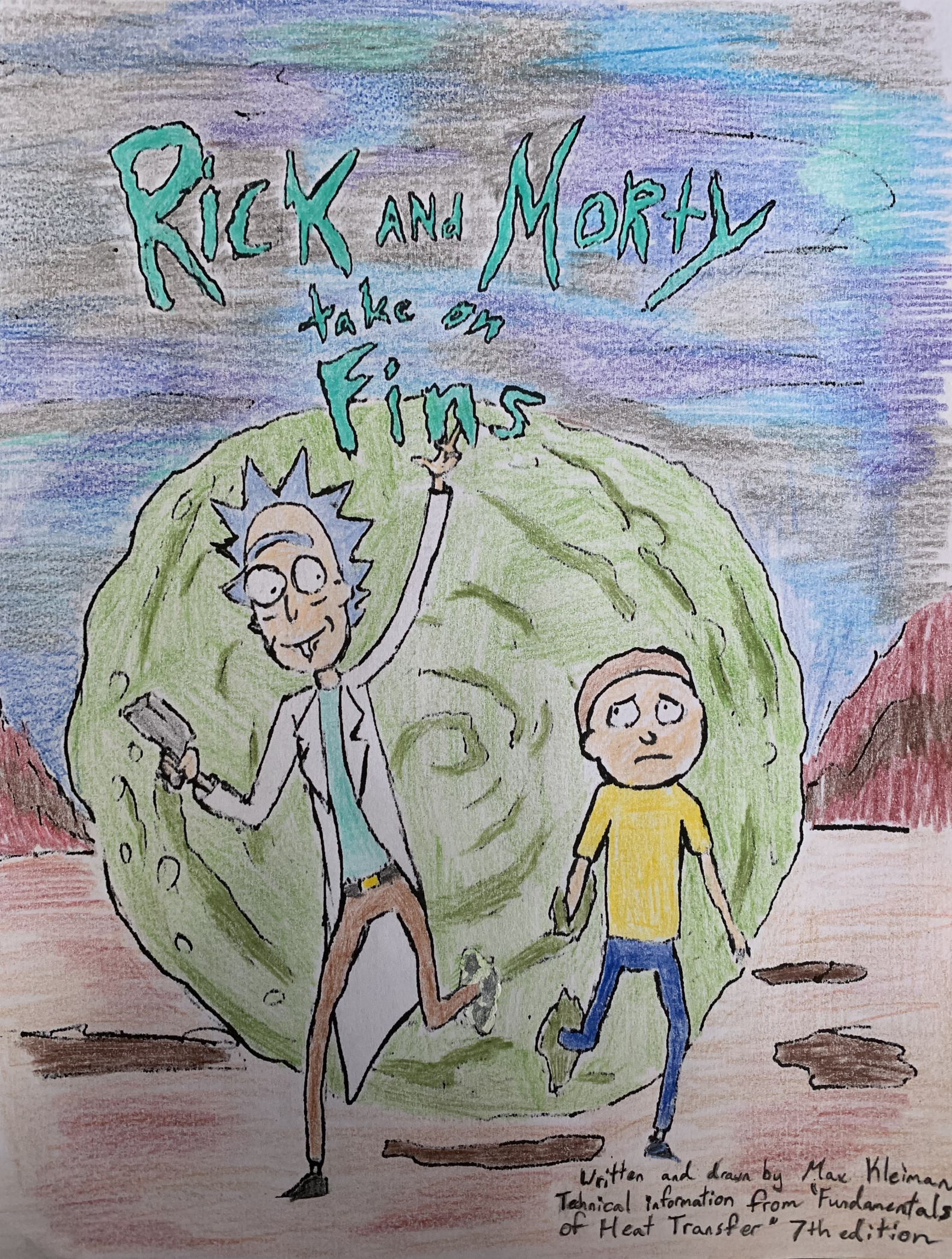
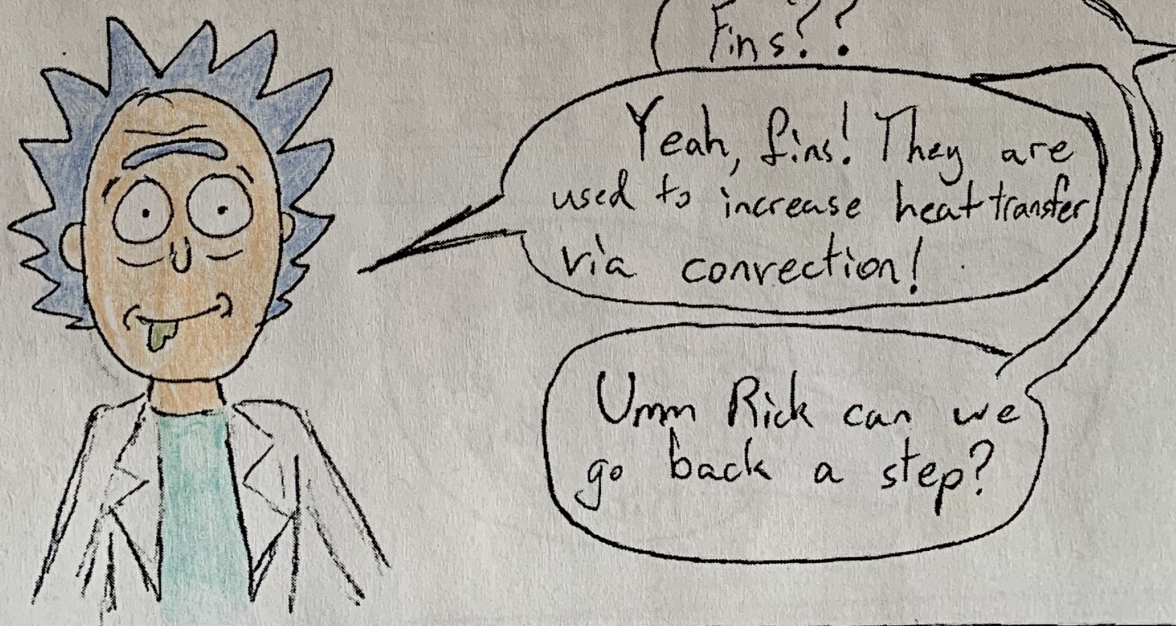

