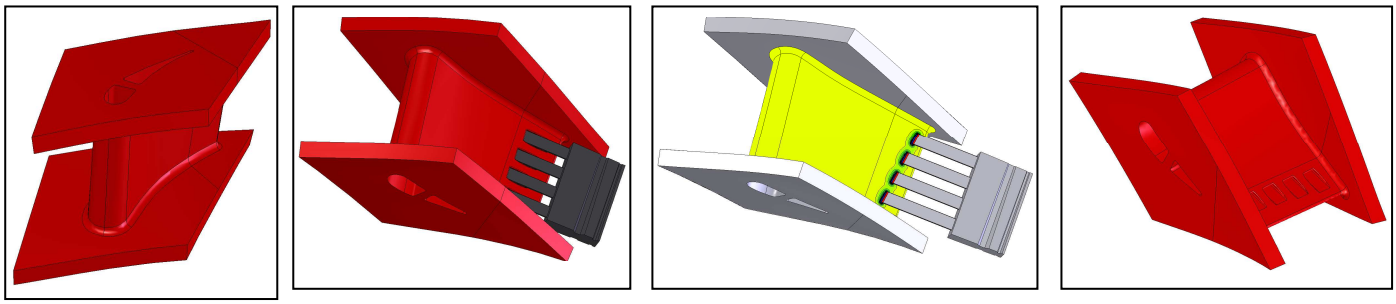
elsyca
electrochemical intelligence

APPLICATION CASE

Electrochemical Drilling of Cooling Holes in Turbine Blades

Aerospace Solutions applied with Electrochemical Intelligence



The Need

Electrochemical Machining (ECM) is increasingly recognized as a viable alternative to fabricating precision metal components. It compares quite favourably to conventional grinding, drilling, laser cutting or electrical discharge machining. There are numerous advantages: the 'cutting tool' is not subject to wear and the resulting machined surface is both stress and crack-free. The process works with a DC or pulsed current source and is combined with a cathode tool that is either fixed or has some linear feed movement. The goal now is to speed up the design process of the cathode tool and also to improve the design of the final work piece.

The Design Challenge

Due to the stringent geometric specifications of many aerospace components, the equally complex design of the cathode tool usually creates a bottleneck in the process. In general, it takes several "trial" wet runs to establish the cathode tool design needed to produce the correct component shape and meet specifications. The concept of using the negative of the targeted end-shape as a base for the cathode tool design sounds feasible. But in reality it seldom achieves results within specifications. "Trial and error" testing of possible cathode tool designs can easily take a few days, wasting valuable time and money.

The non-perfect copying accuracy creates an addition design problem: the final shape is uncertain such that e.g. strength calculations are difficult to perform in advance.

The Solution

In contrast to the time and money-consuming trial and error, ECM process simulations can perform the cathode tool optimization very quickly.

Elsyca's Advanced Engineering Services simulations based on *Elsyca ECMMaster* take into account the electrolyte type and temperature, the component material, time dependent electrical signals (imposed current or potential, pulse and pause times), time dependent movement of the cathode tool or control of the minimum distance of the cathode tool from the component. The software also provides powerful tools for the current density and shape change result visualisations and includes a probe able to determine removal rate at specific points on the surface.

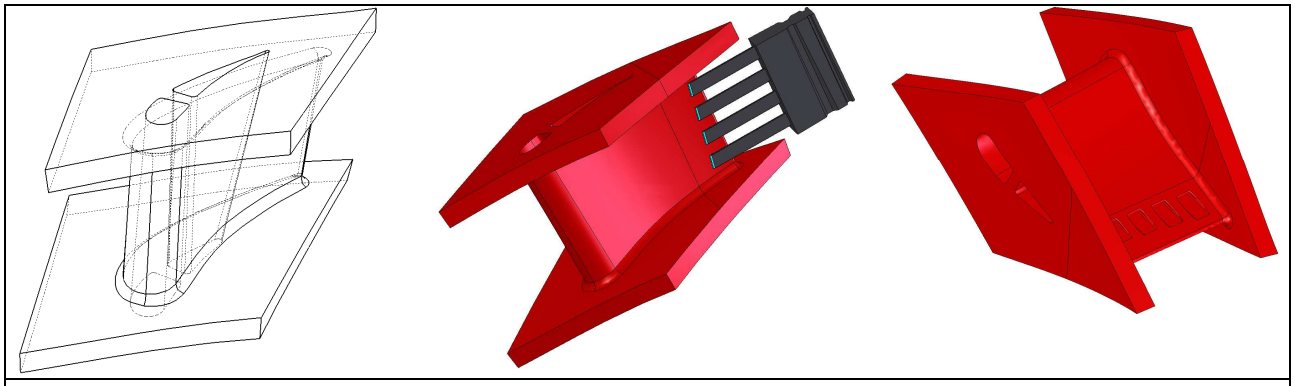
As a result of the full integration of *Elsyca ECMMaster* into an industry standard CAD environment, the "virtual" definition of the draft cathode tool and the initial component shape takes a very short time. A fully simulated run using this defined cathode tool can be achieved quickly (depending on the complexity of the shape to be achieved). Visualisation and comparison of the result to the targeted component shape provides feedback that can be used to modify and further optimize the cathode tool CAD design, if needed. Many simulation "dry runs" can be carried out rapidly until the "virtual" cathode tool achieves the exact component shape specifications. In this way, instead of taking several days, Elsyca Advanced Engineering Services can quickly deliver the optimum cathode tool design within hours.

