eyeRow

Design Journal

By Dylan Sury

Year 7

Redeemer Baptist School

eyeRow

Year 7 Science Project by Dylan Sury

February 18, 2013

The problem-

The best way of coming up with an invention is to think of a problem that needs to be fixed. Mum and Dad suggested the problem of not being able to see where you are going when rowing a rowboat.

“Where am I going?! I’m rowing my boat on a lake but I can’t see where I’m going because I’m rowing backwards.”

One of my ideas that I came up with was to change the action of rowing to forwards rowing by pushing your arms forward with the oars in the water rather than pulling. That way the boat would move forward. But the problem with that is rowing forward is weaker than rowing backwards because you are using different, smaller and weaker muscles to do the power stroke. The muscles used for pulling; upper back, shoulders and thigh muscles are much stronger than the muscles used to push.

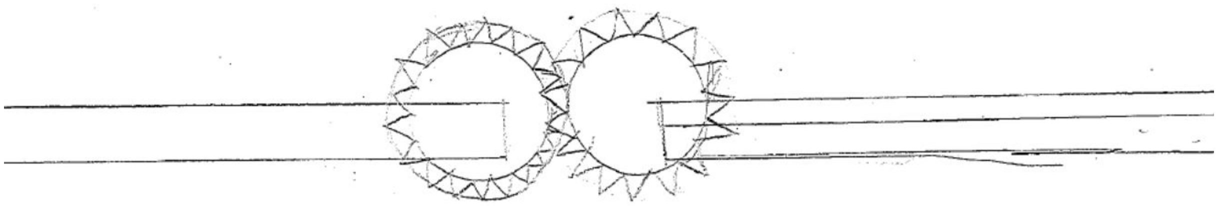
I tested this out by trying to push my Dad over and then pulling my Dad over. The result of this test was that pulling wins.

I realised that I would need to come up with a way of rowing forwards while still using the backwards-rowing movement so that we can still use the bigger, stronger pulling muscles.

The next idea I thought of was a reversing camera like what is used in 4 wheel drive vehicles. The problem with this is that looking at a camera in front of you while moving backwards can be confusing for the mind. Also, the camera view won't give you any peripheral vision so you won't see what is coming up beside you if it is outside the viewing of the camera. Another thing is that the sunlight will reflect off the screen so you can't see what is going on when you are in bright sunlight.

It was then that I realised that I should put a hinge in the middle of the oars to split them. The problem with that is that the hinges would just flop around. When the end of the oar is in the water only the end in your hand will move. So a hinged jointed oar won't work.

Then I thought of geared oars. The oars would be cut at the point where they attach to the boat and a gear would be attached to each of the cut ends. The gears would then mesh together. That way when the handle end is pulled backwards, the end in the water will move backward as well, pushing the boat forward.



March 5, 2013

To help me understand more about how gears work Mum bought me a game called KogWorks by Dr. Wood. I used this to understand the way meshed gears change the direction of movement.

March, 2013

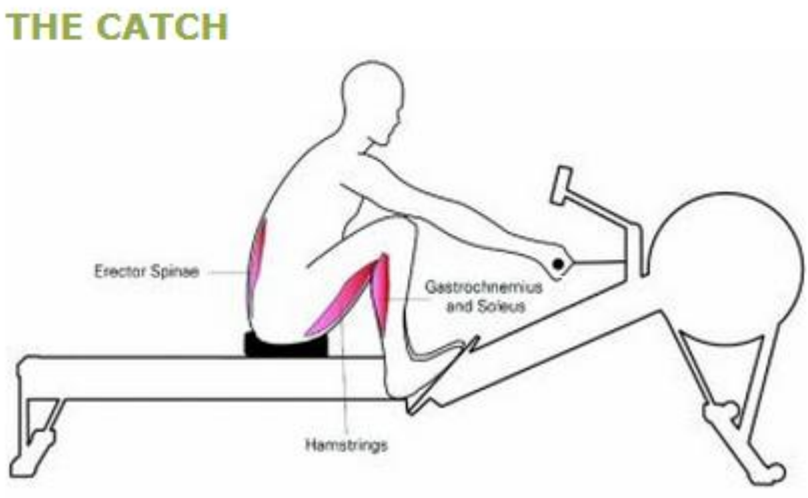
Mum helped me research why we row backwards.

Why do we row backwards?

