

# Designing parts

## Interview with Julian Charity

By HispaBrick Magazine®

Many times we have seen the machines and molds that manufacture our beloved bricks. LEGO® has given us a fantastic opportunity to speak with Julian Charity, CAE engineer, who tells us in more detail about all the technical effort behind the design of a new part.

**HBM:** Which department is in charge of designing new parts?

**JC:** The department I'm in! Part Design – this department helps take the sketches and ideas from our LEGO designers from concept to reality.

**HBM:** How many people work in the department?

**JC:** Part Design as of right now has 80-100 (we are growing all the time!) I work in a specialist team of 6 people within Part Design called CAE, every new part design to be made in Billund has to go through a computer simulation by the CAE team.

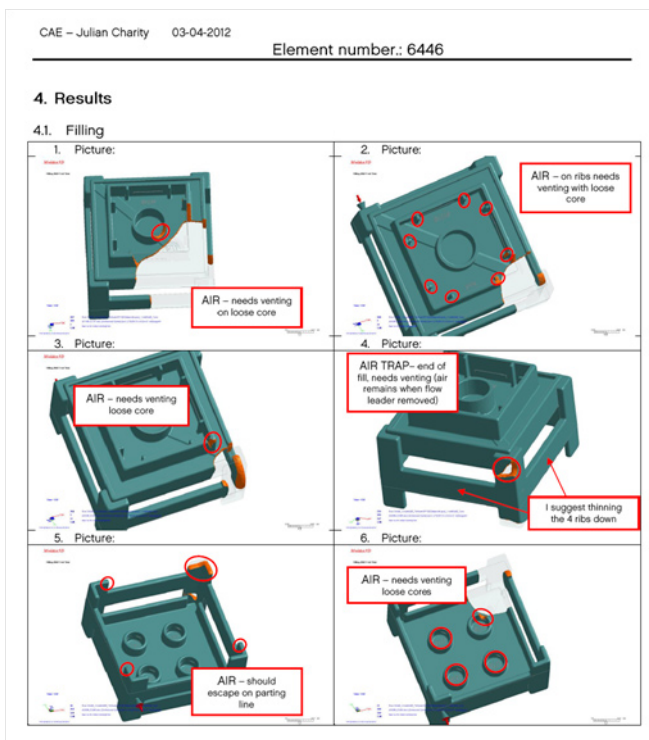
**HBM:** What is your role in the department?



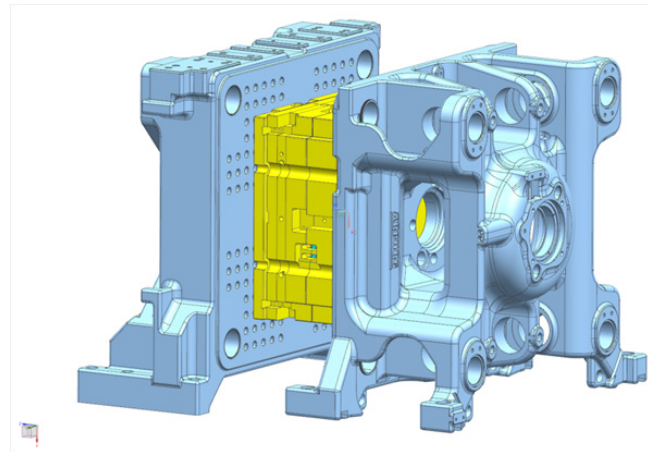
**JC:** CAE- Computer Aided Engineering – once a part is designed by the Part Designers in our CAD program, I help to ensure that the part quality is ok before it goes to tooling and manufacture. I do this by conducting filling and structural simulations using our specialist computer software. This helps to ensure that the part is moulded correctly in manufacturing and that people using our bricks can't seriously injure themselves.

My role is to predict where the air needs to escape from the part cavity once the mould is shut and plastic starts filling the void, I also look at the pressure it takes to fill the mould with plastic, these predictions assist the toolmakers in the tool design. Moulds have cooling water running around them when manufacturing the bricks to maintain the correct temperature, just like a radiator passes water around your car engine block. I often help with the cooling system layout and predict how the part cools when going from liquid to solid plastic.