Rick and Morty
take on
Fins
Written and drawn by Max Kleiman
Technical information from "Fundamentals of Heat Transfer" 7th edition

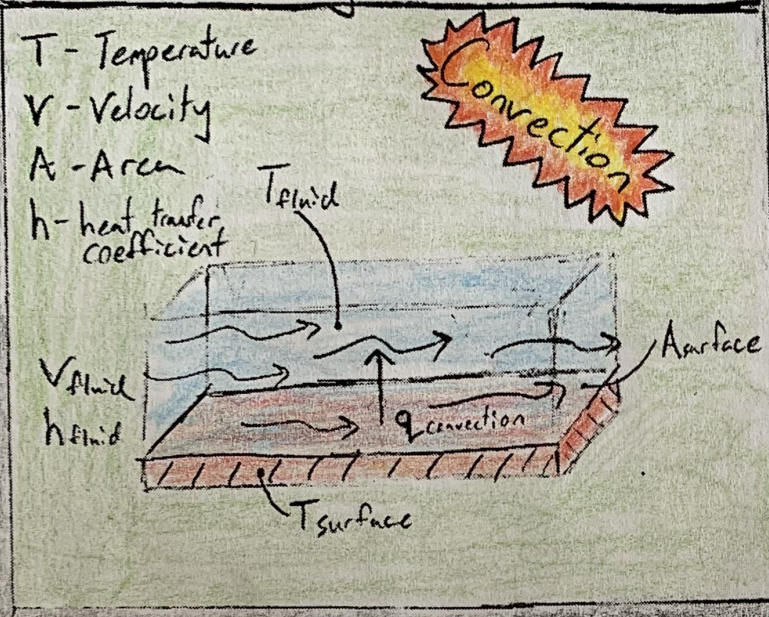

Morty get over here!

