



Digitalisation of High Value Manufacturing

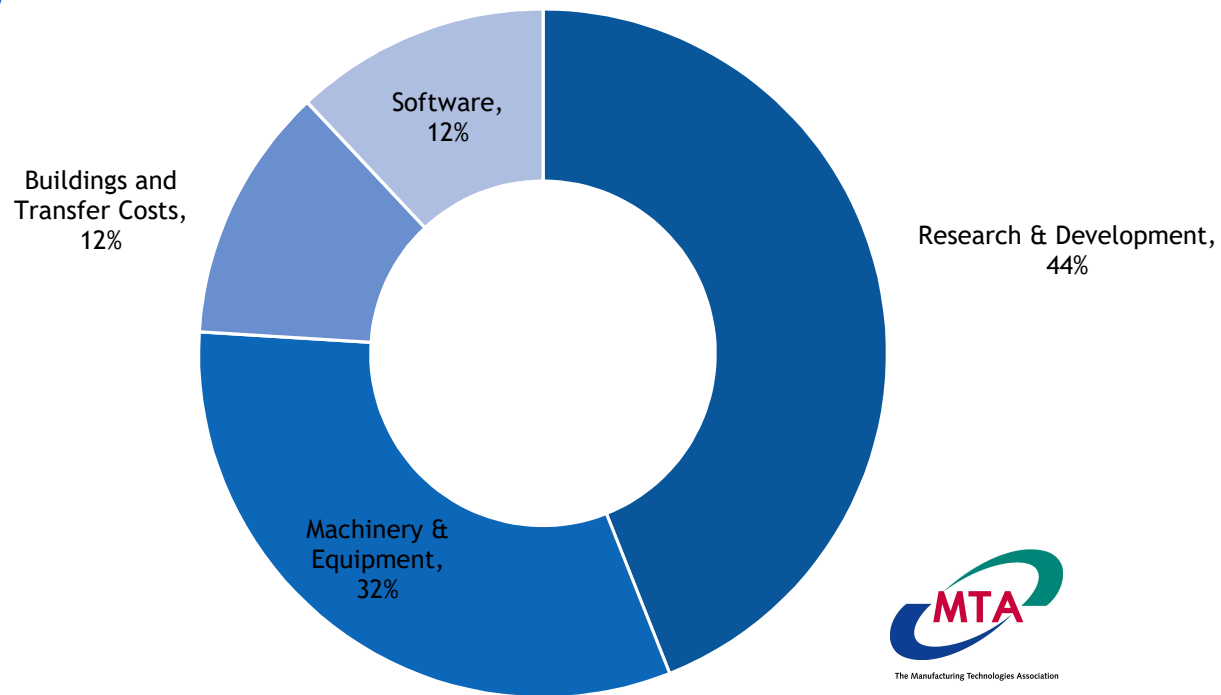
(Reference to Advanced Metal Forming and Composite Forming)

C. Mark Ridgway OBE, DL
CEO Group Rhodes

22nd January 2020

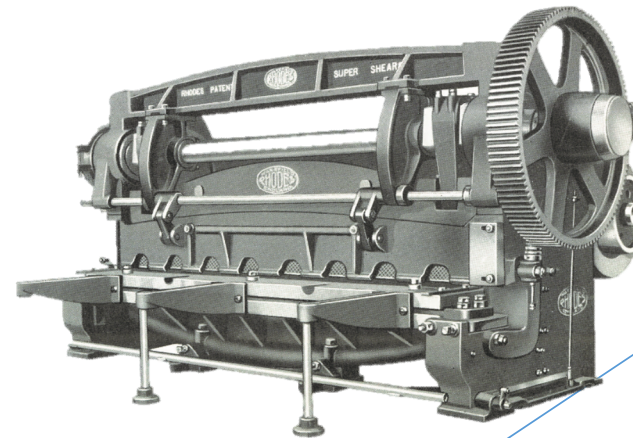
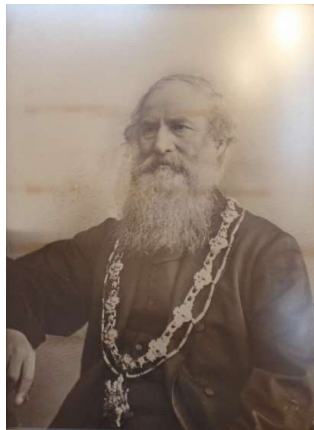
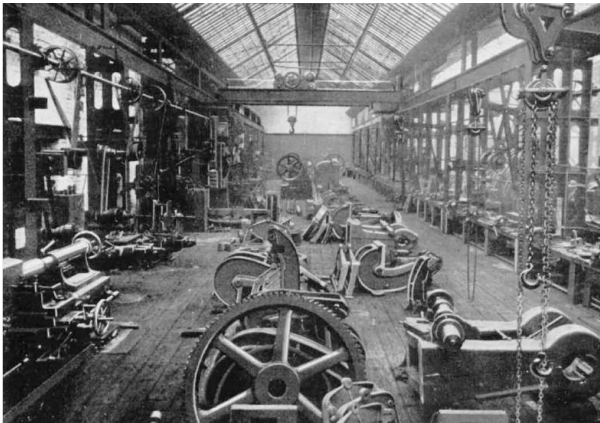