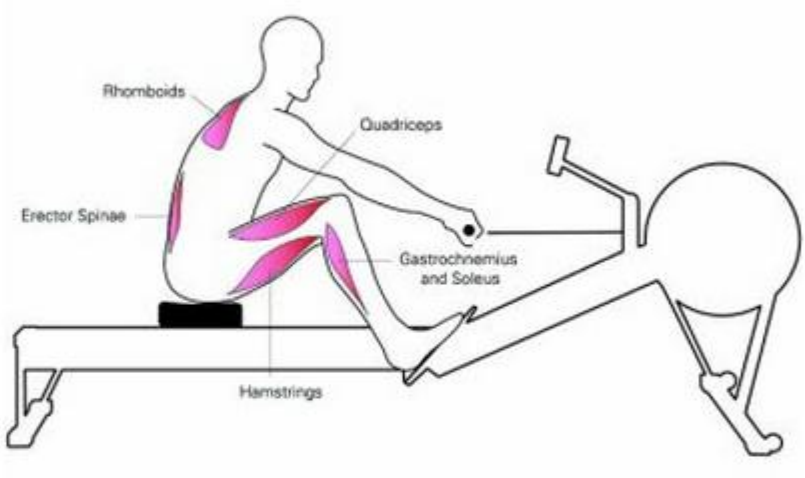
The Biomechanics of rowing

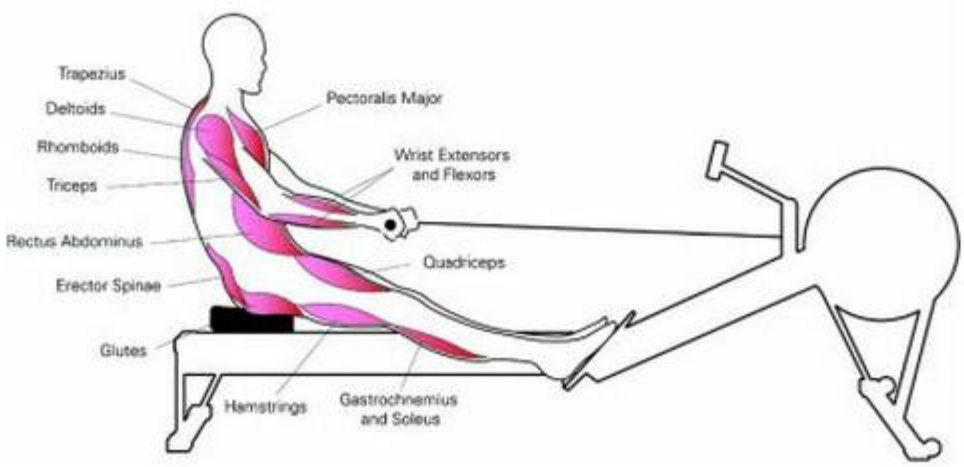
We row backwards because we are stronger and can deliver more power with a pull stroke than a push stroke. Standard oars in a row boat push the water to the back of the boat with each pull stroke on the oars. This pushes the boat forwards as the rower faces the back of the boat.

The images below show the 3 stages of the rowing action; the catch, the drive and the finish. It also shows the muscle groups that are used in each stage.