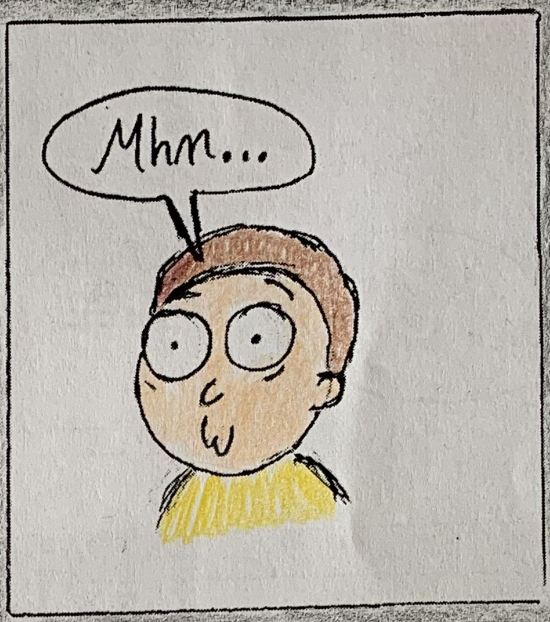

I'm busy Rick!
Morty!


Morty, I need help with my new space ship. You know about fins, right?

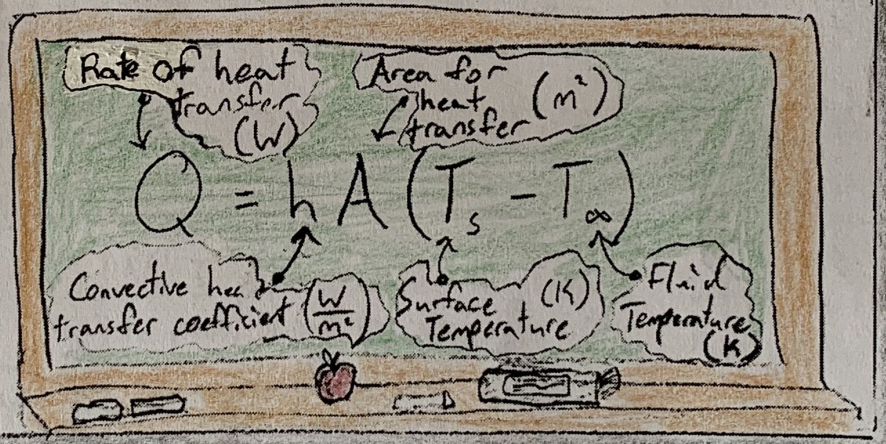

Fins??
Yeah, fins! They are used to increase heat transfer via convection!
Umm Rick can we go back a step?

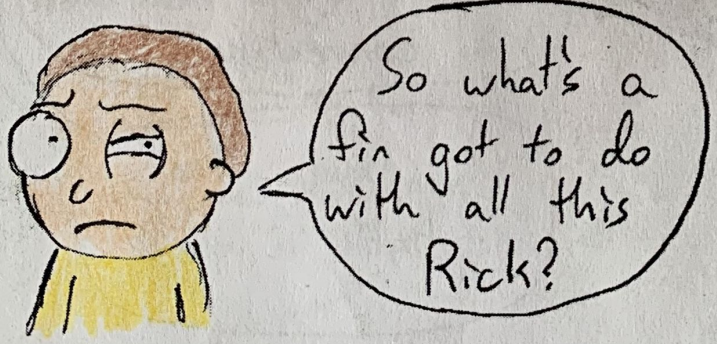
So, I think I've explained convection in the past. Basically its just the transfer of thermal energy by moving fluids.



