Optimization of A Die Press (T.E.A.M. Problem 25)

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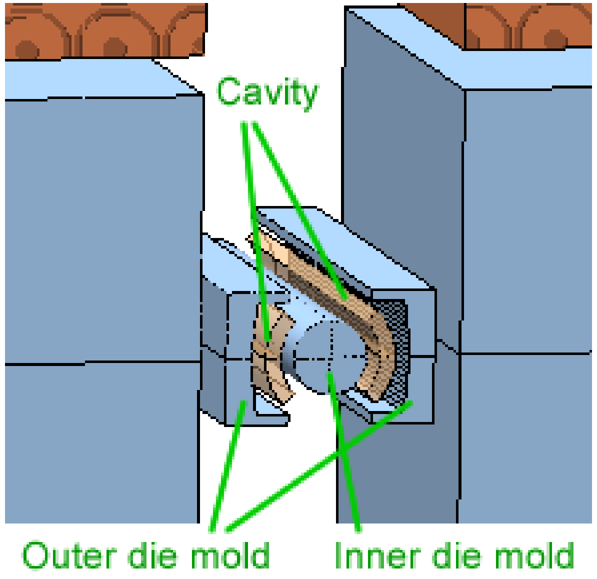
A large electromagnet that can set up a strong magnetic field is used to orient the magnetic powder in a component. The orientation and strength of the magnetic field should be controlled in order to obtain the required magnetization, in the component that is being magnetized. In this device, the objective is to find the size of the inner die mold and the shape of the outer die mold in order to obtain the desired magnetic field in the cavity shown in the figure.



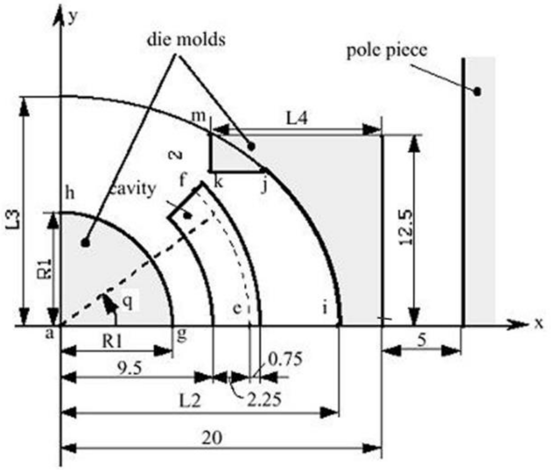
Using MagNet and OptiNet, the optimal radius for the inner mold and the elliptical shape for the outer mold can be determined given specified design objectives.

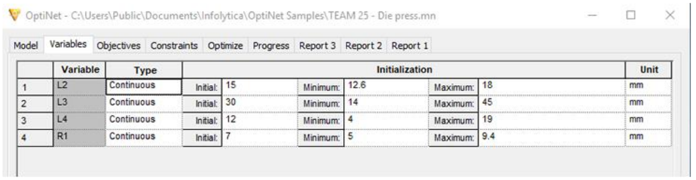
The following is based on the Testing Electromagnetic Analysis Methods (T.E.A.M.) problem #25: Optimization Of A Die Press Model. The benchmark can be found on the International Compumag Society's website.

Geometry Variables Definition

This figure shows the parameters that the OptiNet optimizer will adjust in order to reach the design. The parameters are R1, L2, L3 and L4. R1 is the radius of the inner mold and L2 and L3 are the axes of an ellipse. MagNet allows even elliptical shapes to be controlled by parameters. Parameter L4 controls the length of the top piece of the outer mold.

The only constraints in this optimization are the range specified for the values of the parameters R1, L2, L3 and L4 as shown in the Variables window in OptiNet.