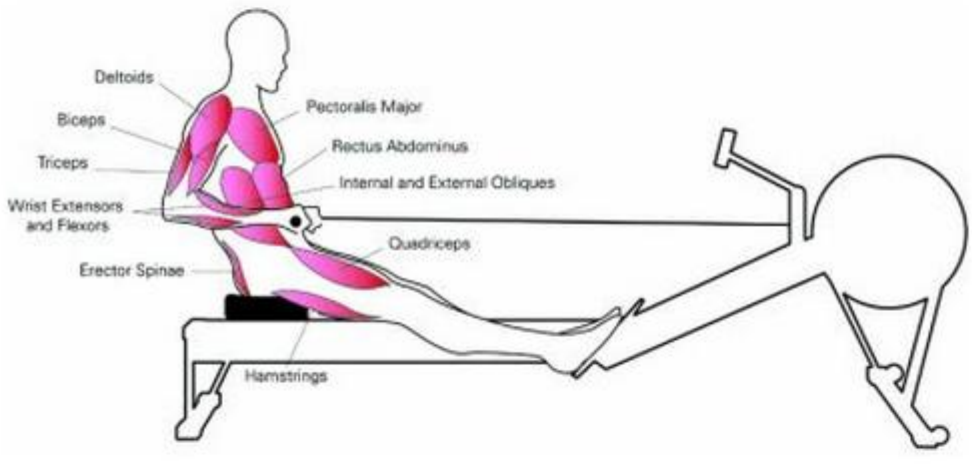


THE DRIVE



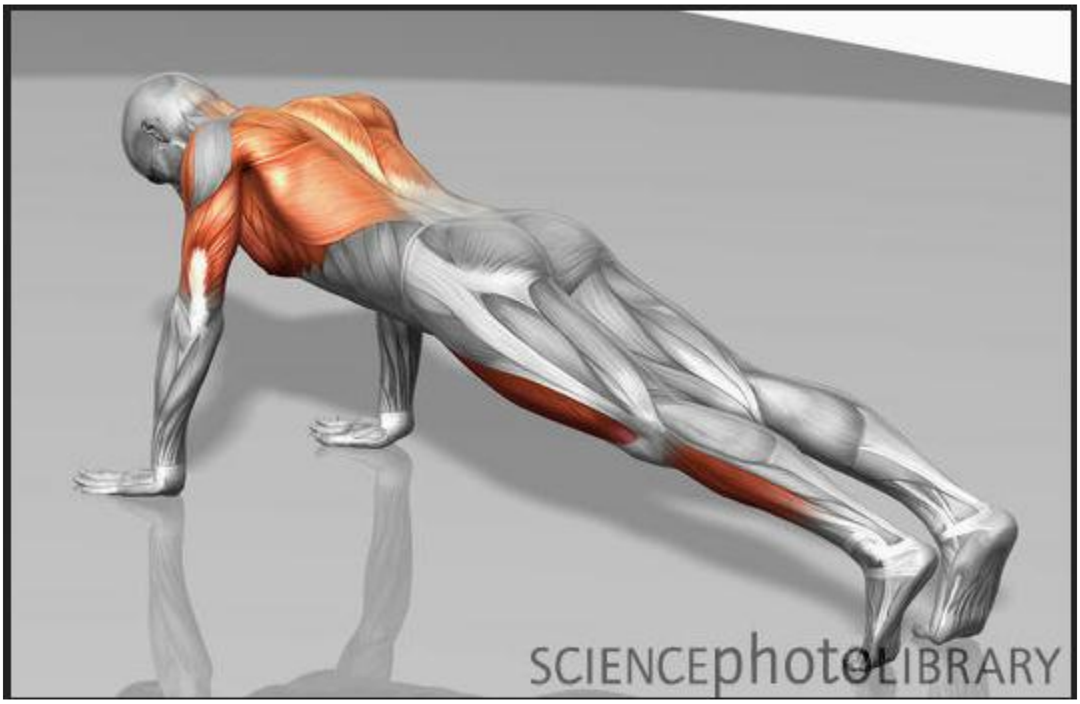


THE FINISH



As you can see from the images above, many very large and powerful muscles are used in the rowing pull stroke. In particular the thigh muscles are especially strong and are used in the drive. Rowing with a pulling action uses a lot of different muscles which spreads the load, or the work, across more working muscle groups. Sharing the work of rowing across more muscle groups reduces muscle fatigue and lets you row for longer.

The push action as shown below uses mostly upper body muscles which generate less power and are quicker to fatigue.



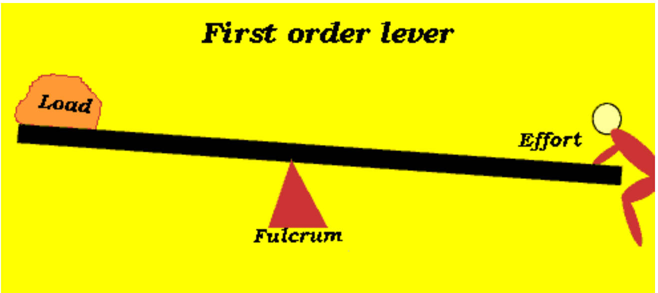
April, 2013

While researching about rowing I learnt that an oar is a type of lever – a 1st order lever. So we did some research on levers.

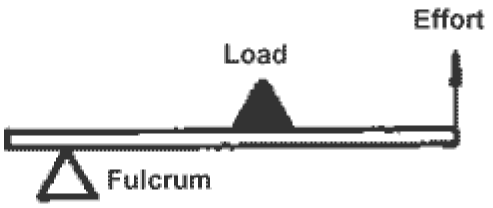
Physics of Levers

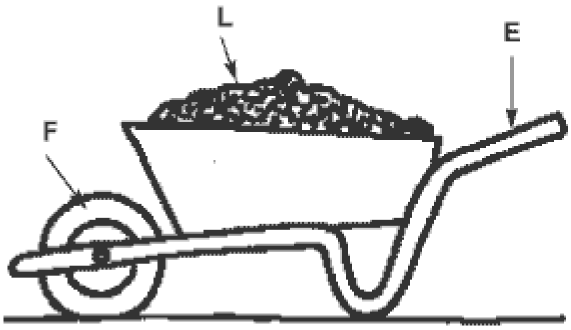
There are 3 classes of levers:

1st Load – Fulcrum – Effort (example see-saw)

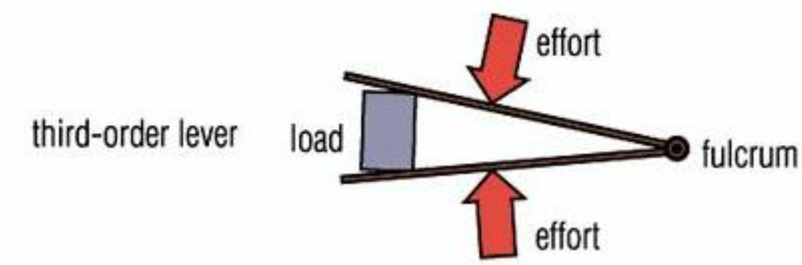


2nd Fulcrum – Load – Effort (example wheelbarrow)





3rd Fulcrum – Effort – Load (example tongs)



When sitting in a row boat the oar acts as a 1st class lever. The fulcrum is the pivot point where the oar is attached to the boat. The load is the force of the water against the paddle. The effort is the part you interact with. For an oar this is the handle that the rower pulls on.

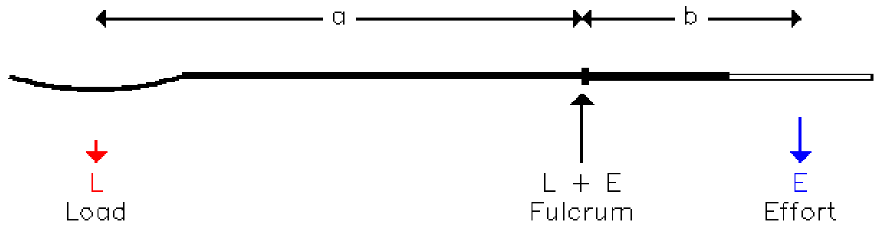


Figure (7.1)

Imagine if you could face forward as you row while still having the power of the pull stroke.

Forward rowing systems that already exist

Gig Harbor Boat Works

Oar doesn't go forwards enough,

It appears to be dangerous with pinch points that you could get your finger caught in.

The design looks too weak,

There is too much movement where energy could be lost,

The design is too complex,

It is too confusing when turning

And the price is too expensive at $804

The beam-extending "wings" in use on a canoe.