Capital purchases of the UK manufacturing industry



Source: ONS business investment release and Oxford Economics

Importance of Innovation



SPF Patent

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing (day/month/year)	29 July 2019 (29-07-2019)
Applicant's or agent's file reference P35214WO/RSW	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/GB2019/051213	International filing date (day/month/year) 2 May 2019 (02-05-2019)

From the INTERNATIONAL SEARCHING AUTHORITY

To:

Appleyard Lees IP LLP
15 Clare Road
Halifax HX1 2HY
ROYAUME UNI

Applicant's or agent's file reference
P35214WO/RSW

International application No.
PCT/GB2019/051213

Applicant
GROUP RHODES LIMITED

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is notified that, if he wishes to amend the claims of the International Application (see Rule 46),

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

From the INTERNATIONAL SEARCHING AUTHORITY

To:

Appleyard Lees IP LLP
15 Clare Road
Halifax HX1 2HY
ROYAUME UNI

Date of mailing
(day/month/year)
29 July 2019 (29-07-2019)

Applicant's or agent's file reference
P35214WO/RSW

FOR FURTHER ACTION See paragraphs 1 and 4 below

International application No.
PCT/GB2019/051213

International filing date
(day/month/year)
2 May 2019 (02-05-2019)

Applicant
GROUP RHODES LIMITED

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

The applicant is notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

The time limit for filing amendments is normally two months from the date of transmittal of the international search report.

How? Send to the International Bureau of WIPO, 34 Avenue des Cornettes, 1211 Geneva 20, Switzerland. Fax: (41-22) 338 92 70.

For more detailed instructions, see PCT Applicant's Guide, International Phase, paragraphs 9.504 - 9.511.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) is not effective and the written opinion of the International Searching Authority is transmitted herewith.

3. ☐ With regard to any protest against payment of (or) additional fees under Rule 41.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau, together with any applicant's request to forward the text of both the protest and the decision to the designated Offices;

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. Reminders

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Specify after the expiration of 18 months from the priority date, the international application will be published to the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the national examinations for international publication (Article 49.1 and 49.2).

Within 18 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed. The applicant wishes to request the entry into the national phase until 30 months from the priority date in some Offices even if no demand is filed within 18 months from the priority date, perform the prescribed steps for entry into the national phase before designated Offices in respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 18 months. For details about the applicable time limits, Office by Office, see www.wipo.int/patents/ib/phase/entry.html and the PCT Applicant's Guide, National Chapters.

Within 37 months from the priority date, the applicant may request that a supplementary international search be carried out by a different International Searching Authority that offers this service (Rule 40.6). The provisions for requesting supplementary international search is described in the PCT Applicant's Guide, International Phase, paragraphs 8.005-8.032.

Name and mailing address of the International Searching Authority

European Patent Office, P.O. Box 5011, D-69110 Heidelberg, Germany
Tel: (49-6223) 345-0
Fax: (49-6223) 345-5011

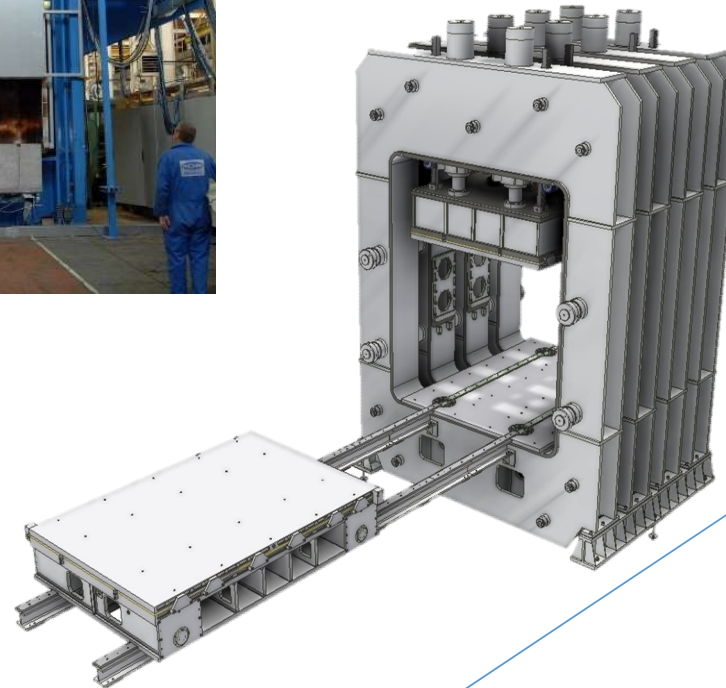
Authorized officer

GRUBER, Ralph
Tel: +49 (0)6223 339-7885

Form PCT/ISA/220 (July 2017)