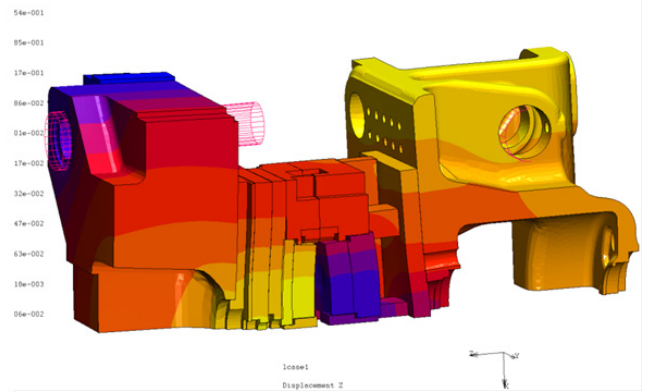
Of course a single mould can make a lot of bricks every time it opens and shuts. I help with the runner system layout to ensure that all those bricks finish filling in the mould at the same time so they shrink and cool at the same time and are therefore same shape.



Report



Mould structural simulation



I also conduct structural analysis on new part proposals, we can use this program for a lot of things, originally it helped NASA in the early space program, but here at LEGO® today it helps me predict the forces with which new parts will shoot, clip together, including how, when and where parts could break. Importantly it helps ensure that we exceed the Toy Safety Standard legally required. There is of course no point spending a lot of money on a mould, making some parts and then finding out that they break during regular play. Likewise, if there is a problem with the part design the mould maker would have to correct the shape of the cavity that makes the brick anything from not just once but let's just say many times in certain moulds! That can cost more time and money to fix than the mould is worth and you end up with a very expensive paperweight. ;-)

**HBM:** Who proposes the idea/need for new parts?

**JC:** The designers. We have a lot of bricks to choose from in the LEGO system. However sometimes a designer will struggle to make a new LEGO set or function without a

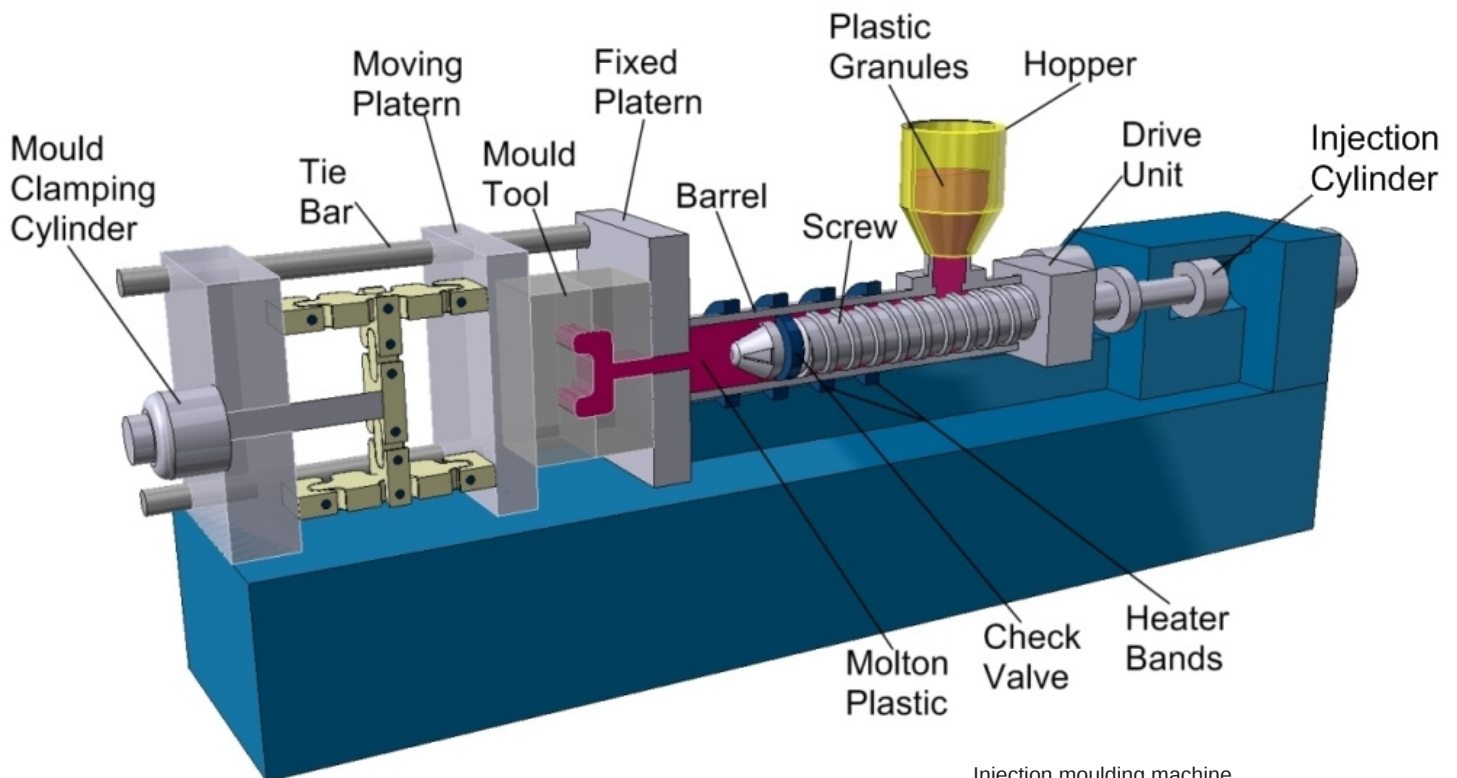
new type of brick. The designers will propose which new bricks to put in the LEGO system each year. Of course we have to ensure a similar brick doesn't already exist in the system. We also work a lot with what we call novelty parts, these are items that add detail to the play/building experience.