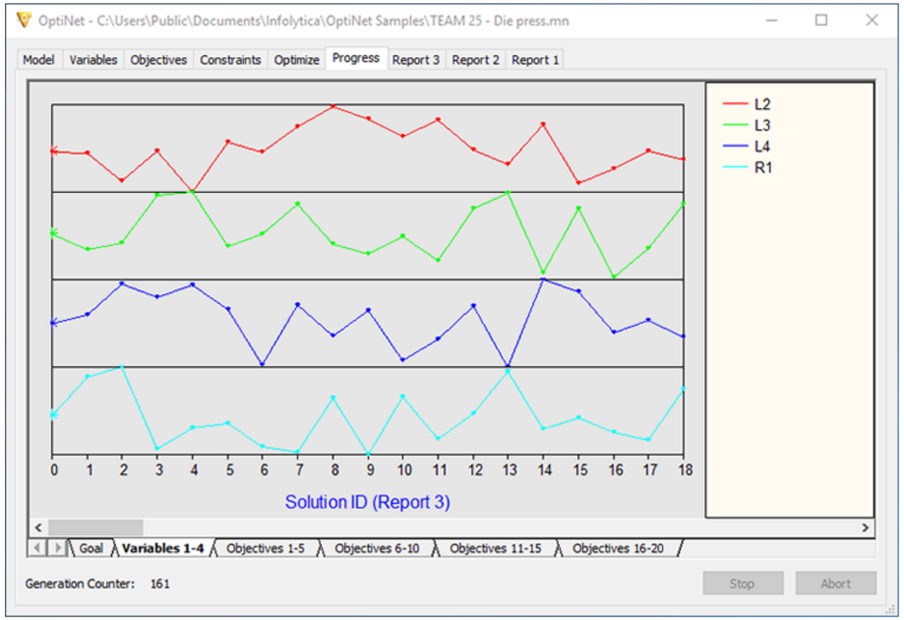


	Variable	Type	Initialization						Unit
1	L2	Continuous	Initial:	15	Minimum:	12.6	Maximum:	18	mm
2	L3	Continuous	Initial:	30	Minimum:	14	Maximum:	45	mm
3	L4	Continuous	Initial:	12	Minimum:	4	Maximum:	19	mm
4	R1	Continuous	Initial:	7	Minimum:	5	Maximum:	9.4	mm

Objective Function and Variables Fluctuation

The objective of the shape optimization is to obtain a flux density that is radial in the cavity space and whose magnitude along the arc e-f is 0.35 Tesla. The objective function is the mean squared error between the Bx and By values sampled along the arc e-f and what they should be in the case of a radial field that has a magnitude of 0.35 Tesla. Defining this expression in OptiNet is easy.

As the optimization is progressing, OptiNet displays the changes in the goal, variables, objectives, and constraints, all in the form of graphs. In this example, each of the four variables' graphs is updated as OptiNet finds a new design.



Initial and Final Magnetic Field in the Die Press

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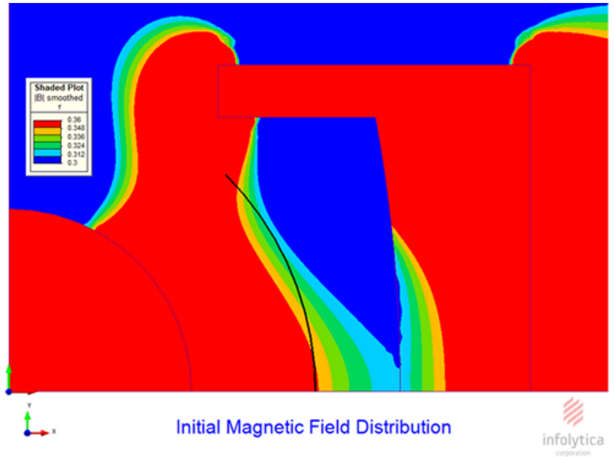
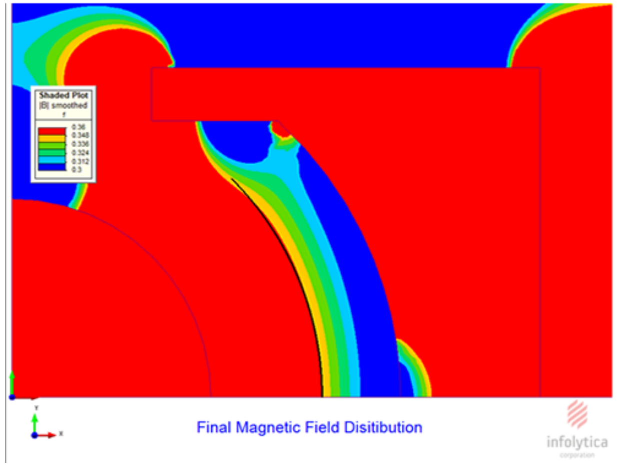
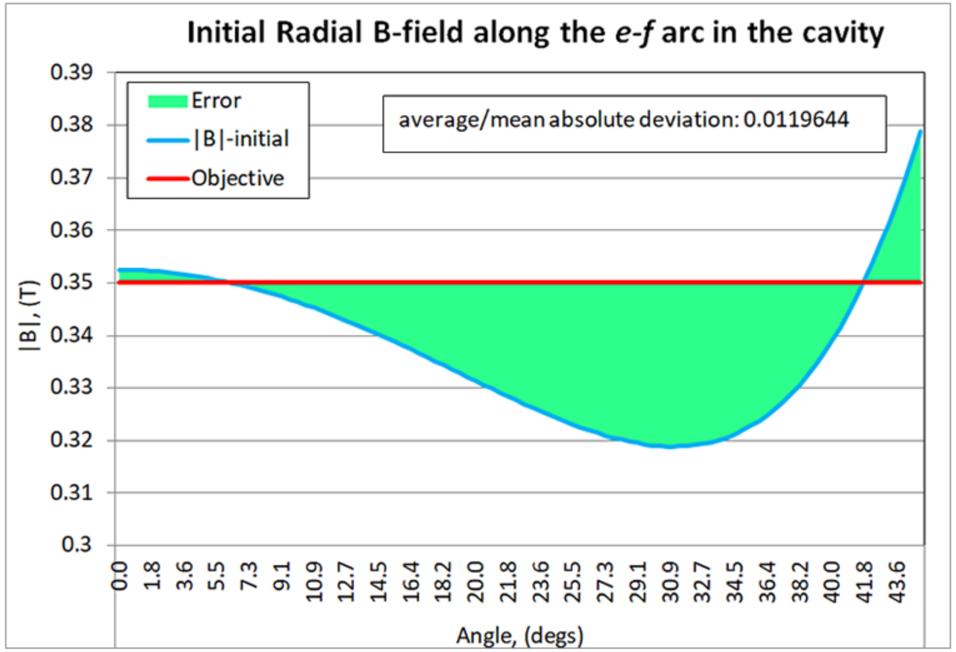
The magnetic field distribution in the die press before (initial) and after optimization (final). The objective arc is shown in black, and the improvement due to optimization is clearly seen in the uniformity in the field distribution.