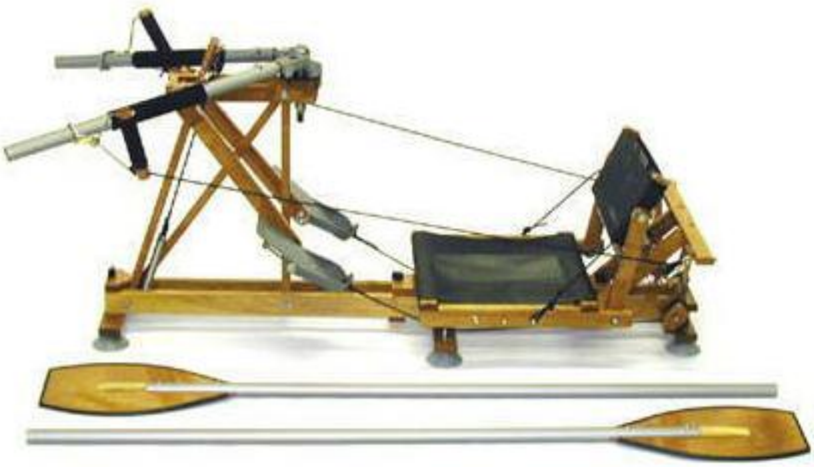
Ron Rantilla front rowing system

Too complex

You have to have a big enough boat

It's hard to use

It uses a lot of energy because it is a third order lever, requiring both arms and legs to row



My solution

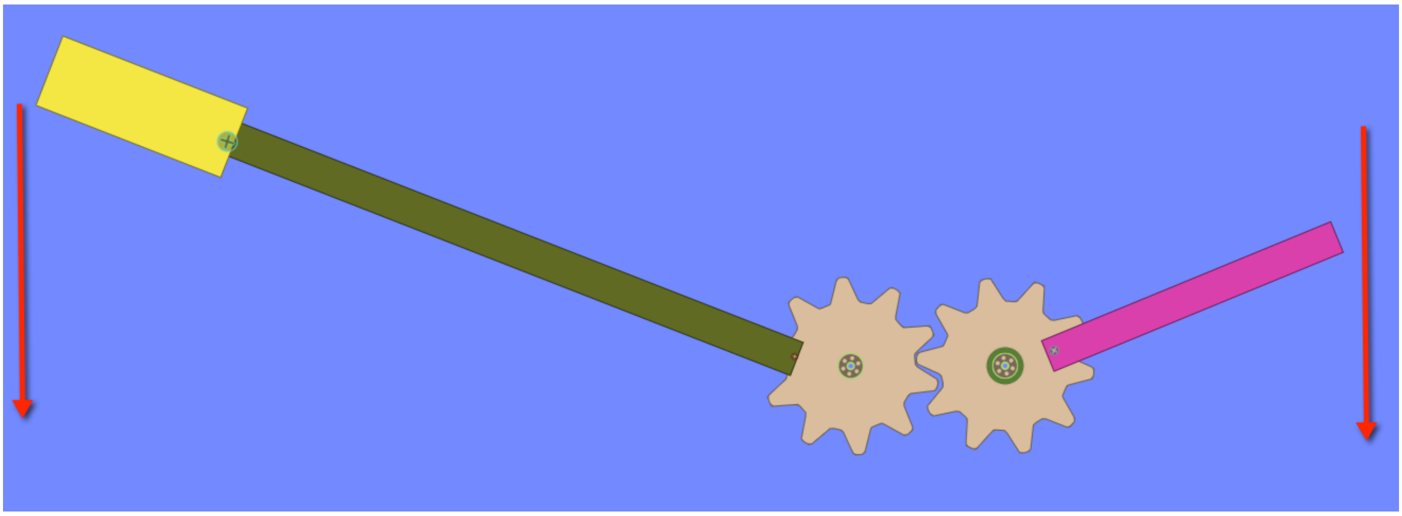
My solution is a double 1st order lever with the fulcrums at the centre of each gear.