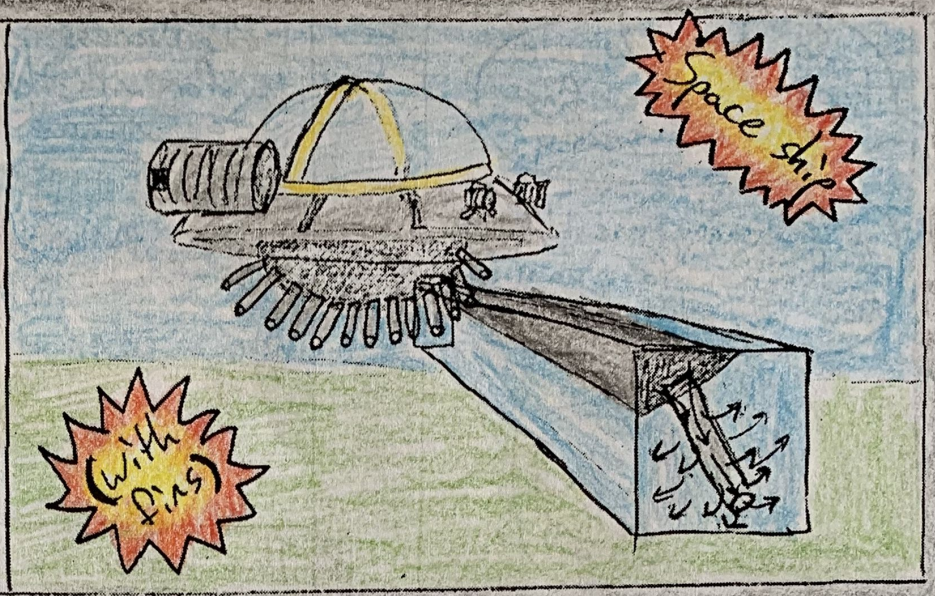


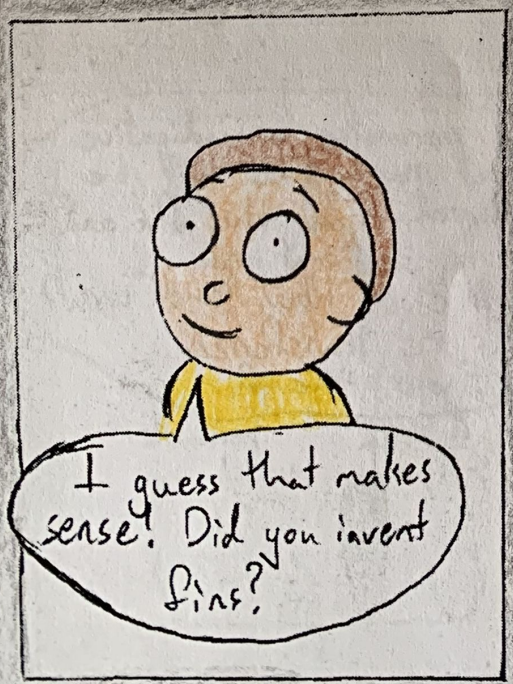
And it's governed by this equation:



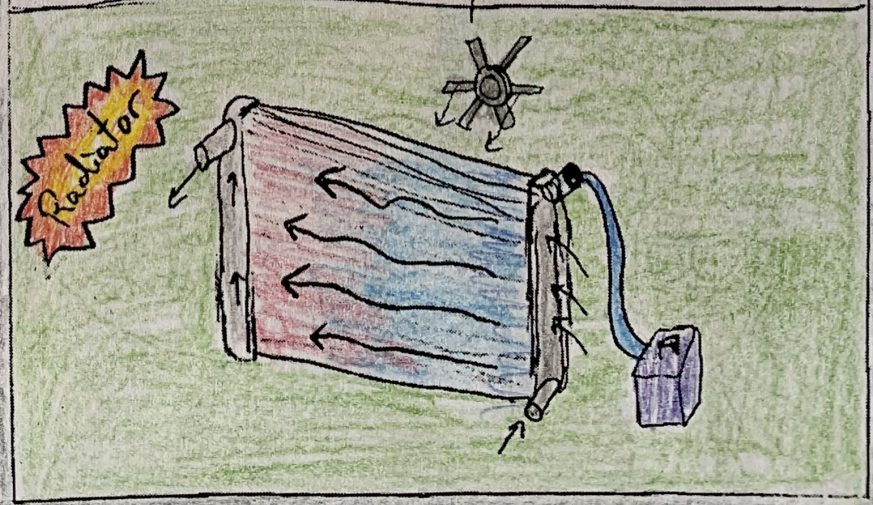


Well, if you want to increase heat transfer to say, cool off a 3500 K space ship, you can do that by adding fins. In doing so, heat can transfer from the body to the fin (via conduction) and then the moving fluid can remove the energy from that fin.





