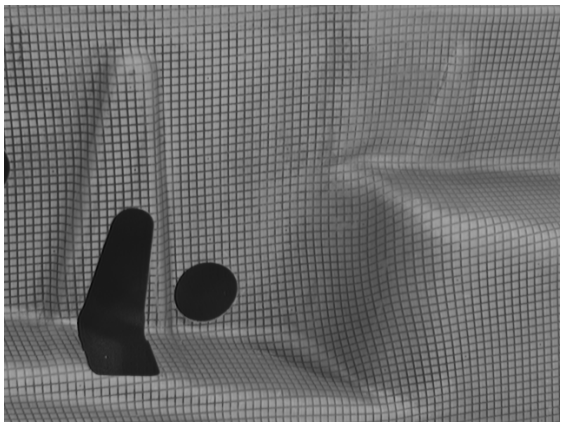
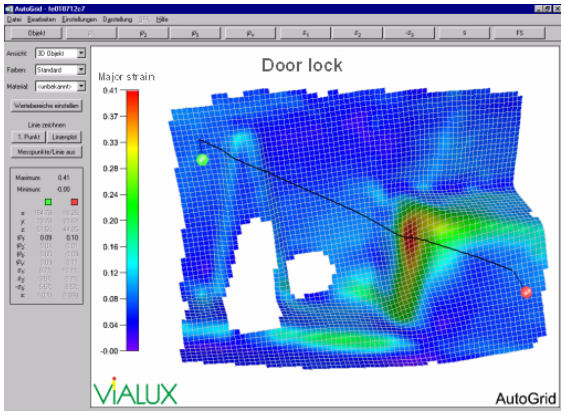
AutoGrid® Basic System Solution

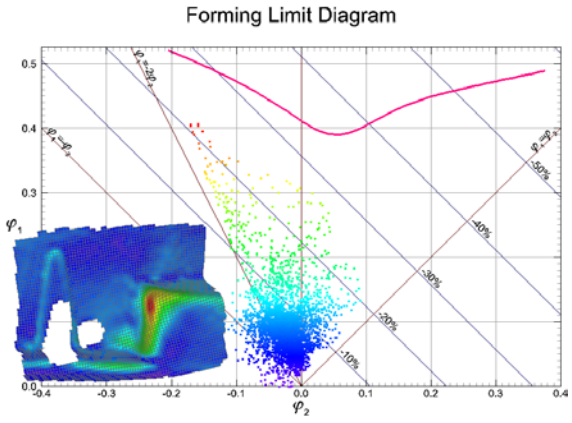
There are various needs for strain analysis in sheet metal industry. In the first step, precise data of material's properties, especially forming limit curves (FLC's), are required in component design for a realistic numerical modelling of the forming process. Secondly, experimental strain data are used in tooling where the applications of forming limit diagrams (FLD's) are a major part of the die tryout and die buy-off process, respectively. Finally, problem solving during the production run requires information about the material flow in the multi-step forming processes.
To get access to the strain values, the blank needs to be gridded before the manufacturing or testing process. In most applications, the grid pattern consists of electrochemically-marked orthogonal lines spaced 1-5 mm. ViALUX provides convenient gridding equipment optimized for the use with an *AutoGrid*® system.



To measure the strain optically, a mobile and light-weight *AutoGrid*® unit is placed in front of the formed part. Four CCD cameras are mounted on this measuring head to acquire the different views of the object simultaneously. The user can easily achieve optimum lighting conditions by advanced features of image acquisition, e.g. recording with interactive illumination. The system calculates automatically the x, y, and z coordinates of up to 120 (120 grid line intersections taking advantage from a mature videogrammetry software solution (AICON 3D Systems). That means, the 3D shape of the object is obtained after only 3-5 minutes and all data can be exported for use with other software systems, e.g. Pam-Stamp or AutoForm.
Engineering strain $\varepsilon_{1/2}$ or true strain values $\varphi_{1/2}$ are calculated from the coordinates of undeformed and deformed grid locations and, in case of constant volume, also the thickness reduction of the formed part is provided. All results are presented as a full-field colored graph on the real 3D surface. As a specific feature, the *AutoGrid*® post-processing uses the original measuring grid for the surface display. In this way an one-to-one mapping is guaranteed for any object point. The color coded graph gives immediately a qualitative impression and allows the identification of critical regions.



A comprehensive, user-friendly graphical interface enables for detailed quantitative analyses. Single measuring points and profiles along user defined paths can be extracted and all data and graphs may be exported. *AutoGrid*® is running on a current Microsoft Windows operating system and direct clipboard copying to other Windows applications is fully supported. The forming limit diagram (FLD) is a specific graphical presentation that compares the current strain values obtained against the forming limit curve (FLC) of the material. It indicates whether the formability of the blanks is exhausted. Please refer also to the "*AutoGrid*® in-process facility" data sheet for more information on making FLC's.



With it's *AutoGrid*® System, ViALUX offers a fast, reliable and non-subjective tool well suited

- to facilitate modelling by material's parameters,
- to monitor the quality of blank deliveries,
- to improve the die tryout and buy-off and
- to speed-up problem solving during production.

The ability of *AutoGrid*® to analyse both, specimens and components with the same equipment contributes to a consistent approach for quality assurance: the strain occuring during high-volume production can be directly compared to the formability limit (FLC) of the current sheet metal delivery.

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Specifications

Measuring head: 4 progressive scanning CCD cameras with f=16 mm measuring lenses
PC connection and power supply via a single 5 m cable
adjustable tripod, convenient transport box
size: 430 (270 (150 mm³, weight: 1000 g

Computer: Pentium PC (midi tower or portable), 256 MB RAM, CD-RW, 30 GB HD
PCI frame grabber with 4 camera input channels, 19" monitor or 17" flat panel

Environment: Temperature: operating 10 ... 35° C, non-operating: -40 ... +70° C
Humidity: 20%...93% non-condensing

Software: Microsoft Windows NT4.0 / 2000
full compatibility with Microsoft Office applications

Measuring volume: min: 100 (100 (40 mm³ (smaller on demand)
max: 500 (500 (200 mm³

Field of data: up to 120 (120 = 14.400 measuring points per view

Grid spacing: 1,0; 2,0; 2,5; 3,0 and 5,0 mm, other user specified values on demand

Calibration: pre-calibration independent from measurement,
automated, robust calibration procedure using certified calibration body

Measuring time: 3-5 min for a complete analysis of one view

Results: 3D shape: coordinates x,y,z at grid line intersections
engineering strain ε , true strain φ, v.Mises equivalent strain, thickness reduction

Accuracy (rms):

field of view [mm³]	) x [mm]	) y [mm]	) z [mm]	grid [mm]	) ,
100 (100 (40	0.005	0.005	0.01	1.0	1.0 %
250 (250 (100	0.01	0.01	0.02	2.5	1.0 %
500 (500 (200	0.02	0.02	0.04	5.0	1.0 %

Graphs: 3D surface display using original object grid
color encoded presentation of strain and thickness on the 3D object
2D data profiles along user defined curves
forming limit diagram (FLD) with various FLC's and auxiliary lines
interactive tool for the creation of FLC's from strain data sets

Export: graphs: clipboard, *.bmp, *.tif, *.png, *.jpg, *.gif, *.ps, *.eps
data: ASCII, AutoForm, Pam-Stamp