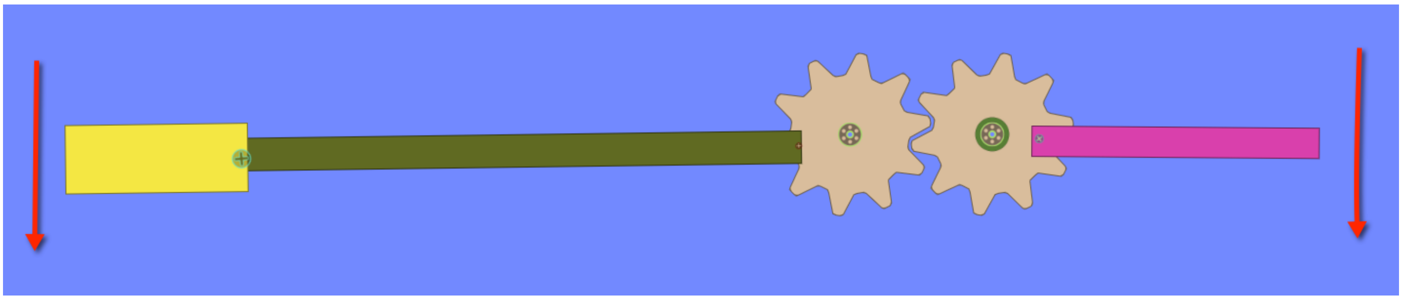
July, 2013

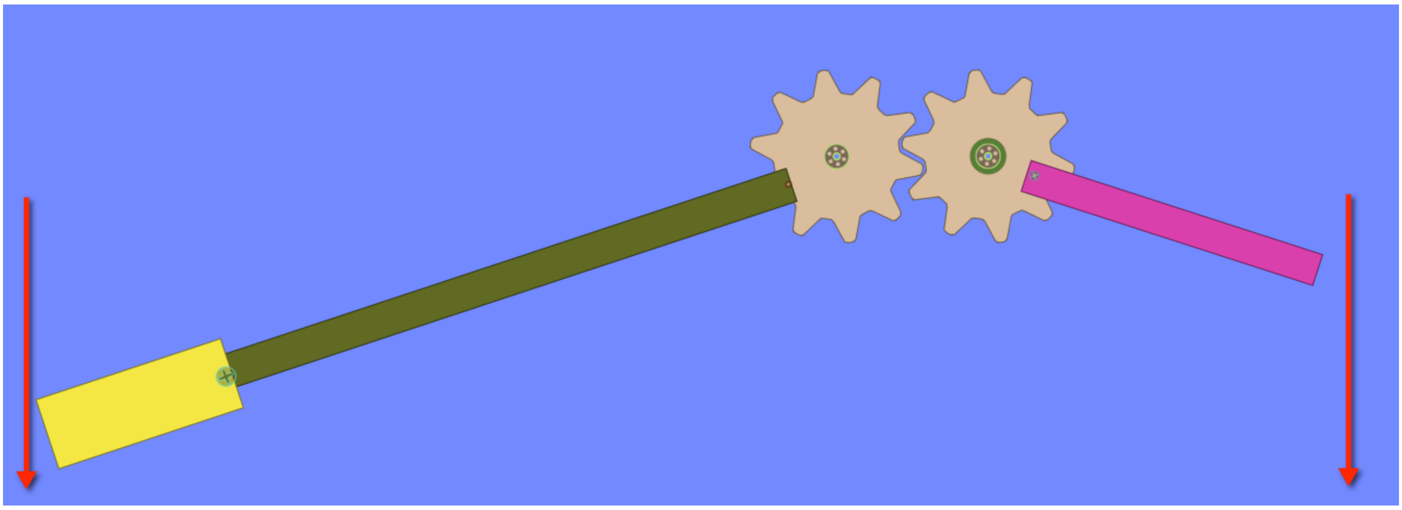
My Design

My design is simpler involving two gears. One is attached to one section of the oar and the other attached to the other length or oar.

I used a program called Algadoo to show how my design would work. The pictures below show the oars in 3 different stages of the rowing action.







August, 2013

Front Rowing Oar – Construction of Prototype

It is not practical to build a full sized front rowing oar:

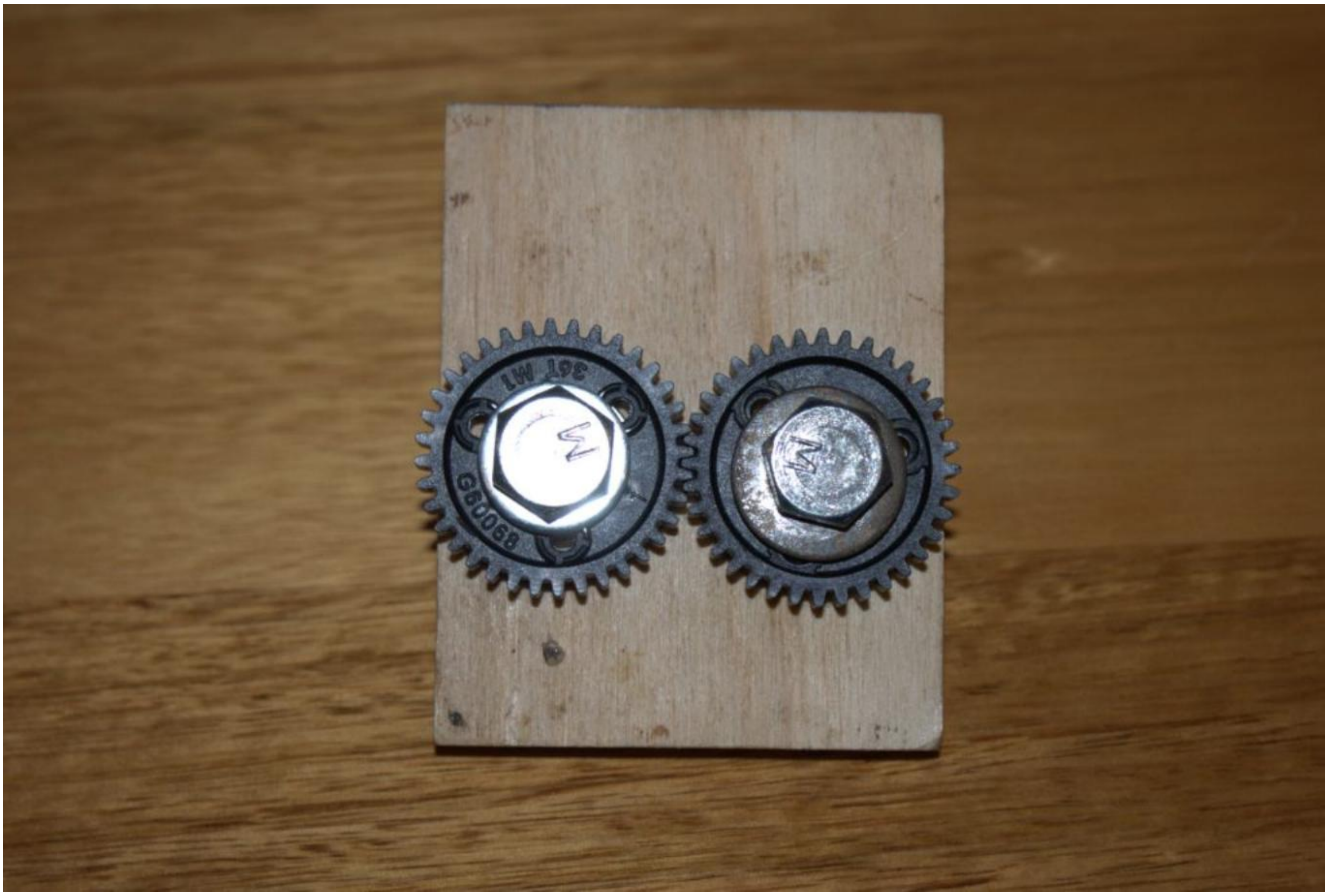
- It would be very large and difficult to bring into school
- It would take a much longer time
- It would cost a lot of money due to expensive materials
- It would require tools we don't have

