

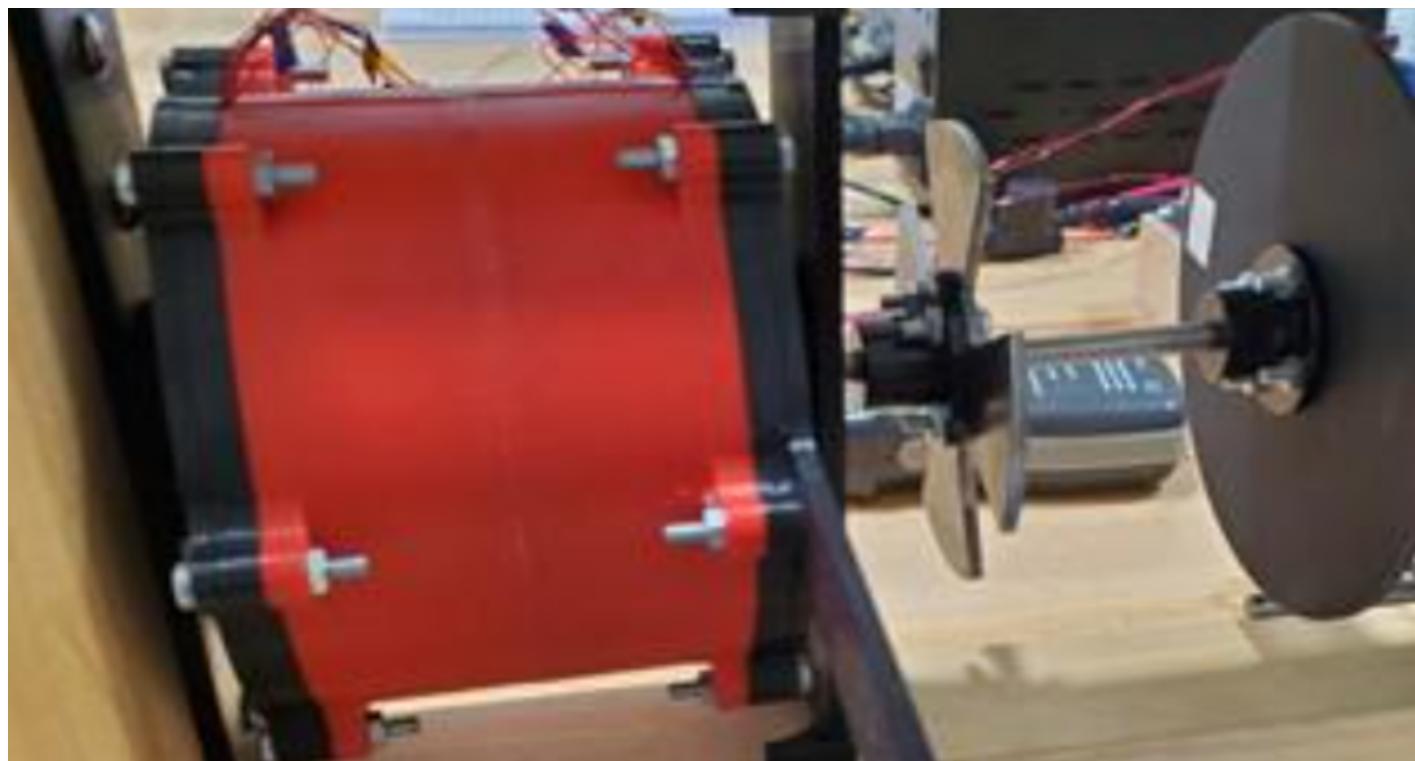


# YOUNG INVENTOR BUILDS MOTOR WITHOUT RARE EARTHS

by: Al Williams

44 Comments

August 12, 2022



[Robert Sansone] is a 17-year-old from Florida and, like most of us, he likes to tinker. He's apparently got the time for it because he's completed at least 60 projects ranging from animatronic hands to a high-speed go-kart. However, his interest in electric vehicles coupled with his understanding of the issues around them led him to investigate synchronous reluctance motors — motors that don't depend on expensive rare earth magnets. His experiments have led to **a novel form of motor** that has greater torque than existing designs.

Rare earths are powerful but expensive, costing much more than common metals like copper or steel. Traditionally, synchronous reluctance motors use steel rotors and air gaps and exploit the difference in reluctance — a term for magnetic resistance— to generate rotation. [Robert's] idea was to replace the air gap with a

different material to increase the ratio of reluctance between the rotor and the gap. Reconfiguring the motor to a more traditional configuration shows startling results: the new design **generated almost 40% more torque** and did so more efficiently, as well.