Initial Radial Magnetic Field

In the initial design, the field along the contour was far from satisfactory. As shown in this graph, the magnitude of the flux density did not remain at 0.35 Tesla.



Optimized Radial Magnetic Field

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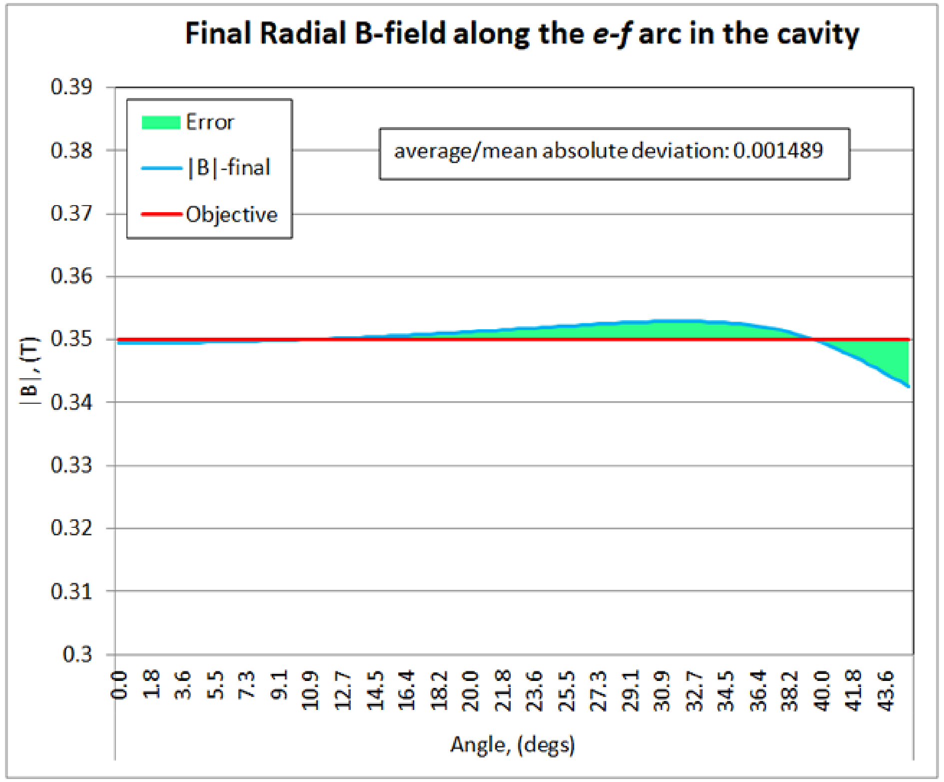
As can be seen, the objective which is the minimization of the mean squared error has been obtained and the magnitude of the flux density along the contour is 0.35 Tesla, as seen in this graph. The error reduces to an average deviation of 0.001489, an 88% reduction in the non-uniformity of the field with respect to the initial design.



Die Press Optimization Geometric variation

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