I am going to build a small demonstration on what my design will do. The materials I will use are a timber mounting block, 2 plastic gears with a diameter of 50 mm, 4 galvanised steel nuts, 8 washers, 2 galvanised steel bolts, an aluminium bracket and wooden dowels as oars.

The real front rowing oar would need to be made of materials that can resist exposure to water and especially salt water. The gear system would need to be contained in a waterproof housing full of grease to keep it lubricated.

The materials would also need to be strong enough to be able to cope with the force of rowing. This would mean the gears and housing need to be made of metal.

Dad bought a pair plastic gears from a hobby shop and bolted them to a wood block to test the idea.



This prototype worked well and taught us how to improve the design to make it better. To improve the design we used different gears with smaller axle bolts to have more room for the oar to fit on

Risk Assessment

The construction will require the use of the following tools and materials whose hazards have been listed below:

- Drop saw – very sharp fast moving blade
- Angle grinder – very sharp and exposed blade and sanding disc
- Cordless drill – drill bit is sharp and gets hot
- 2 part epoxy and PVA glue – toxic materials that can stick skin together
- Pine – rough edges can cause splinters

Safety precautions

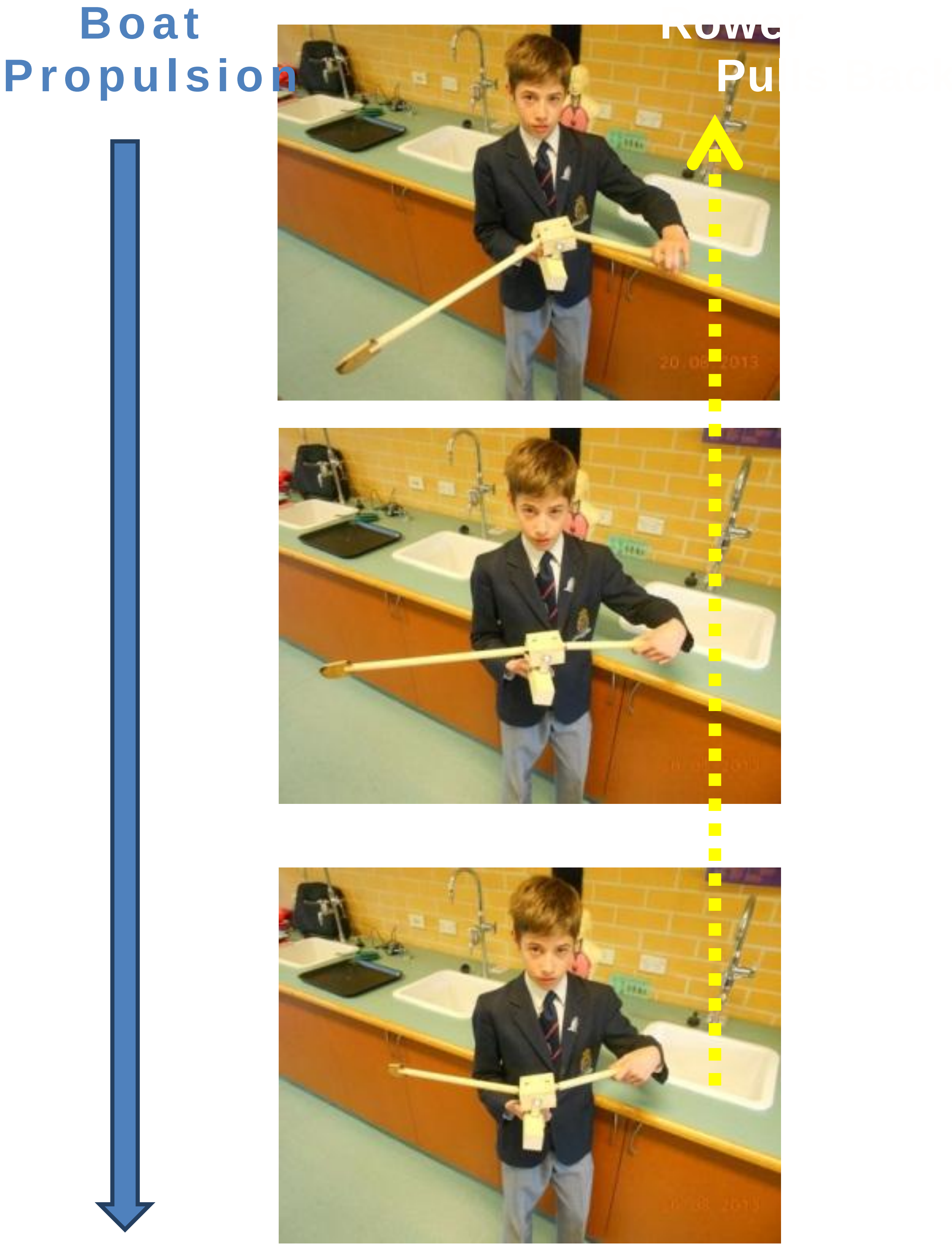
- Use a tidy and clean work surface
- Ensure power tools are in good working order and cords are not trailing on the ground
- Use gloves to protect from splinters
- Use latex gloves to protect skin from glue
- Wear safety glasses when using a drop saw or angle grinder
- Put tools away when finished with them
- Get Dad to do the work involving power tools

