Energy Sources (MNES), GOI we embarked on the design of an electric auto rickshaw and by 2000 [developed the first electric rickshaw in India](#). We christened it ELECSHA and filed the registration for trademark.

We used an American controller since the locally made units were mostly not available and the few which were in the market were not up to the mark. Also we got a special two speed gear box designed for ELECSHA so the load on the motor going uphill could be reduced. In the present Chinese made e-rickshaws they have a bigger motor with consequently higher drain on the battery for going uphill.



ELECSHA 2000

ELECSHA (pictured) has been running for almost 14 years and has logged more than 35,000 km. We use it at our Institute to transport guests and run small errands. Except for occasional battery changes and a few minor repairs, it runs well on rural roads. I feel that with new developments in hub motors

ELECSHA can be modified and made more efficient.

I also feel that ELECSHA type vehicles should be made into hybrid ones so that their range can be increased. In a hybrid vehicle a small petrol-powered IC engine charges the battery which powers the electric vehicle. Presently [our ELECSHA can go to 40-50 km in one charge](#) and a hybrid system can extend this easily to 100-200 km easily. Hybrid ELECSHA can be a great last mile and point-to-point vehicle for urban and rural India.

In late 1999 I presented our work on the improved cycle rickshaw and its conversion to ELECSHA at an International Conference on Electric Vehicles at IIT Kanpur. The paper elicited tremendous response from the participants since this was probably the first attempt in improving the humble rickshaw and making it into an electric one.

I sent a copy of this paper to Dr. David Wilson at MIT who promptly published it in the *International Human Powered Vehicle Journal* published

by MIT. A [detailed paper on our later effort was published in *Current Science*](#).

I believe our work at NARI in ‘electrifying’ the rickshaw in the late 1990s **was the first such serious effort anywhere in the world.** [We put all the details of our rickshaw on the internet.](#) Our work was copied by many agencies the world over. In fact, several of them copied ad verbatim material from our paper and other material without giving us any acknowledgement. The copying of our design (though patented in India) was a loss for our Institute, but also an indication that we were ahead of time.

Our technical paper was picked up by the [press in early 2000](#) and [large scale publicity](#) ensued. In my view, the latest electric rickshaws plying in various towns in India can be [traced to our original design](#).



Inaugurated by Madhur Bajaj and Pune VC, Kolaskar

In early 2002 we donated five MAPRAs to Pune University to be used on their campus. The rickshaws were inaugurated with fanfare with Mr. Madhur Bajaj, Vice-chairman of Bajaj Auto and Mr. Ashok Kolaskar the Vice Chancellor of Pune University taking an inaugural

ride in them.

The rickshaws worked quite nicely but the University did not want the responsibility of repairing them, even though they were given free, and the University had a full-fledged workshop with technical staff. So, even for a simple thing like repairing a tire puncture or other minor repairs I had to send across our technicians from Phaltan. They also had a problem to get rickshaw pullers since there is no tradition of cycle rickshaws in Western Maharashtra. Hence it was getting to be a headache to manage them from

Phaltan. So after a year we took back all five rickshaws and felt sad at losing an excellent opportunity to expand such efforts on a university campus.

We tried a similar venture with IIT Kanpur but there too the authorities did not want to take any responsibility; they wanted us to deal with the rickshaw-pullers directly.

We thought of setting up a rickshaw-pullers cooperative society in Lucknow, which has the largest number of cycle rickshaws in the country. This idea was further helped by one Mr. Agarwal from Lucknow who approached us after reading of our efforts in newspapers. In 1999 we signed an MOU with him to manufacture our MAPRA and improved cycle rickshaws and sell them in north India. Though Mr. Agarwal did not have funds, he had connections in the U.P. Government. That is when I learnt that the Central Government gives huge grants and loans to poor members of backward classes and minorities who want to buy rickshaws.