No I did not invent fins Morty. They're used in most heat exchangers. Like car radiators for example



So how do we know if the fins are even working?

We usually use effectiveness of the fin to quantify how well it is working

Effectiveness is the ratio of the heat transfer with the fin to the heat transfer rate without the fin.

$$\varepsilon = \frac{q_{fin}}{q_{w/o\ fin}} = \frac{q_{fin}}{hA_{c,b}(T_s - T_\infty)}$$

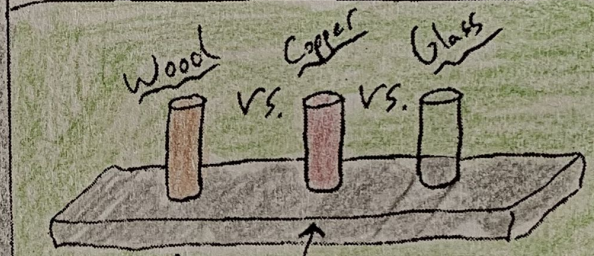
Cross sectional area at the base

The higher the effectiveness, the more, well, effective your fin is!

And how do we increase effectiveness? To make a better fin?

There are a few ways to do that Morty. First you need to pick the right material.

If you want the fin to increase heat transfer as much as possible do you think you'd use a more conductive or less conductive material?

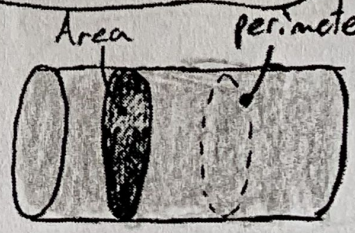


More!

Right Morty, that was a pretty easy question though

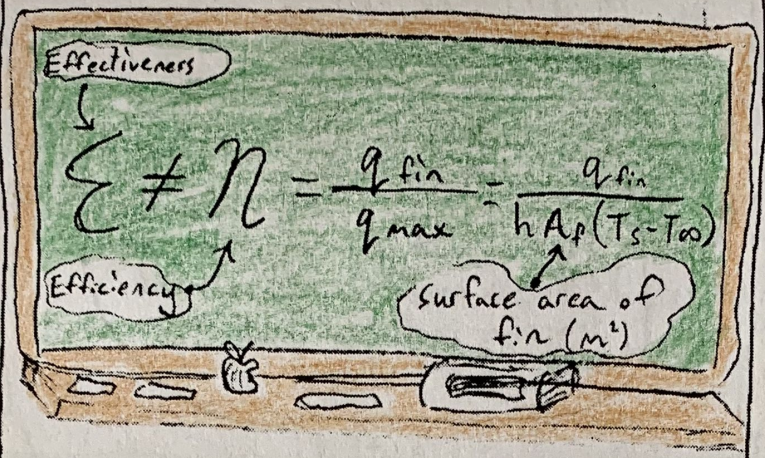
You can also design the fins so they have a high perimeter to base ratio

The perimeter is indicative of how much heat will be transferred from the fin and the cross-sectional area is indicative of how much would would be transferred without the fin