My model


WORLD

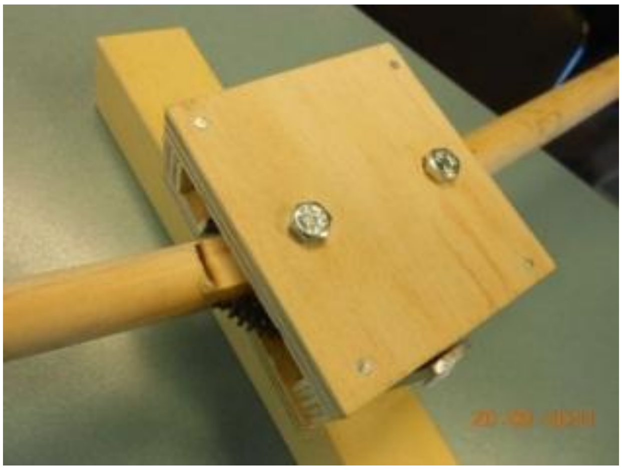
How the model moves:

As the rower pulls back on the section of the oar in the boat, the section of the oar in the water pulls back on the water, propelling the boat forward in the same direction that the rower is sitting.



How the model works:

2 identically sized gears are arranged in tandem so as one spins clockwise, the other spins in the opposite direction.



Each gear is connected to the two different sections of the oar. The gears are positioned inside a protective housing that would be positioned on the edge of the boat. A cradle supports the housing and allows for the additional movement to lift the oar out of the water for the return stroke.

I think my model demonstrates the idea very well. I think this design will work best for pleasure rowing. You can see where you are going when you are rowing, making it more enjoyable when you are rowing on a sightseeing trip down the river.

Evaluation and Testing

August 19, 2013

When I finished my model, I took it to school to show my teacher Ian Cannon. He was really impressed and told the Young Scientist teacher, Mr Garth about it.

August 20, 2013

Mr Garth had a look at my project and got me to explain how it works and how I came up with the idea. He told me that he will help out by getting some photos and emailing rowing associations for some feedback and evaluative comments. He sent emails to NSW Rowing, Rowing Australia, Sydney Regatta Centre, Rowboat manufacturers and he also tried to get in contact with some past Olympians especially Kim Crow and Drew Ginn. Kim Crow is a lawyer in Canberra and so he sent an email to the firm to pass it on to Kim.

August 20, 2013

Mr Garth received an email back from Chris O'Brien, the high performance coach with Rowing Australia who passed the information on to Drew Ginn.

On 21/08/2013, at 11:38 AM, Stuart Garth
stuart.garth@redeemer.org.au> wrote:

Dear Mr O'Brien,
I have a student from our school, Dylan Sury, Year 7, who has designed and made a working model of a rowing oar that allows the rower to face the direction in which they are travelling while using the same rowing action. He has designed this invention so a rower can actually see where he is going and also keep a visual of his competitors, without compromising any speed. He is entering this into the NSW Young Scientist Awards in the Models and Inventions category.
Last year a Year 11 student from our school came second in Australia with a model that alerts the public to the presence of a child left in
a car. I have attached a 2-page document showing Dylan and his project.
As part of his entry, due this Friday, Dylan needs some evaluative feedback of his design. Would you or anyone else involved with rowing be able to write a few words of feedback, either positive or critical, on his idea or concept in the next few days. For instance, have you heard of any similar inventions.
Would you please be able to forward this onto Drew Ginn or any other Olympic rower for some feedback, which would be fantastic.

Yours Sincerely,
Stuart Garth
Science Competition Coordinator
Redeemer Baptist School
North Parramatta
0407295829
On 2013-08-21 13:18, Chris O'Brien wrote:

Stuart,
Thank you for your e-mail. I have copied Drew Ginn in on this request. Is it possible for you to send some further information? Sounds interesting but I am operating on my iPad and the document provided does not seem to be formatting or showing up anything in detail.

regards
Chris
Chris O'Brien
National High Performance Director
National Rowing Centre of Excellence
Australian Institute of Sport | Rowing Australia

My Dad contacted a colleague at work, Barry Radburn, who rowed between 1977 and 1989, representing NSW in 1979 and was Nepean Rowing Club Captain between 1988/89. Barry looked at the model and his thoughts are below.