Technological Impact



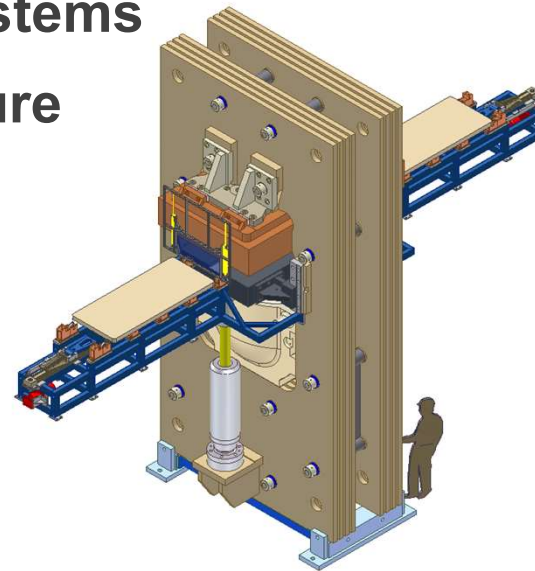
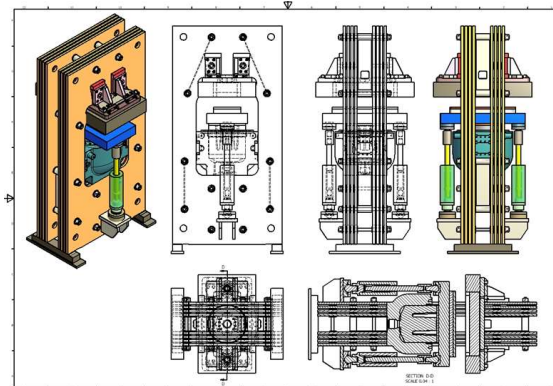
Standard Metal Forming

- ▶ Customer: Hindalco, India
- ▶ **Description:**
 - ▶ 250T Double Sided Mechanical Press
 - ▶ Servo Roll Tool Manipulation
 - ▶ Coil handling equipment >10T Coils
 - ▶ Hydraulic shear
 - ▶ Circle handling system
 - ▶ Automatic Palletising system
 - ▶ Packing and wrapping system



Polymer Bolster Forming

- ▶ Customer: Hindustan Aeronautics, India
- ▶ Automotive Tool (Pad) Changing Systems
- ▶ Application of (near) Uniform Pressure
- ▶ Form Pre-Coated Materials
- ▶ One Process Cycle



Superplastic Forming

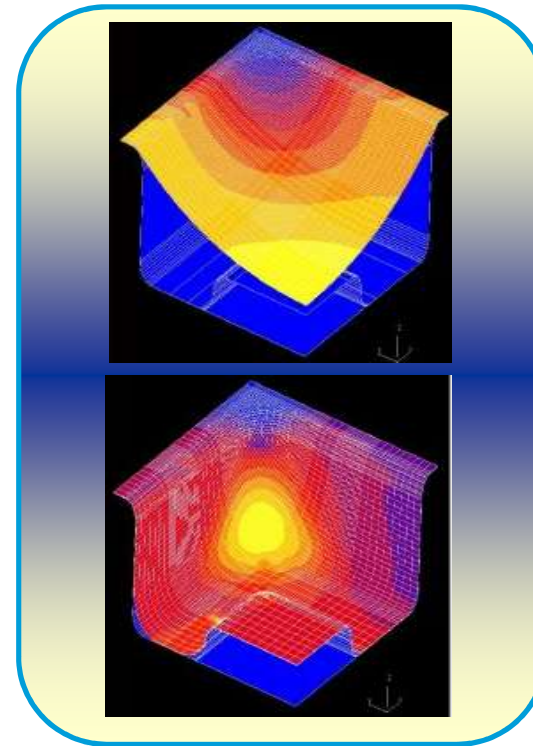
- ▶ Customer: BAE Systems (Typhoon/JSF)
- ▶ Description:
 - ▶ 2 off 2000T SPF/DB Press Lines
 - ▶ New Press Platen Ceramic Support Blocks
 - ▶ Innovative Hydraulic Load Application
 - ▶ Quick Change Hot Die Loading System
 - ▶ Patented Gas Pressure Compensation System



Superplastic Forming (SPF)

► What is Superplasticity?

- **Superplasticity is the ability of certain materials to undergo extraordinary tensile deformation without fracturing.**
- Superplastic Forming' (SPF) - offers engineers a method of accurately forming single or multiple sheets of material into extremely complex, accurate, deep drawn shapes.