His work has earned him first prize, and \$75,000, in this year's Regeneron International Science and Engineering Fair. It took 15 tries to get the motor to its current state, something made easier with 3D printing. There are plans for a 16th version that [Robert] hopes will perform even better. We can't wait to see what he'll do next.

Electric vehicles have made people look into many **motor design topologies**. The reluctance motor has been around for a long time, but controlling them has become significantly easier. That's true of **many kinds of motors**.

**Robert Sansone, winner of the 2022 George D. Yancopoulos Innovator Award**



Posted in **Transportation Hacks**

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# 44 THOUGHTS ON “YOUNG INVENTOR BUILDS MOTOR WITHOUT RARE EARTHS”

**rewolff** says:

August 12, 2022 at 5:00 am

Currentl Synchronous reluctance motors run at 90+ percent efficiency.

When this guy claims a 37% improvement in efficiency... I call bullshit.

His measurements are wrong, he's measuring something different. Something.

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**Frankel** says:

August 12, 2022 at 5:27 am

Why so negative? Let us read this part:

“He found that his novel design exhibited 39 percent greater torque and 31 percent greater efficiency at 300 revolutions per minute (RPM). At 750 RPM, it performed at 37 percent greater efficiency. He couldn’t test his prototype at higher revolutions per minute because the plastic pieces would overheat”

At such slow speeds I can totally imagine it working good! Is it relevant for industrial use? Likely not, as you pointed out. But at least consider this could be useful for slow speed applications. Why do you refuse that a dielectric applied into it rather than air cannot work?

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**plus** says:

August 12, 2022 at 5:37 am

plus the sentence beforehand:

“Sansone tested his motor for torque and efficiency, and then reconfigured it to run as a more traditional synchronous reluctance motor for comparison.” I doubt, that his own motor in traditional configuration is running at “90+ percent efficiency”

## Reply

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**Johannes Burgel says:**

August 12, 2022 at 8:36 am

Exactly. He didn't compare his design to an actual commercial design, he compared it to his personal version of a “traditional” design. Since he himself points out how much of a difference even small variations can make, his “traditional” version might simply not have been very good.

Also I don't see any mention of third-party validation.

It's a good science project and pulling it off at this age is nice, but I do expect HaD authors to point these things out in the article and not simply repeat press claims.

## Reply

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**Foldi-One says:**

August 12, 2022 at 9:20 am

When it sounds like its the same design and build constraints its as apples to apples a comparison as you can get. If I came up with some really efficient new gate stack to make up a CPU or ASIC for a job but could only run it on FPGA or perhaps got help from a not hugely cutting edge fab house testing a ‘standard’ design and my new one on the same platform is as fair as it can get...

And under those conditions getting a dramatic improvement in performance is suggestive at the very least that the method has more universal merit – either in allowing lower tolerance in production of high spec motors, or improving the result when made with no expense spared...

Is it the full picture and superbly polished science? No, but cut the kid a break, he is a kid. Also you very very rarely get great

science without this quick and dirty but as fair as practical tests of daft ideas from bugger in the shed, as nobody puts a year or more of serious equipment, people, repeated testing and thus ultimately lots of money into it without some reason.

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### Anonymous says:

August 14, 2022 at 11:16 am

Rewolff has a point. Having been a ISF runner up, his win is truly hyped nowadays with it being run by corp sponsors: intel, regeneron, Honeywell, ibm, whomever sponsors nowadays. ISF is now a silicon valley “entrepreneur farm”. Back in the day I won by comparing radiation pressure between computer sim vs real experiment, mind that another contestant was a guy named Sergey doing something on NLP....

Hopefully this kid was awarded from a clear understanding of the scientific method (measure, test, analyze, compare, standardize) and a novel view of experimentation ... vs the potential claims of “revolutionary discovery” without good scientific method. Latter is the the silicon valley fake it til you make it attitude.

(steps off soap box)

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### Daphne A. says:

August 12, 2022 at 5:36 am

You did not understand the article.

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### miguel says:

August 12, 2022 at 5:42 am

I don't think he is claiming that. That is a "out-of-context" statement from the article, based on his presentation, that should be checked for details.