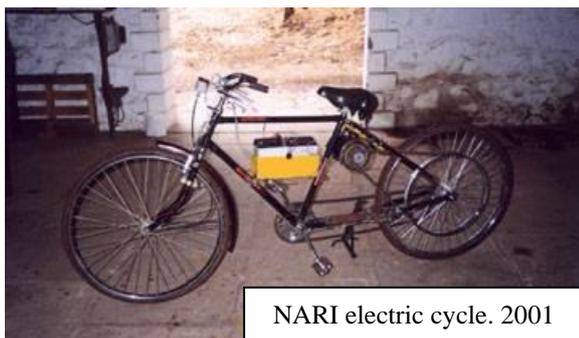
Mr. Agarwal took me to meet the Director of the Minorities Commission in Lucknow. He liked the design of our rickshaw but said it would be difficult to promote them under the Central Government scheme since they were different; he insisted that we convert the existing cycle rickshaws into electric ones. I told him that the existing rickshaws were of a very poor design and converting them into an electric rickshaw would be very inefficient. I also explained to him that this was the reason we had first improved the existing rickshaw and then converted it into the MAPRA!

He was not convinced by my argument and so our meeting was inconclusive. Only when I came out of his office did I realize what he was hinting at! Most of the time the huge funds that came from the Central Government for loans/grants to minorities seeking to own a rickshaw were shown as 'given'; nobody counted the rickshaws on the road as they all looked the same and were not registered. Our improved rickshaws would have stood out like a sore thumb!

Though the loan was shown as disbursed on paper, it was never given to the rickshaw-pullers; instead it was siphoned off by the politicians and government officers. This fraud was further helped by the fact that rickshaw manufacturing was a footpath industry; hence there was no mechanism for counting their numbers.

Despite this setback I still believed that we should set up a rickshaw-pullers' cooperative society in Lucknow even if NARI had to pay from its own pocket. I approached the Registrar of Cooperative Societies in Lucknow, who told me that no cooperative society succeeded in U.P. and that I was wasting my time. Sadly, this state of affairs still continues in U.P. and may have even become worse. Our efforts to introduce our improved rickshaws in Lucknow in the late 1990s thus failed. Now I am told that there are number of efforts to introduce improved and electric rickshaws in some cities of U.P.

In 2001, I also suggested that our electric cycle rickshaws be used in the Taj Mahal area in Agra. All the 5-star hotels in that area liked the idea but they were not interested in the logistics of running the rickshaws. It seemed like everyone wanted us to manufacture the rickshaws and sell them. Nobody was interested in buying our design and commercializing it.



In the late 1990s we also started work on an electric bicycle just out of interest and made quite a few models. However the unavailability of a low-cost hub motor, good controller, and low-cost high-density battery hampered our efforts. In any case for a few years I had fun testing and riding the electric bike back and forth from my office to home – a total distance of 10 km daily.

In 2002 I was invited by TI Cycles, Chennai – the second largest bicycle manufacturer in India - to help with their electric cycle work. I tried to make them interested in our electric rickshaw, but they did not think it was

a commercially viable proposition. Their efforts to produce and market electric bicycles failed at the time because of the unavailability of a low-cost hub motor.

Due to the current availability of good hub motors and controllers the electric bike program has picked up world over and there are millions of e-bikes across the globe.

The publicity around our work on cycle rickshaws resulted in lots of fan mail. In 2003, a mother from Chandigarh wrote to us, stating that her son was paralyzed from waist down and could we design an electric trike for him.

This set me thinking about the design of a rickshaw for physically handicapped (PH) persons. When I tried to get data on the number of handicapped persons in India, I was shocked to find that it did not exist. Innumerable emails to associations working for the handicapped all over India gave conflicting numbers. Nevertheless we decided to design such rickshaws. To start with we got a PH person from Phaltan and quizzed him about what he would like to see in a good vehicle for the handicapped. Based upon this feedback we designed the final vehicle.