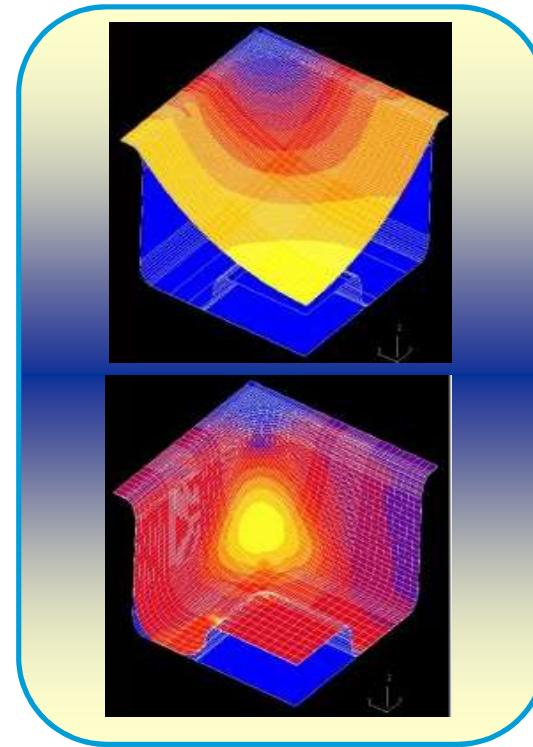
Superplastic Forming/ Diffusion Bonding

▶ A UK Success Story

- ▶ 1912 - G. D. Bengough – Liverpool University.
Anomalous material deformations at high temperatures.
- ▶ 1934 - C. E. Pearson – Newcastle University 2000% elongation of extruded tube.
- ▶ 1968 - British Aircraft Corporation (Now BAe) Assessed SPF for aircraft manufacture.
- ▶ 1979 - BAe and Group Rhodes build the largest commercial SPF production unit in Europe.
- ▶ 2010 - Rhodes completes work on the worlds most advanced SPF/DB installation.

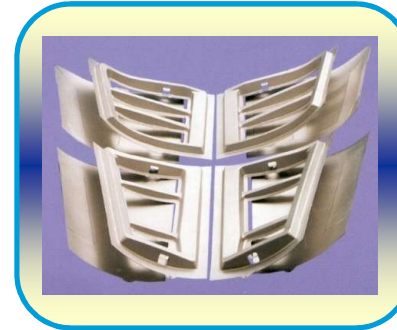
Superplastic Forming (SPF)

- ▶ What is Superplasticity?
 - ▶ Superplasticity is the ability of certain materials to undergo extraordinary tensile deformation without fracturing.
 - ▶ **Superplastic Forming' (SPF) - offers engineers a method of accurately forming single or multiple sheets of material into extremely complex, accurate, deep drawn shapes.**



Diffusion Bonding (DB)

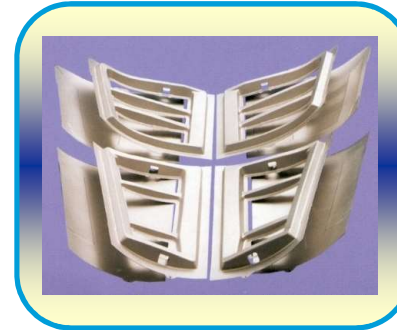
- ▶ **What is Diffusion Bonding?**
 - ▶ **‘Diffusion Bonding’ (DB) is a solid state joining process achieved by the application of load at elevated temperatures. The resultant molecular bond offers a fully homogeneous joint, which, in many cases, is undetectable under microscopic examination.**



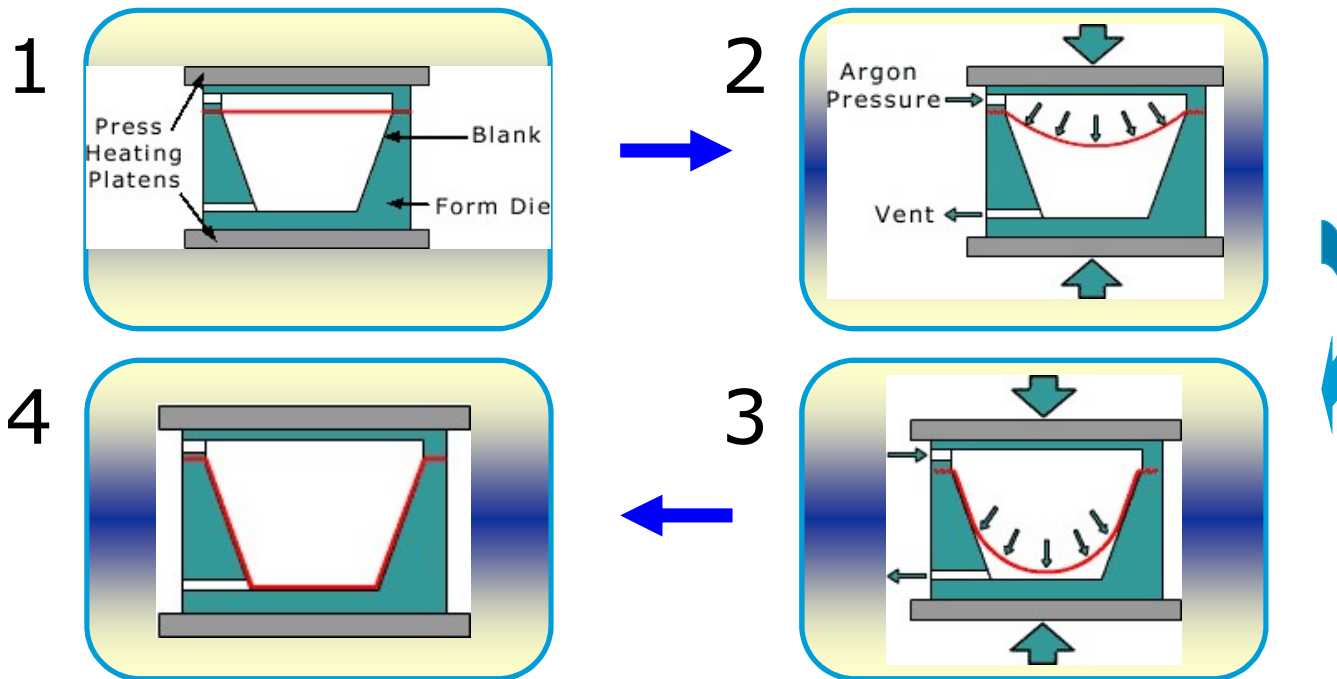
Diffusion Bonding (DB)

