

# The Untold Story of Electric Rickshaws in India

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## Introduction

As of 2022 India had about 2.4 million battery-powered three wheeled rickshaws called e-rickshaws. There are guestimates that 85% of all electric vehicles on Indian roads are e-rickshaws and by 2030 their numbers will reach about 4 million.

These e-rickshaws have brought about a major revolution in clean mobility in urban areas of India. The [e-rickshaw was developed in 1990s at Nimbkar Agricultural Research Institute \(NARI\)](#), Phaltan. This article traces the history of its development at NARI and shows what needs to be done to increase their numbers and make them better.

## Genesis of idea

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 horrifying and upsetting. Yet, that was the only mode of public 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

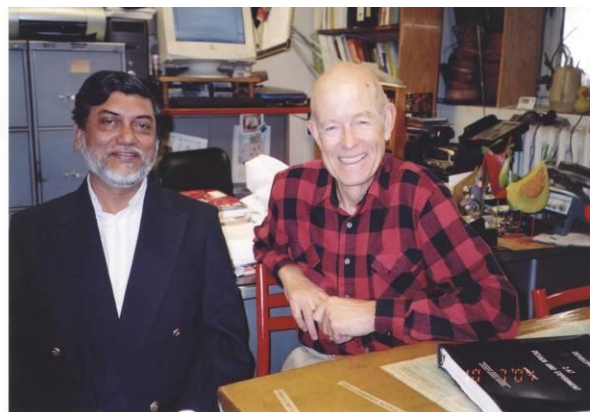
vehicles were banned in the 1960s on humanitarian grounds by Mr. Morarji Desai - at that time the Chief Minister of Bombay State.

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 bicycle 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 me 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 bicycle and felt that any improvement in its design will have bearing on the rickshaw design as well.

Literature on bicycles revealed that one [Dr. David Wilson](#), a distinguished 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 bicycle where the driver sits in a reclining position and uses his leg muscles efficiently like those 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. Unfortunately David passed away in 2019.

I thought of incorporating some of David's ideas on recumbent bicycle design into rickshaws. Data on



AKR with David Wilson in his MIT office

energy use in various transportation systems also revealed that pedal power was the most efficient mode, consuming the lowest energy per unit mass transported.

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 12 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 narrow 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 a 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 brain-storming 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.

### **Early legwork on the project**

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 are 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 done anywhere in the world 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 the readers. I think this was probably the first article anywhere about modernizing the cycle rickshaw and converting it into e-rickshaw.

In 1996 we also purchased a few rickshaws from Lucknow in knocked-down condition and assembled them at our Institute NARI in Phaltan to study their performance. We then designed a [lightweight and easy-to-drive rickshaw](#) and

NARI's improved cycle rickshaw. 1996



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) in late 1998. The issue of a low-cost reliable controller has, however, remained unsolved and there is a need for R&D on it.



MAPRA, 2000



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 regular 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) and most of them preferred a completely motorized one. We filed a [patent on e-rickshaw in 1997 which was the first patent in India](#).

With the help of funding from the Ministry of Non-conventional Energy Sources (MNES), GOI we therefore 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 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 do not have the gearbox but 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 has been running 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 as hybrid ones so that their range can be increased. In a hybrid vehicle a small petrol-powered IC engine running optimally 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 easily extend this to 100-200 km. Hybrid ELECSHA can be a great last mile and point-to-point vehicle for urban and rural India.

### **Spreading of e-rickshaw idea**

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 at 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 efforts 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 written material from

our paper and brochures without acknowledging our contribution. The copying of our design (though patented in India in 1997) was a monetary 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 present e-rickshaws plying in various towns in India can be [traced to our original design](#).

We also tried many things to popularize these e-rickshaws in 2001-2002. Thus we gave [five MAPRAs to Pune University](#) and also tried to put them on IIT Kanpur campus but the Institute authorities were not at all supportive of the efforts and wanted these vehicles to ply as commercial vehicles. Our plea that plying of these e-rickshaws on the campus and their management by a concerned engineering department will be a great way for students to learn about these vehicles and develop them further, were somehow not taken up by the IITK authorities for reasons best known to them.