Since E*lsyca ECMMaster* reconstructs at each time step the modified geometry of the part, a full CAD model is available which can also be used for other design purposes as strength calculations. With this additional outcome, Advanced Engineering Services can perform in a very early stage, the design of a complex part where also the limits of manufacturing are considered.

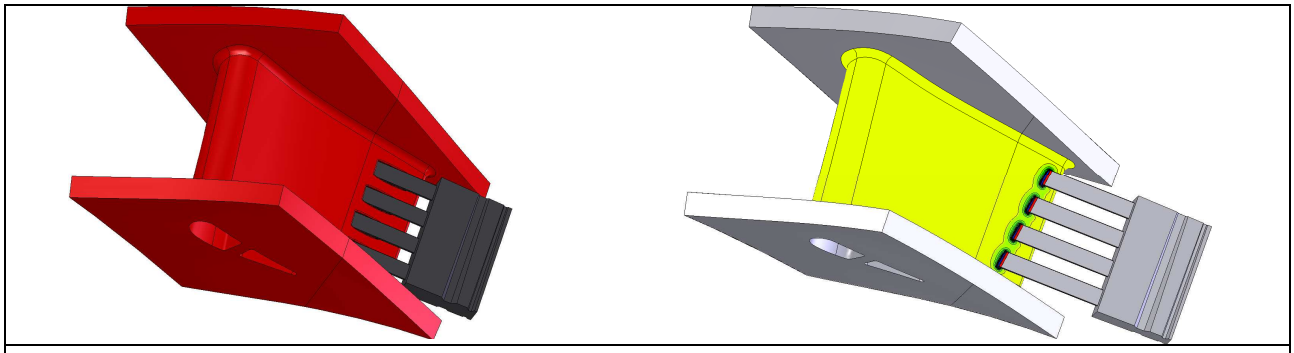
The Benefits

Dramatically faster and more accurate cathode tool design realises the full production potential of an already optimised process. Reducing wet run trials saves significant amounts in time, labour and materials and speeds up eventual time-to-market.

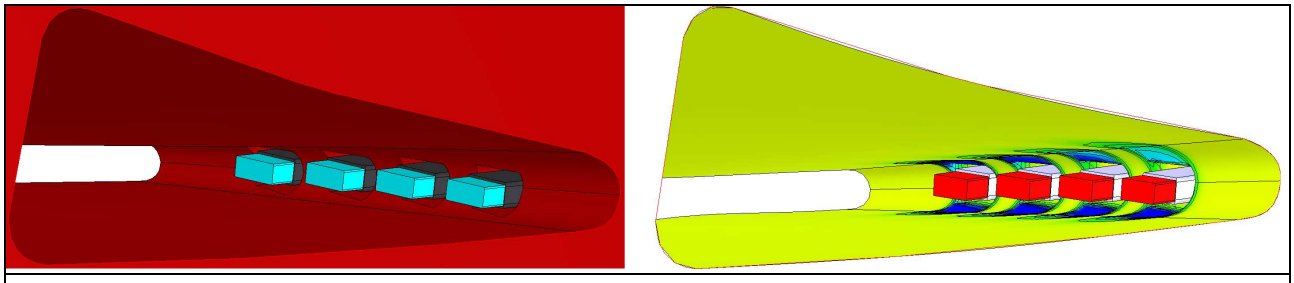
ELSYCA N.V.
Vaartdijk 3, bus 603
3018 Wijgmaal
Tel. + 32 16 47 49 60
Fax. + 32 16 47 49 61
E-mail : info@elsyca.com
web : www.elsyca.com



Left: CAD drawing of turbine blade in initial shape
Middle: cathode tool (grey) and turbine blade (anode, red)
Right: final shape



Left: moving cathode tool to create cooling holes
Right: current density distribution



Left: breakthrough of cathode tool
Right: current density distribution

ELSYCA
electrochemical intelligence

ELSYCA N.V.
Vaartdijk 3, bus 603
3018 Wijgmaal

Tel. + 32 16 47 49 60
Fax. + 32 16 47 49 61
E-mail : info@elsyca.com
web : www.elsyca.com