- ▶ **Application Benefits**

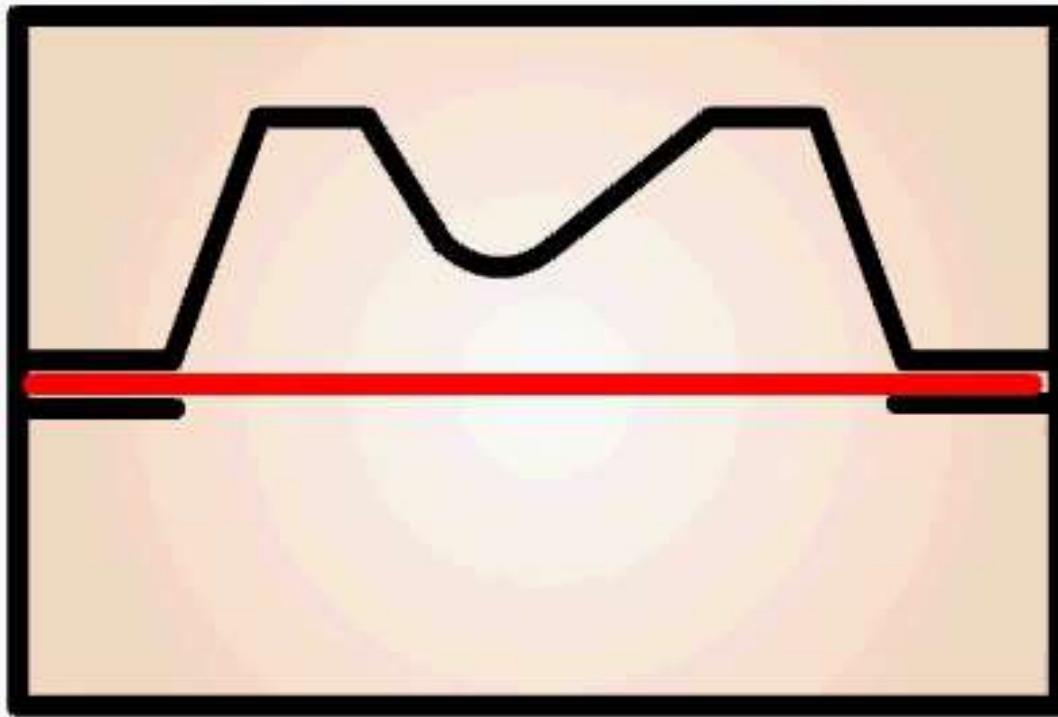
- ▶ The DB process offers freedom to produce more complex, stiffer, stronger and lighter structures in one piece thus giving improved component integrity, and the elimination of unnecessary joints.