Similarly we tried to introduce these e-rickshaws in 2001 in the Taj Mahal area in Agra since they would have provided an environmentally sound vehicle for ferrying tourists. We did have discussions with the hotel authorities, but they wanted readymade rickshaws operated by an independent commercial entity. Simultaneously we also tried setting up an [e-rickshaw cooperative society in Lucknow](#) but were not successful because some of the authorities wanted substantial consideration to move the concept forward !

Though we had filed the first patent in India on e-rickshaws in 1997 but we were not equipped to manufacture them and so our pioneering development efforts failed to get them commercialized. In the meantime we found out that people [started copying our design](#) and introducing it on a limited scale in the market. This happened since a large number of people would visit our facilities and photograph our e-rickshaws.



## **Failure of Indian companies to take up e-rickshaw**

In 2002 I was invited by TI Cycles, Chennai – the second largest bicycle manufacturer in India - to help with their electric bicycle work. I tried to make them interested in our electric cycle 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.

Similarly interactions with the two of the biggest two-wheeler manufacturers in India also took place in early 2000s and we tried to make them interested in getting into the e-rickshaw segment, but they scoffed at the idea and said that these things are impracticable.

Not only in this technology but in other things also I have been amazed at the lack of vision in most of the captains of Indian industries. Probably this is the reason why very little R&D takes place in corporate sector. I feel if they had looked at e-rickshaws seriously in the early 2000s, we would have been the world leaders in this technological segment.

## **Commercialization of e-rickshaws in India**

With our information available freely on the internet quite a lot of development effort on e-rickshaws was done in China. And as usual Indian entrepreneurs sometimes around 2010 started getting the whole e-rickshaws from China in knockdown conditions and assembling them in India. Very soon these Indian entrepreneurs found out that they could manufacture the body locally and import all other components like motor, batteries, controllers etc. from China. This led e-rickshaws, in early stages, becoming a footpath industry where small roadside workshops manufactured the bodies and fitted them with the imported motors, controllers, and lead acid batteries.

Even today the situation is not different. Most of the manufacturers make the rickshaw bodies here and fit them with imported motors, etc. from China. This is how the e-rickshaws manufacturing has proliferated in India. Even

big-name players manufacturing them only make better bodies but use imported motors, controllers, and fancy batteries (lithium-ion).

It is really sad that no R&D was ever done by the manufacturers. Even in 2000 we realized that with hub motors we could make the rickshaws lightweight and better controlled since there was no need of having differential drive for back wheels. Yet very little work has been done by Indian manufacturers in this regard.

Similarly the issue of battery design and its recycling remains a thorny one and no worthwhile R&D has been done on it. The same goes with motor and controllers design. With very limited resources we were able to pioneer the design and development of e-rickshaw in 1990s using only Indian-made components and feel that the resources that the big manufacturers have should have made them do better and achieve much more.

### **What needs to be done ?**

In order for e-rickshaws to become the main stay of urban and rural last mile transport system it will be useful if the following issues are addressed :

1. Excellent R&D is needed in India for making efficient electric motors in the range of 1-5 kW. Also needed is excellent R&D in designing efficient and recyclable batteries for small vehicles.
2. The above may take some time to develop. In the meantime there is a need to set up rickshaw pullers cooperative societies in different cities. These cooperative societies will do the following :
  - (a) Own the e-rickshaws and give it on hire as taxis.
  - (b) The society will be partially owned by rickshaws pullers and will help them in giving employment.

- (c) Will have a place to store them in a shed or warehouse and the roof of the housing with solar PV will charge the batteries of these rickshaws. This place can also provide shelter for out-of-town drivers.
- (d) This solar charging will help e-rickshaws become a truly sustainable transport system.
- (e) Society will also provide a mechanism to interact with the manufacturers to help in maintaining these rickshaws properly and to recycle batteries properly and in an environmentally sound manner.
- (f) Will also provide a place for battery banks to be replaced in rickshaws.

[HOME](#)

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