Interesting concept.

Re the sport of rowing, I'm not sure how important it is for an oarsman to face forward as the course is straight and has lane markers that allow you to stay on target efficiently. Also, facing to the rear allows the oarsman to monitor any attacks by boats in the rear.

I think Dylan needs to consider the principle design of a racing shell and the seat slide system which allows maximum leg-drive which delivers 80% of the energy in each sweep of the oar, with the remaining 20% balance between shoulders and arms at the end of the stroke. An important aspect at the end of each stroke is the oar's release which involves a drop and twist technic with the wrists that may be hampered by the gear system. Furthermore, the current carbon fiber blades are designed with enough flex to add additional force at the end of each sweep which I suspect Dylan's system may compromise.

In conclusion, Dylan's system would require a whole new ergonomics to ensure maximum output in racing.

That said however, I believe Dylan's current system would be worth exploring smaller, slower pleasure boats, dinghies and fishing kayaks/canoes that would benefit facing forward. He could also consider gearing ratios that may produce a greater sweep through the water with less energy from the rower.

Stuart Garth contacted Drew Ginn from the Australian Rowing Team, showing him my design and his comments are in the email below.

From: Drew Ginn <drew.ginn@rowing.ausportnet.com>
Date: 22/08/2013 10:02 (GMT+10:00)
To: Chris O'Brien <chris.obrien@rowing.ausportnet.com>
Cc: Stuart Garth <stuart.garth@redeemer.org.au>
Subject: Re: Student rowing invention

Hi Stuart
Great to see Dylan’s design. It’s simple and looks to solve a key challenge in the sport of rowing. Being able to see where you are going could be very helpful. Particularly on busy waterways. The design also achieves another key element to our sport that is the use of leverage. Its great to see Dylan looking proud of his design and I do wonder how he could continue to enhance it. Other materials would need to be used to ensure strong enough. If the design was made to work on a boat the length and strength of the equipment.
Great to see.
Drew Ginn
Australian Rowing Team
National Head Coach

Athlete profile
Drew Ginn

9 World Championships, 3 Olympic Games

- 2011 World Rowing Championships – BRONZE MEDAL men’s four
- 2008 Beijing Olympic Games – GOLD MEDAL men’s pair
- 2007 World Rowing Championships – GOLD MEDAL men’s pair
- 2006 World Rowing Championships – GOLD MEDAL men’s pair
- 2004 Athens Olympic Games – GOLD MEDAL men’s pair
- 2003 World Rowing Championships – GOLD MEDAL men’s pair
- 2002 World Rowing Championships – 4th men’s pair
- 1999 World Rowing Championships – GOLD MEDAL men’s pair
- 1998 World Rowing Championships – GOLD MEDAL men’s coxed four, SILVER MEDAL men's pair
- 1997 World Rowing Championships – BRONZE MEDAL men’s eight
- 1996 Atlanta Olympic Games – GOLD MEDAL men’s four
- 1995 World Rowing Championships – 11th men’s eight

August 21, 2013

From: Tim Murdoch <tim@rowingvictoria.asn.au>
Date: 22/08/2013 15:15 (GMT+10:00)
To: stuart.garth@redeemer.org.au
Subject: RE: Student rowing invention

Hi Stuart,

What a great idea from such a young inventor! As you may be aware there has been very little development in the way the sport 'works', apart from technological advances in the materials used to construct boats and oars (ie carbon fiber), so young inventors like Dylan is exactly what this sport may need in the future.

There have been a couple of similar inventions, which I have seen before. One which came to mind straight away I have attached a link to the youtube video.
www.youtube.com/watch?v=mtfst5fqUdE

One advantage of this system that is immediately identifiable is the feathering, or turning, of the actual blade, which is a fundamental component to rowing fast.

Additionally, another invention which I have personally used is the 'ergo bike', a cross between a bike and a rowing machine (ergometer). This was designed by a bio mechanist and an engineer from the University of Western Australia as a concept to facilitate more specialised cross training for elite rowers. While everything worked from an engineering and bio mechanics point of view when the 'ergo bike' was stationary, a major issue came when experienced rowers tried to ride the bike. The sensation of moving forward while 'rowing' felt unnatural and 'messed with the heads' of athletes. Having personally tried the bike myself, I can attest to the fact that for a seasoned rower, it is an uneasy feeling to move forward instead of backwards, especially at the speeds that this bike could quite easily get up to!

Sorry to sound like we are pouring cold water on the idea, however I strongly encourage Dylan to keep at it! We need young innovators like him if we want to remain competitive in sport.

Kind regards,

Tim
Tim Murdoch
Club Development and Education Coordinator
Rowing Victoria

Future Developments

- Build a larger working model to demonstrate on a small rowing boat.
- Research suitable materials that would offer corrosion resistance and the required strength.
- Design a proper mounting system that allows for easy oar removal from the boat for transportation.
- Investigate the benefits of different gears to obtain mechanical advantage.

Bibliography

Rowing images

http://www.concept2.com.au/products/indoorrowers/muscles.aspx

Push up image

http://raymondonyango.com/tag/range-of-motion/

Gig Harbour Boat Works

http://www.ghboats.com/options/accessories/forwardrow/

Ron Rantilla Front Rower

http://www.frontrower.com/frontrower.htm

Acknowledgements

My Mum and Dad helped me with the research required throughout this project.

My Dad helped me construct the model and instructed me on the safe use of various power tools required to complete the model..