The Superplastic Forming (SPF) Process

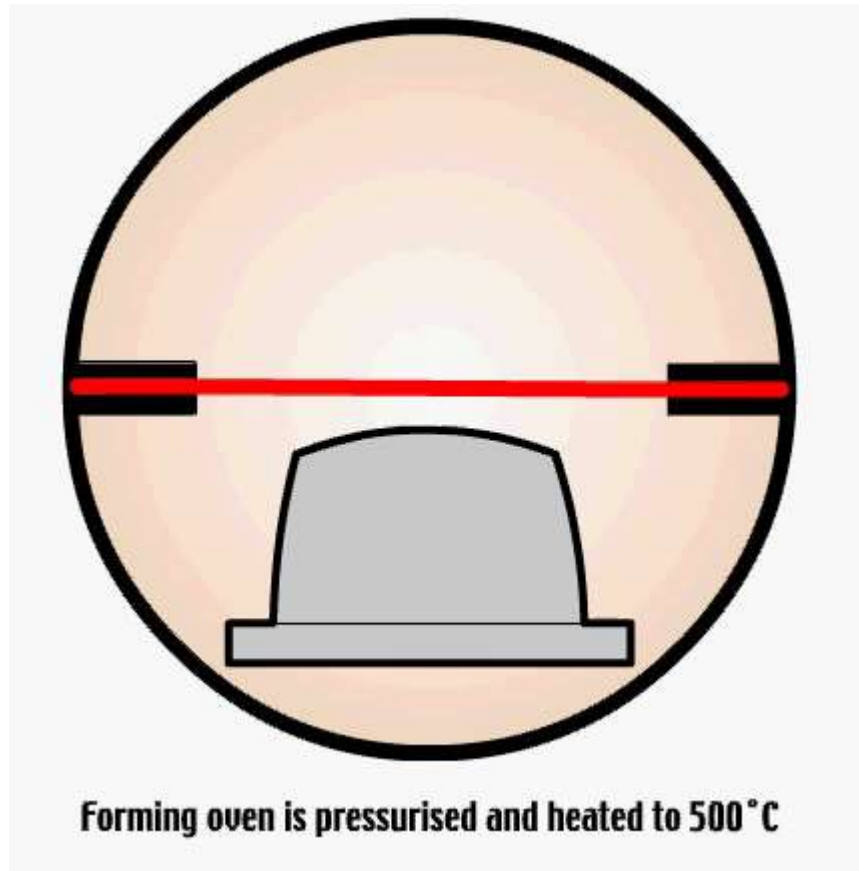


The SPF Process: 1. Cavity Forming

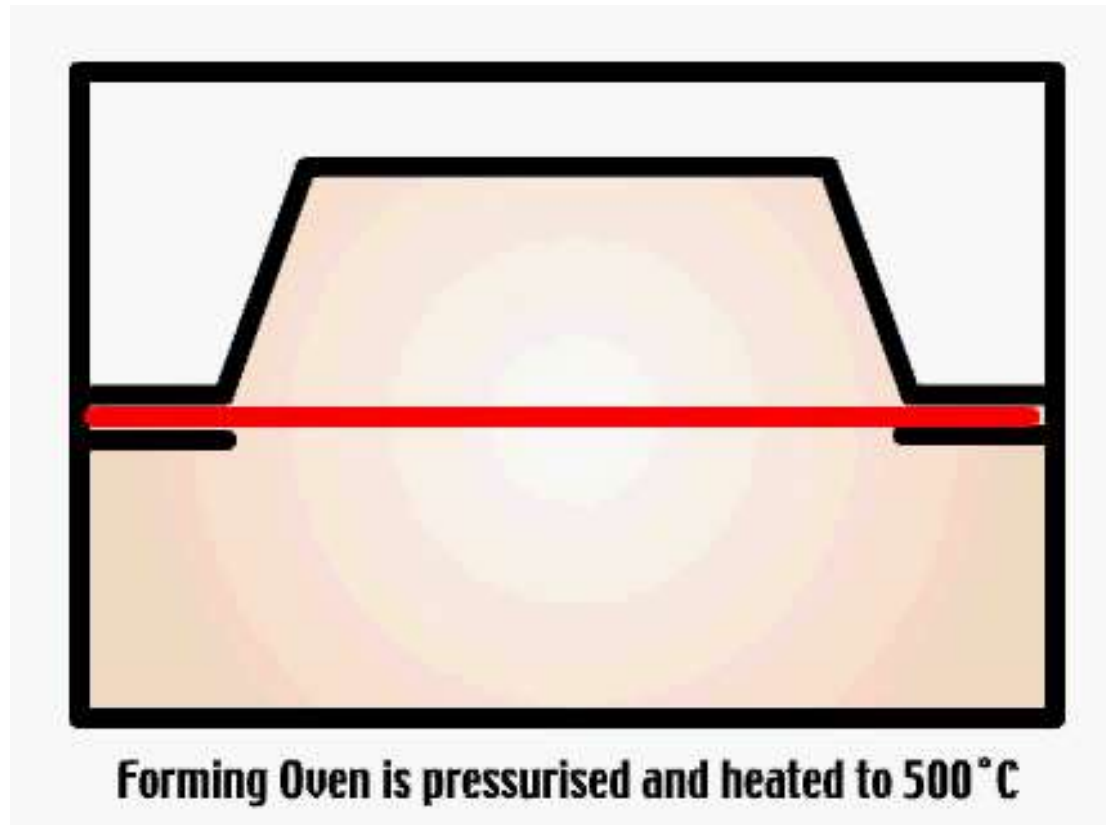


Forming Oven is pressurised and heated to 500°C

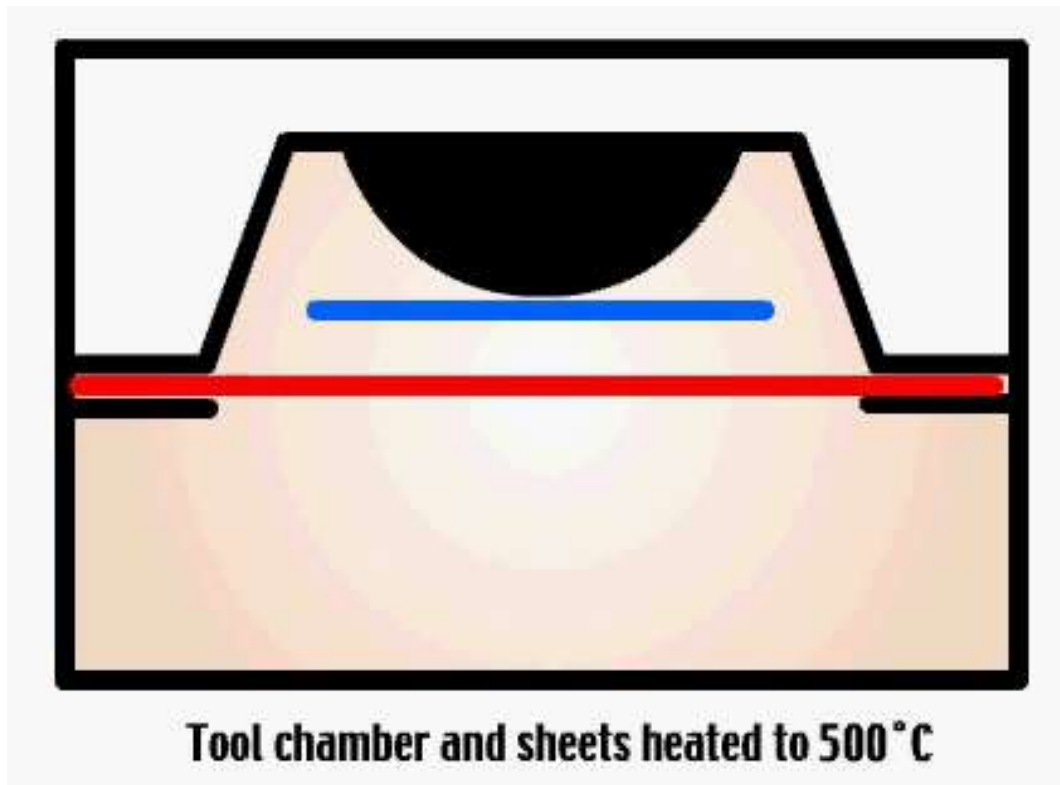
The SPF Process: 2. Bubble Forming



The SPF Process: 3. Back Pressure Forming

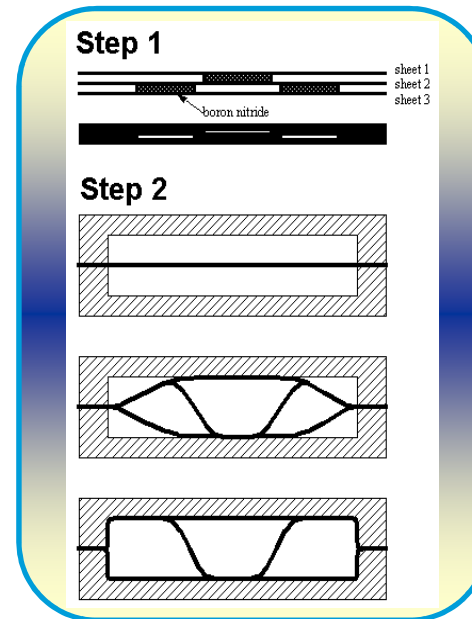


The SPF Process: 4. Diaphragm Forming



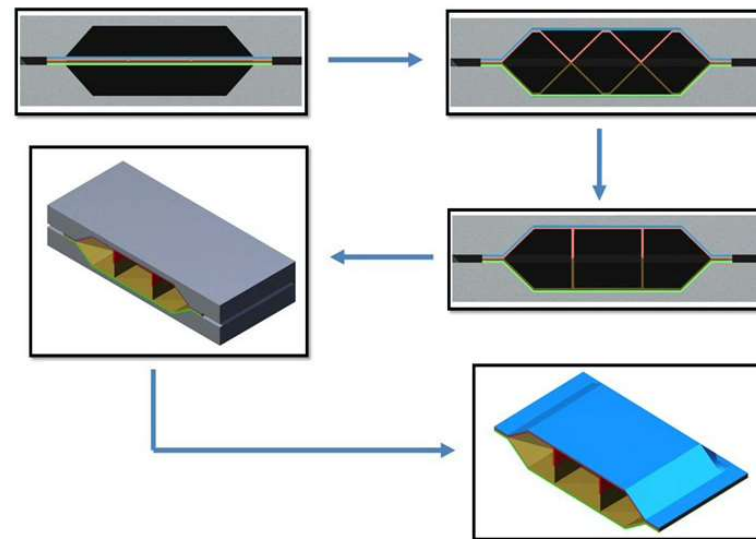
The Diffusion Bonding (DB) Process