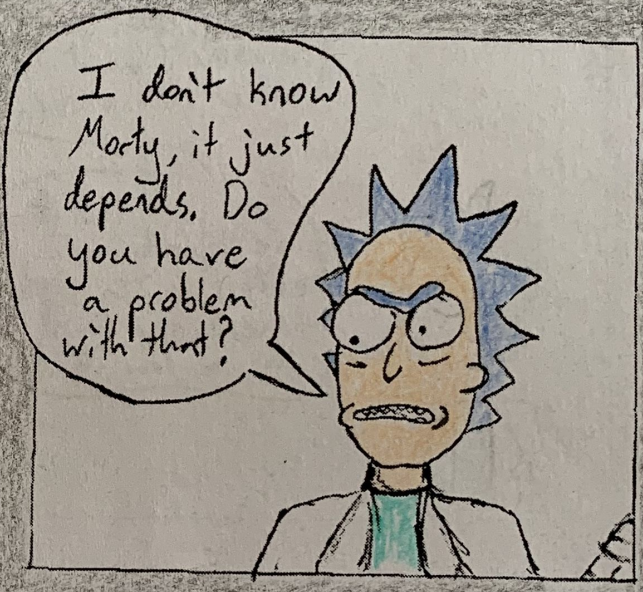


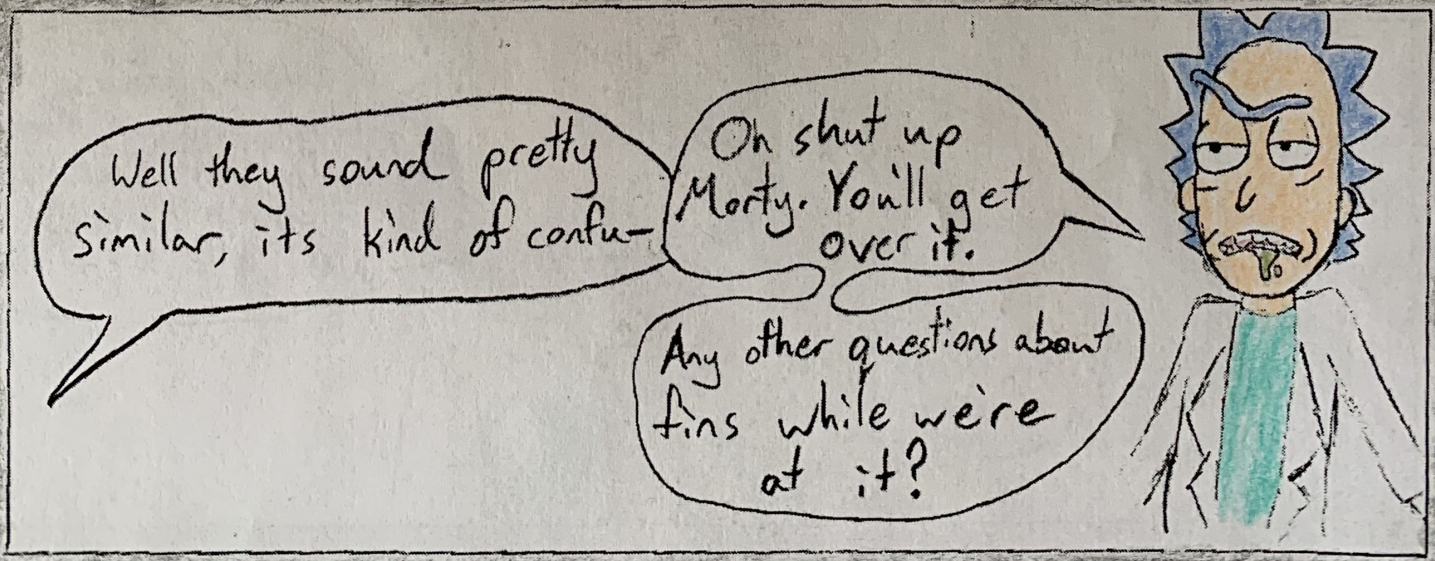

And what about the fluid? What type of fluid is best?
Well usually it is easier to control the shape and material of the fin than it is to control the fluid. But if you can control the fluid, a smaller convective heat transfer coefficient results in a higher effectiveness.
Don't get me wrong Morty, you don't necessarily want to lower this value.
It's just that fins are typically most effective in systems where the fluid has a low "h".
Oh I see Rick!
Sooo... fin efficiency should always be over one, right?
Woah Woah Woah hold up there buddy! Efficiency and effectiveness are NOT the same thing!

Effectiveness is the rate of heat transfer with the fin to the heat transfer without the fin. And that should always be over one. Or else, the fin would serve no purpose.



Efficiency, on the other hand, is actually the ratio of how much heat a fin is removing to the maximum amount of heat the fin could be removing.

