Extreme lightweight technology
(now available for licensing)

Description:
ASTRON has developed a design and manufacturing method for producing very light, stiff and strong structures from a single piece (a monolith). The most obvious application is the production of a flat or slightly curved sheet-shaped support structure with a height in the range of 1 to 20 cm. However, this technique can also be used to produce parts with various other shapes.

Via small openings in the exterior of a block of material, more than 95% of the interior can be hollowed out. Since almost all the material in the external surfaces is retained, the part now is up to 50% lighter than can be achieved with traditional machining techniques, given equal bending stiffness. Moreover, with this new manufacturing method, it is possible, for example, to produce in-and external walls measuring only 0.3 mm in thickness with local thickening if needed. Since all the surfaces in the remaining structure are interconnected, the entire structure is much less susceptible to buckling effects and can, therefore, bear heavier loading.

Briefly, the most important qualities are:
✓ lightweight
✓ stiff and strong
✓ made from a single piece
✓ homogeneous structure
✓ applicable for all materials suitable for milling and materials suitable for ultrasonic machining.

Space Background:
The technology arose from a design study carried out by ASTRON for the Mid Infra Red Interferometer for the James Webb Space Telescope. Ensuing from this, the technology has been applied in the lightweight and extremely stiff balance arm for the box-shaped main structure of a cryogenic spectrometer (X-Shooter).

Innovative Aspects:
This technique enables constructions in metal or ceramic to compete better with expensive carbon fiber reinforced plastics (CFRPs). The method can be implemented only on milling machines with simultaneous 5-axis motion and in combination with a high-end CAM system.

Application Areas:
- Semiconductor industry: lithography, where rapid and precise positioning is required; such as for wafer steppers or wafer dicing;
- Aerospace: complex lightweight structures made from a single piece; such as sheet-shaped support structures, beams, double and thin-walled tubes and housings, metal mirrors;
- Science: cryogenic applications, light, compact, stiff and low mass; such as cryogenic infrared instrumentation;
- Optical instrumentation: lightweight metals or ceramic mirrors, integrated optics in the walls of a support structure; such as a 3-mirror system;
- Mechatronics/assembly industry: fast and accurate pick-and-place positioning systems.

Cooperation and Licenses:
This technology now is available for licensing, consultancy, design and/or production of customer specified parts. ASTRON is quite willing to advise you about implementing this extreme lightweight technology in your business.
This technology is patented in D, FR, IT, NL and UK. A USA patent is pending.

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Extreme lightweighted mechanical structures

*Put your systems on a diet: a new design technique and strategy.*

**New Principle of light weighting (patented):**
creating cavities from two or more sides in such a way that they will form an efficient structure that suits the requirements of the design such as size, weight, stiffness and strength.

**More freedom of design:**
This technology enables creating various shapes according to the actual design requirements. You may create one homogeneous (monolithic) construction element including e.g. a mirror-function and mounting lids.

**Comparing traditional lightweighting vs. ASTRON extreme lightweighting:**

<table>
<thead>
<tr>
<th>Achievable amount of light weighting (manufacturing)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional light weighting (open lw)</td>
<td>80-85%</td>
</tr>
<tr>
<td>New method (ASTRON closed lw)</td>
<td>90-95%</td>
</tr>
</tbody>
</table>

**FEA Comparison (comparing stiffness to weight performance):**

<table>
<thead>
<tr>
<th>Part #</th>
<th>Light weighting method</th>
<th>Wall thickness</th>
<th>Mass</th>
<th>Displacement *</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(mm)</td>
<td>(grams)</td>
<td>(mm)</td>
<td>(mm)</td>
</tr>
<tr>
<td>1</td>
<td>Open back</td>
<td>2</td>
<td>1085</td>
<td>4.88E-4</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Closed back</td>
<td>1.48</td>
<td>1085</td>
<td>3.45E-4</td>
<td>71</td>
</tr>
<tr>
<td>3</td>
<td>Closed back</td>
<td>0.6</td>
<td>576</td>
<td>4.34E-4</td>
<td>89</td>
</tr>
</tbody>
</table>

* models have been calculated for displacement in Z direction (bending stiffness) measured at the three green connection pads resulting from both gravity and an external dummy load of 10N.

~ 50% of mass reduction but retained stiffness! Lose weight without penalty to stiffness