- ▶ **Step 1 - Sheets are put down in layers and heat and pressure are used to bond sheets together.**
- ▶ **Step 2 - The laminated sheets are placed into a mould, and SPF is used to shape the external parameters.**



The Diffusion Bonding (DB) Process

- **Step 3 – Pressure is applied by blowing inert gas between the sheets forming strong, intricate and light-weight structures.**



Superplastic Forming/Diffusion Bonding

► Applications in the Aerospace Industry

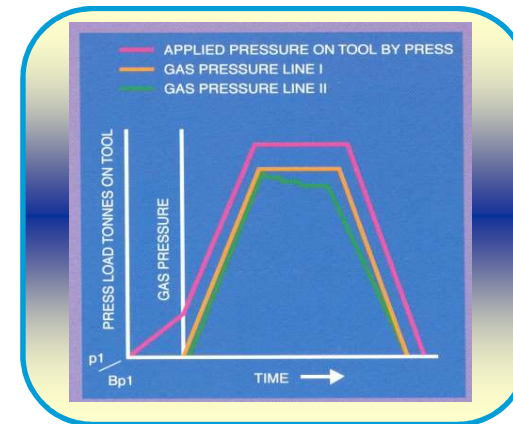


A380 Fitted with Rolls Royce Trent 900 Engines.