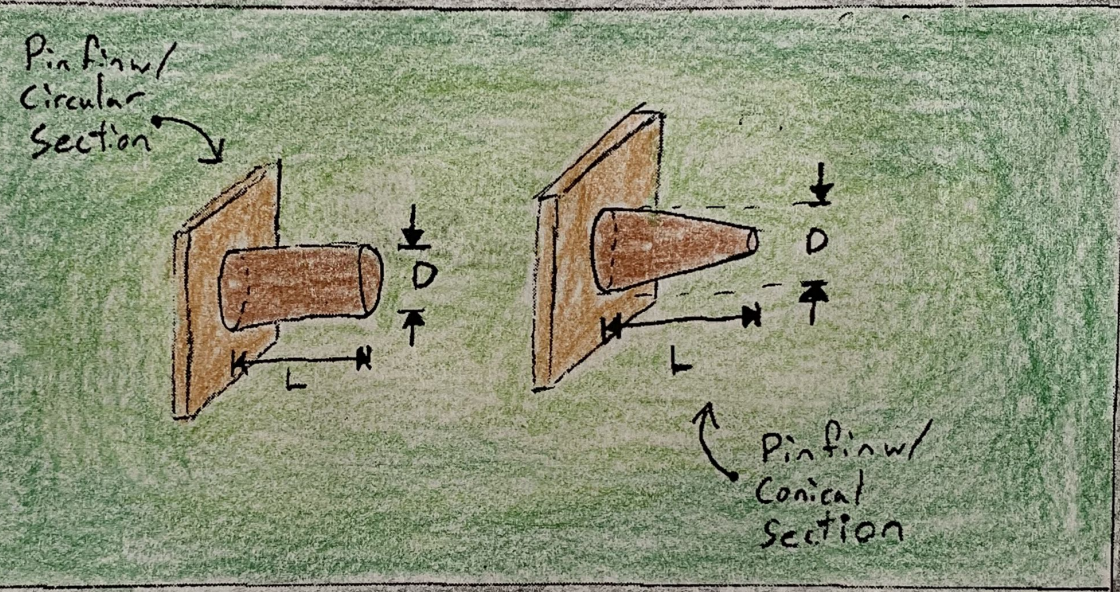




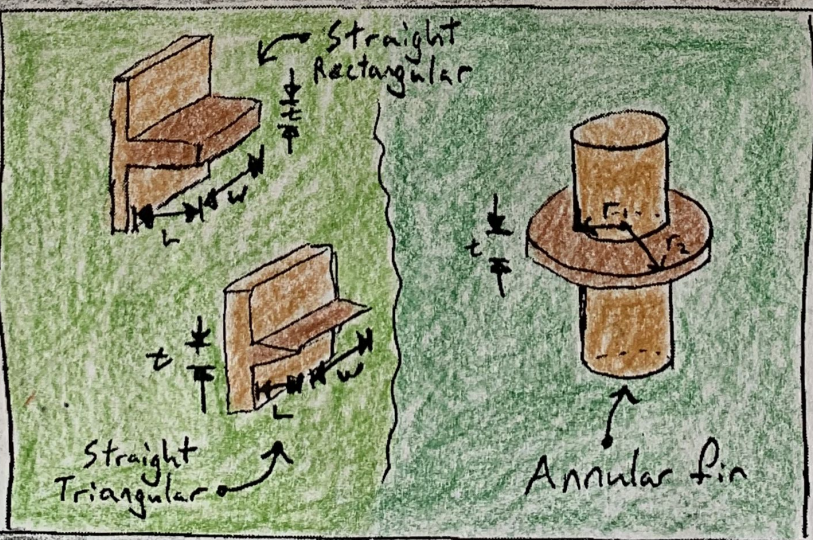
Umm yeah. What do these fins actually look like?

Well if you just have heat dissipating from a wall, or say, the bottom of a space ship, you can use what's called a pin fin.