**HBM:** What steps do you follow from the initial idea to the final part?

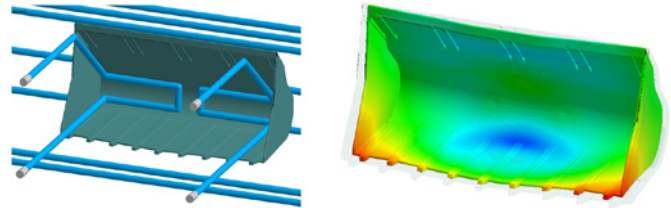
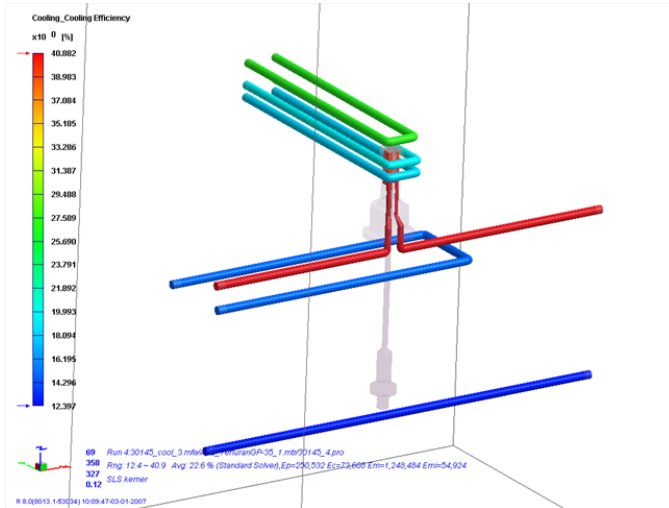
**JC:** An idea, a sketch, some basic CAD and rapid prototyped models, part design CAD, CAE simulation, a prototype mould, product safety and quality checks, ending in a full production mould. We are quite thorough!