[https://projectboard.world/isef/project/etsd014—investigating-a-novel-electric-motor-design?utm\\_source=shareLink\\_share\\_82939](https://projectboard.world/isef/project/etsd014—investigating-a-novel-electric-motor-design?utm_source=shareLink_share_82939)

Slide #4: Methodology – Experiment 1. Bullet #2: "The design was modular so that it could be reconfigured as a more traditional SynRM design that could be tested for comparison."

Slide #7: Discussion – Experiment 1. Bullet #3: "The torque and efficiencies were quite low for the size motors that were tested due to limited resources. The particular values are thus of little meaning, but since both configurations were similarly constructed, the comparisons between them still hold their value."

So he is telling that these values are from the comparison of his motor to a "traditional" version of his own motor, that he admits is probably of little value about actual numbers if applied to more resourceful motors, but could be useful as confirmation of some improved efficiency.

In my opinion, @rewolff you should blame hackaday about the "clickbait" and give the guy claims some slack.

That said, I would expect that a 75.000€ prize would require from the winner enough info to replicate it, as needed by scientific method. If he keeps the info due to the patent, maybe the money should be provided by the future patent earnings instead. But well, its a private initiative so I guess they can give the money to whoever they want under the rules they want.

Anyway, kudos to the guy for all the work, and hope that the ideas of this are real, even if that is just to increment from 90+ percent efficiency to 91+ or 92+ ;)

And thanks for the comment @rewolff, since knowing the current industry "numbers" is also useful. I am noob on this.

Reply

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Sword says:

August 12, 2022 at 6:20 am

Pretty valid to compare his improvement to normal on the same setup.

Reply

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**Twisty Plastic says:**

August 12, 2022 at 6:46 am

Blame HaD? Or blame the reader for confusing the concepts of summary and source material. I mean what do you want, copy pasted full articles?

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**miguel says:**

August 12, 2022 at 7:31 am

Yes, reading again, looks like the article is also quite good explaining it:

“Reconfiguring the motor to a more traditional configuration shows startling results: the new design \*generated almost 40% more torque\* and did so more efficiently, as well.”

The sentence after the colon sounds a little clickbait if read alone, but it said in the first part about “Reconfiguring the motor to a more traditional configuration” so it is fair from Hackaday.

So sorry about deflecting the blame to Hackaday ;)

Anyway, in my opinion the title of the article could be more precise:

“Young Inventor Improves Efficiency of Without-Rare-Earths Motor” because the “build” part is nothing as remarkable. But at least the article has plenty of links to further check the context (as usual from HaD).

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**Elliot Williams says:**

August 17, 2022 at 11:03 am

I really think the thrust of the project is to play around with improvements on reluctance motors, and I think that's well captured in the title especially, but also in the text.

I'm pretty sensitive to clickbait too, and this one didn't trigger me, at least. :)

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**ZamboTN says:**

August 18, 2022 at 12:41 am

Yes, but if he created an engine with traditional design to compare and show that his new design is better, who tell me that he didn't deliberately create a bad designed traditional engine?

When you do comparison you should show you are better than the state of the art. As his slides suggested, he is claiming the targets are EVs, so he should compare to the most advanced reluctance motor built for that purpose, or at least the most sold.

Given the results presented, the level of approximation is too big to be meaningful, aka his evaluation is kind of worth not much more than flipping a coin (but in his defense, it often happen in academia too: when supposedly more trained grown ups submit poorly written scientific papers too).

**Reply**

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**Ben Carrington says:**

August 12, 2022 at 5:42 am

“Sansone tested his motor for torque and efficiency, and then reconfigured it to run as a more traditional synchronous reluctance motor for comparison.”

**Reply**

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**Steven-X says:**

August 12, 2022 at 6:45 am

I'm willing to be that wrong to with \$75,000.

And now he gets to go to pretty much the college of his choice (winning something like this will open doors to places like MIT)

**Reply**

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**dave says:**

August 12, 2022 at 9:50 am

and beer and hookers.

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**Brett Head says:**

August 12, 2022 at 9:35 pm

Yes agreed. Figures can be fudged up or down. I say don't believe it until it's repeated in the real world ( on road testing)

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**Catnip says:**

August 13, 2022 at 6:13 am

You realise that percentages are not additive?

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**Neanja says:**

August 15, 2022 at 12:59 am

When the base of 90% result is kinda close to adding (everything over 11.11 goes over 100. If you were to add, everything over 10 goes over 100)

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**Marvin B says:**

August 13, 2022 at 6:44 am

You sound like a "very closed minded person", and you're obviously envious and jealous. This isn't the first time a young mind has done something great. Get over yourself.