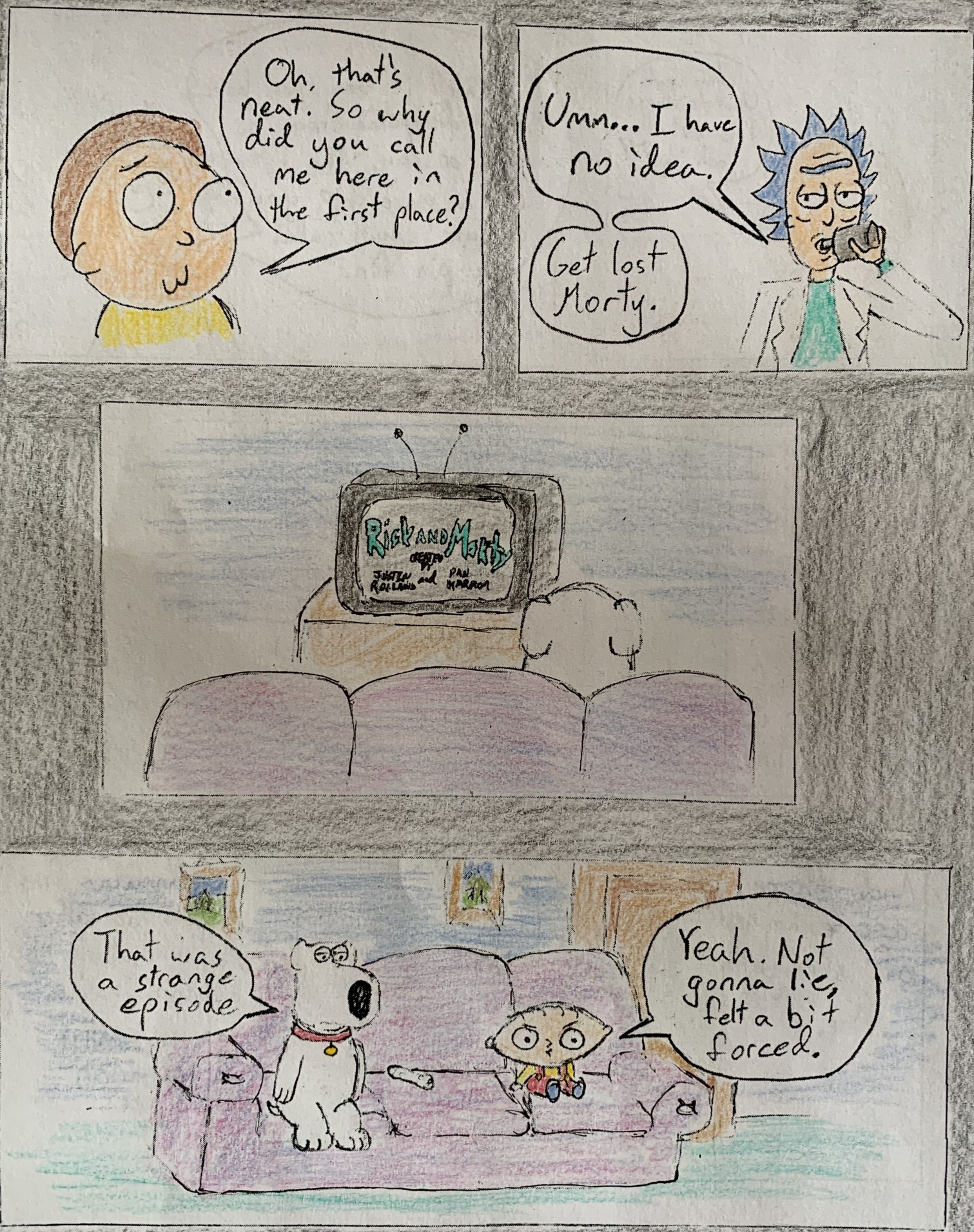
Pin fins basically just look like... pins. These are some examples of what they could look like.



And these are examples of straight fins.



Annular fins on the other hand look like this. They're frequently used on pipes.


Oh, that's neat. So why did you call me here in the first place?
Umm... I have no idea.
Get lost Morty.
Rick and Morty
created by
Justin Roiland and Dan Harmon
That was a strange episode
Yeah. Not gonna lie, felt a bit forced.