**HBM:** How long does this process usually take?

**JC:** It depends on the part! Some simple parts could go from a sketch to being in the box in stores in 6 months. Some projects involving new clips or shooting mechanisms can go through several stages and redesigns and take well over a year. Sounds like a long



Injection moulding machine

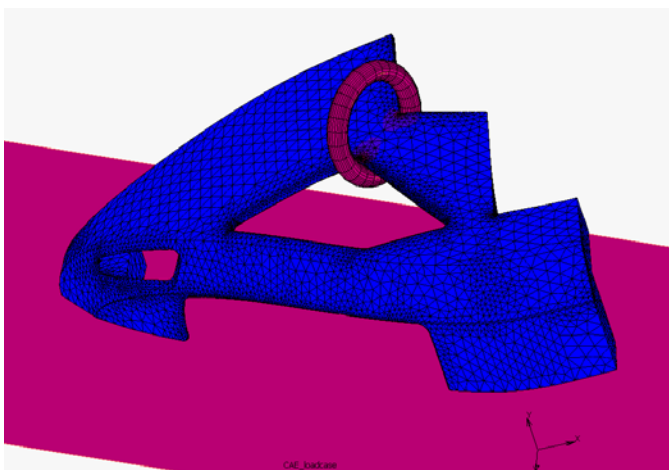


time doesn't it? But we can sometimes manufacture the mould that makes the part in just a few weeks... so there are a lot of processes either side.

**HBM:** What kind of tools do you have for the design of the parts?

**JC:** As you can imagine, a company the size of LEGO® has some pretty amazing tech. SLA & SLS rapid prototyping, including DMLS (rapid prototyping in metal), 3D scanning, we even looked at buying a CT scanner! The moulds that make the bricks are made using high speed milling and spark erosion which involves passing electric current through copper in a bath of oil to slowly erode away the metal to the shape you want. We also use MIM (metal injection moulding) to internally manufacture some common parts in steel for use in our steel mould construction, not many companies have this technology right now.

Specifically in CAE we currently have 3 computer servers each with 8 CPU's running simulations 24/7, this allows us to run well over 1000 simulations a year. My job relies on simulating on computer what will happen in reality. Predicting the future if you like. Of course we are constantly looking back and benchmarking our

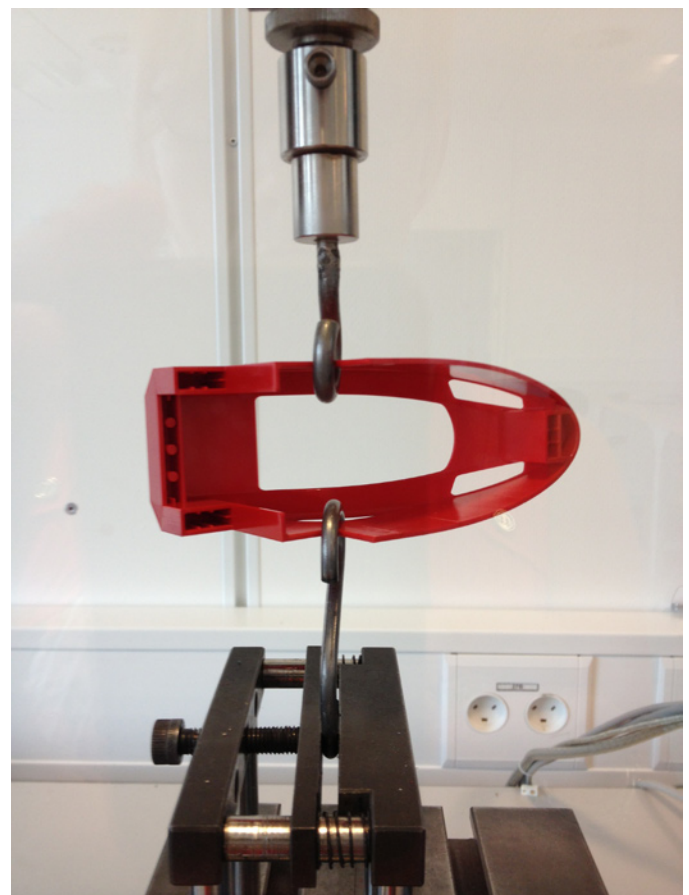


Product safety simulation

simulations against what actually happened in real life. I was recently involved in a project where we made a mould with a glass window in it so we could actually see inside the mould as the plastic ran around it, we filmed it with a high speed camera and compared it to our computer simulation. There are a lot of exciting engineering projects here at LEGO.