[Reply](#)[Report comment](#)**Randy says:**[August 13, 2022 at 12:12 pm](#)

Good for the young lad, at least he is trying to learn and improve his skills!

[Reply](#)[Report comment](#)**Dalton says:**[August 16, 2022 at 9:13 pm](#)

Not 1 person in these comments has attacked the kid for his achievement, they've only called attention to the sensationalized nature of the 'revolutionary and transformative' claims implied by the completely ambiguous efficiency measurement. And what's wrong with a website trying to get clicks anyway? You should really ask yourself why it makes you so upset, without even having a technical understanding of the point they're making, that you'd go out of your way to attack our fellow readers just for pointing it out.. The work the kid is doing is truly impressive regardless, and not a single person has said otherwise. I can't understand why \*You\* are so upset?

[Reply](#)[Report comment](#)**Jason Belec says:**[August 12, 2022 at 5:32 am](#)

At least he's trying...

[Reply](#)[Report comment](#)**Piotrsko says:**[August 12, 2022 at 7:55 am](#)

Annnnd: he has impressed enough people to have his name associated with prestige.

[Reply](#)[Report comment](#)**Jan says:**[August 12, 2022 at 11:06 am](#)

Not many kids of his age are interested in this field of technology. I really like his persistence in making it work and then making it work better in various iterations. How cool that he won an award with it. Really cool!

[Reply](#)[Report comment](#)**Sven says:**[August 13, 2022 at 1:38 am](#)

Well funny how people think rare earths are rare. They are not at all. Its just that child labor is used to obtain them...

[Reply](#)[Report comment](#)**Ostracus says:**[August 14, 2022 at 11:25 am](#)

And 17 years olds to build them. ;-)

[Reply](#)[Report comment](#)**Murray says:**[August 15, 2022 at 4:33 am](#)

Not rare, but rare in an unalloyed, usable form.

[Reply](#)[Report comment](#)**RustyShackleford says:**

August 12, 2022 at 11:38 am

Uh-Oh!

Just hope the rare earth moguls don't put out a contract on this kid.  
Remember Stan Meyer and the water powered car.  
(Only half kidding.)

Reply

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**AKA the A says:**

August 13, 2022 at 12:02 am

induction motors are a thing and are actually being used in some EVs...

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**Brett Head says:**

August 13, 2022 at 12:13 am

Yeah the water car hoax...

Reply

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**Comedicles says:**

August 12, 2022 at 1:16 pm

This situation seems kind of unique. Did the judges have to sign non-disclosure agreements in order to evaluate the invention? How do you get them to do that in a competition? How do the other entries know what beat them? It sounds like an invitation to litigation.

Reply

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**Daniel Matthews says:**

August 12, 2022 at 4:34 pm

Rare earth elements are not actually rare, and the limit we will hit due to EVs and robotics is peak copper. I could not see where the guy proved that the design is novel, but top marks for methodology otherwise.

[Reply](#)[Report comment](#)**Conor Stewart says:**[August 13, 2022 at 3:39 am](#)

If this is really something new or great, then it needs properly manufactured and compared to a properly made synchronous reluctance motor. Then you can compare efficiency and torque between two properly made motors, not between a single 3D printed motor that can be configured as both, there is nothing to say that his motors are actually any good, he may only be achieving 10 % efficiency for all we know and then a tiny increase in efficiency seems a lot. I'm still not convinced. This does need tested against a commercial motor of the same power to see if it actually is an improvement. If it's getting hot enough to melt the plastic then it probably isn't that efficient.

[Reply](#)[Report comment](#)**James R Beavers says:**[August 13, 2022 at 4:35 am](#)

I hope someone invents a lawnmower without Grand Funk Railroad.

[Reply](#)[Report comment](#)**H. Hubert Dreiling says:**[August 13, 2022 at 8:04 am](#)

What is really new?

The first Tesla Roadster did not need any rare earth metals, no magnets. But only permanent magnet motors need rare earth elements like Nd. But many electric cars, like Tesla model X and 3 use standard induction motors.

[Reply](#)[Report comment](#)

**Göran Andersson says:**

August 16, 2022 at 8:17 pm

Almost correct.

Roadster, early Model S/X before 2019 did NOT use rare earth metals.

Model 3/Y and newer Model S/X use rare earth metals.