Electric trike



Because of our experience with designing electric cycle rickshaws we designed [two rickshaws for handicapped persons](#). One was a Motor Assisted NARI Handicapped Rickshaw (MANHARA), and the other was a completely automated rickshaw called an electric trike. Both have been given to few handicapped persons. An [excellent video on trike and MANHARA was shot in 2009](#).

In late 2008 there was news in almost all mass media of a new cycle rickshaw called Soleckshaw, which was introduced in New Delhi by the Council of Scientific and Industrial Research (CSIR), Government of India. The vehicle looked remarkably similar to our MAPRA and even the name Soleckshaw rhymed with our ELECSHA. Also their publicity photo of Delhi inauguration was almost identical to ours!

I did not pay any attention to this but a journalist friend (a very senior science journalist), who remembered our work on electric cycle rickshaws in the late 1990s, called me in 2010 asking whether I had seen the design of the Soleckshaw. He said it looked remarkably similar to our MAPRA and he wanted the details of our work. I sent him all my previous work including the photographs of our rickshaw and those of Pune University inauguration.

Digging a little deeper it did seem that CSIR may have copied our design. In science and technology, evolution of a design takes place based on the existing work and hence it would have been justifiable if CSIR had acknowledged our contribution but unfortunately, they did not. I have found that very often the research community in India uses ideas and designs from others without proper acknowledgement. I think this is very unprofessional. In any case the journalist friend [wrote a story on the CSIR Soleckshaw and about our work](#) so that the record could be put straight. Nevertheless, I am happy that CSIR promoted our concept and showed that we were ahead of times.

Since our work in the late 1990s lots of development has taken place in hub motors and controllers and we believe that the issue of developing a cheap electric cycle rickshaw should be explored again. MAPRAs and ELECSHAs can be excellent last-mile and environmentally sound conveyance system. Just recently GOI has announced help in spreading electric rickshaws all over India. We [feel vindicated that our pioneering work started in 1995 has now borne fruit.](#)

Development of other battery powered technologies



Since ours is an agricultural research institute we thought of using battery powered systems for agricultural machines. Our first invention was a battery powered safflower petal collector. Safflower petals can be used as excellent herbal tea. Since safflower is a thorny plant and difficult to handle, we developed a [battery powered knapsack type petal collector](#). This was probably the first such collector system anywhere in the world and has elicited tremendous response. It has been exported to various countries like Iran, Nepal, etc.

To collect research data from small plots we need stand-alone small threshers. Such threshers are available, but they run either on noisy diesel engines or on AC electric motors. Therefore for field operations we designed small battery powered threshers for safflower and sweet sorghum. This could be easily wheeled to the fields.



Battery powered safflower thresher

Future research areas

1. The main stay of rural transport is petrol driven motorcycles. They can be easily displaced by more efficient electric ones which are becoming [easily available in the European and American markets](#). They match the speed and torque of the existing motorcycles and go to a distance of 50-60 km in one charge. Besides, they give an average of 200 km/1 of petrol equivalent which is nearly 5 times more than the petrol ones. Similarly a [unique technology of air motorcycles](#) can be a zero-emission rural vehicle. These air bikes are in early stages of development but with rapid

strides in their technology may become available at low cost. Thus electric and air motorcycles can in future become the main transport system in rural areas. The challenge is to design them for rural roads, reduce their cost and develop local electric and air charging systems.

2. For rural areas there is also a need to develop hybrid motorcycles i.e. a small IC engine charges the batteries and runs an electric motor. Thus the hybrid motorcycle is basically an electric one. Not only will it allow more efficient running of petrol engine, but the system can also be used to provide electricity for rural huts when it is not being used for transport. Rapid improvement in battery technology world over makes this idea quite attractive.
3. Finally there is a need to develop liquid fuels like kerosene and petrol from agricultural residues. These fuels can power the two wheelers and the farm machinery.

Team members:

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[HOME](#)

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An article on the history of e-rickshaws in India based on this work was recently [published in South Asia Monitor](#). 25 December 2024.