**HBM:** What are the main factors you take into account to decide if a new part is necessary?

**JC:** The designer and marketing teams have to try and predict how many boxes the proposed new part could



Product safety testing

be used in and how many of those boxes might be sold. Sometimes we will slightly redesign an old part when the mould has reached the end of its life.

**HBM:** How many new parts are designed each year?

**JC:** This of course changes year to year but this year around 300-350 new parts.

**HBM:** Is there a different design process for transparent parts?

**JC:** Not so much. We use several different types of plastic at LEGO® and each type has different filling properties. Most of our transparent parts are made in PC or HVPC plastic which has its own specific handling characteristics, there are limitations to the part thickness and size in this material. It's quite a hot plastic when liquid, it goes in to the mould at 320 degrees C! Usually our transparent parts are very opaque and have a nice polished finish to them, in order to achieve this the mould also has to be polished to a near mirror finish.

**HBM:** And for Technic parts?

**JC:** Nope, all LEGO plastic bricks whether is it Technic, Duplo, Mindstorms etc are manufactured using injection moulding. Some of our more interesting parts are made using techniques like overmoulding and co-injection.

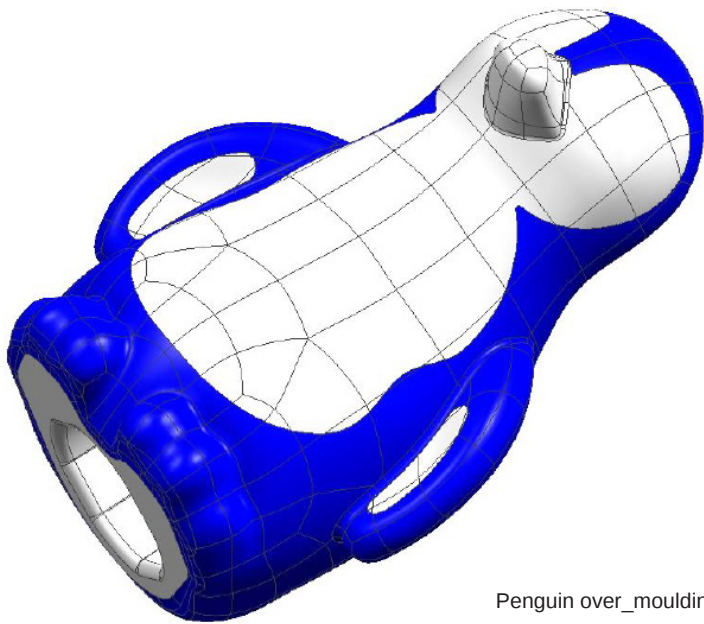
**HBM:** What factors influence the substitution of an existing part with a new part?

**JC:** For our most common mass produced parts we kind of have a one in one out policy if you like. The same with new colours. This prevents things from getting too complex in mass manufacturing.

However for a new movie IP such as TMNT or a newly developed line like LEGO Friends we will create a lot of new part designs, wigs, animals, heads etc these are called "novelty parts" internally at LEGO.

**HBM:** Do you bear in mind the suggestions you receive from AFOLS? Do you have anything to say about the much desired plate with studs on both sides?

**JC:** Well we have a lot of AFOLs working at LEGO of course! Technically a part with studs on both sides would be easy to make. I'm sure if enough people keep requesting it LEGO will look in to it. AFOL power! New parts have to be compatible with all our other LEGO parts. That's why LEGO is so great of course. We have a department called Design Lab here in Billund, a lot of LEGO employees call them the LEGO police because they enforce and ensure that the LEGO system is upheld. That way all our parts remain compatible and can continue to be combined in so many different ways.  
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Penguin over\_moulding