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**John F Bramfeld says:**

August 13, 2022 at 9:36 am

I think a comparison to rare earth motors would have been instructive.

**Reply**

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**Drone says:**

August 14, 2022 at 1:06 am

Synchronous Reluctance Motors (SRMs) today are highly efficient, and with sophisticated control systems they can be fairly powerful. Not as quiet, fast, or powerful as motors that depend on rare-earth permanent magnets though.

I doubt there are major gains to be discovered these days when it comes to SRMs. It is their drawbacks that keep them out of modern electric vehicles. There is a lot of vibration (hence noise) from torque ripple which lowers maximum useful speed, and lower magnetic saliency compared with rare-earth permanent magnet motors. Multi-rotor designs can help overcome some of the SRM drawbacks, but they get very complex (hence expensive and failure-prone) to control, especially at high speeds. But then again, rare-earth permanent magnets are very expensive because of material costs and the fact they are tied up with China (more on this below).

I wish [Robert Sansone] all the best in his investigations. But color me skeptical, for now.

Perhaps [Robert] should spend a bit more time working on the theory of what he's trying to do instead of building prototype motors. Simulating the work can be an invaluable time saver compared to banging around in the laboratory. (I mean really, you're on prototype motor #16 today [Robert]?). The Finite Element Method Magnetics simulator (FEMM) [1] is free, runs natively in Windows and under Wine in Linux and looks like it may work for

applications like this. Very powerful electromagnetic – electromechanical simulators are available but cost many thousands of dollars per seat just to rent and will require a workstation-grade PC to host it. Ansys Maxwell [2] and EMWorks [3] come to mind, there are plenty more out there. Perhaps [Robert] can approach one of these companies and see if they will allow him access for free. At worst the simulations may prove he's chasing a rabbit down a bottomless hole. If that's the case he won't end up wasting years of his time.

Then there's China. (These points actually make the case FOR [Robert]'s success.) Much of what constitutes the rare-earth magnets used in today's electric vehicle motors comes from or via China. Reluctance motors will really take off out of necessity if we (God forbid) end up at war with China. But then there's the Taiwan factor. Most of the electronics needed to control sophisticated synchronous reluctance motors comes from Taiwan. So there's a good chance we'll lose that too if things go south with China. If you can't control them to begin with, what's the point in shifting to reluctance motors to avoid Chinese rare-earth magnets?

\* References:

1. FEMM – Finite Element Method Magnetics Simulator

<https://www.femm.info/wiki/HomePage>

2. Ansys Maxwell

<https://www.ansys.com/products/electronics/ansys-maxwell>

3. EMWorks

<https://www.emworks.com/product/EMS>

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**Matt says:**

August 15, 2022 at 10:57 am

Tesla uses a variation of the SynRM in one of their designs. It operates on the same principle but uses magnets to help deal with some of the problems of a traditional SynRM. <https://uk.motor1.com/news/462107/video-tesla-model-3-electric-motor-explained/>

IIRC, there were some complaints about things like torque ripple when the motor first entered use in the model 3 as a budget option. I don't know if they have been able to work around those issues with software.

[Reply](#)[Report comment](#)**Mark says:**[August 14, 2022 at 12:58 pm](#)

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[Reply](#)[Report comment](#)**Elliot Williams says:**[August 17, 2022 at 11:07 am](#)

Got it. Sorry about that.

[Reply](#)[Report comment](#)**Centurion says:**[August 14, 2022 at 1:16 pm](#)

"can't disclose any more details because he hopes to patent the technology in the future."

How far with come in science to win awards without showing what's you actually did. I thought science was about sharing/open information?

[Reply](#)[Report comment](#)**Sparks says:**[August 14, 2022 at 2:11 pm](#)

You are all missing the point. What is important in this work is the principle of increasing the differential in reluctance. The rest of your comments are noise. I think he is on to something that if properly developed can lead to a significant improvement in motor technology

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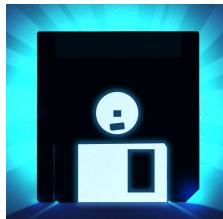
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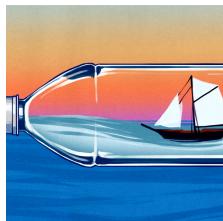
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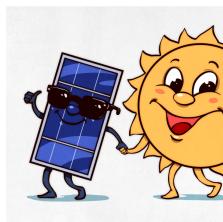
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