Superplastic Forming/Diffusion Bonding

► Key Requirements

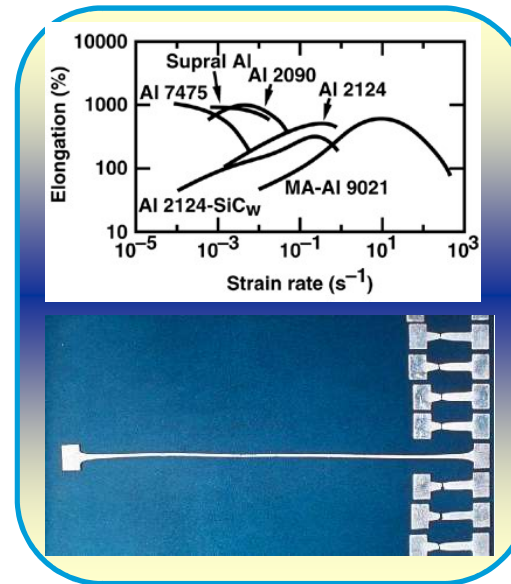
- Rigid press construction.
- Correct Material Selection
- Accurate temperature control of the process tooling. (Within ± 5 Deg C)
- Accurate, gas, process forming control. (Within ± 0.15 Millibar)
- Accurate reaction load application control. (Within ± 2 Bar)



Superplastic Forming/Diffusion Bonding

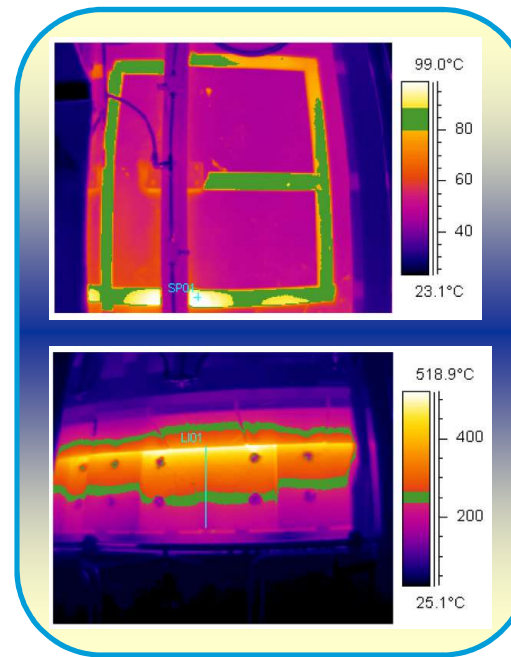
► Materials

- Aluminium Alloys
- Titanium Alloys
 - Tensile Ductility
 - Strain Rates
 - Fatigue Toughness
 - Corrosion Resistance
 - Post Forming Welding Properties



Superplastic Forming/Diffusion Bonding

- ▶ **Temperature Analysis**
 - ▶ Thermal imagery of a Group Rhodes SPF Press
 - ▶ Benefits Include:
 - ▶ Consistent Product Geometry
 - ▶ Optimum Cycle times
 - ▶ Energy Conservation



SPF Patent

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

From the INTERNATIONAL SEARCHING AUTHORITY

To:
Appleyard Lees IP LLP
15 Clare Road
Halifax HX1 2HY
ROYAUME UNI

(PCT Rule 44.1)

Date of mailing
(day/month/year) 29 July 2019 (29-07-2019)

Applicant's or agent's file reference
P35214WO/RSW

FOR FURTHER ACTION See paragraphs 1 and 4 below

International application No.
PCT/GB2019/051213

International filing date
(day/month/year) 2 May 2019 (02-05-2019)

Applicant
GROUP RHODES LIMITED

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is notified that, if he wishes to amend the claims of the International Application (see Rule 46),

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing
(day/month/year) 29 July 2019 (29-07-2019)

FOR FURTHER ACTION See paragraphs 1 and 4 below

International filing date
(day/month/year) 2 May 2019 (02-05-2019)

From the INTERNATIONAL SEARCHING AUTHORITY
To:
Appleyard Lees IP LLP
15 Clare Road
Halifax HX1 2HY
ROYAUME UNI

Applicant's or agent's file reference
P35214WO/RSW

International application No.
PCT/GB2019/051213

Applicant
GROUP RHODES LIMITED

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

The applicant is notified that, if he wishes to amend the claims of the International Application (see Rule 46),

the time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

How? Send to the International Bureau of WIPO, 34 Avenue des Cornettes, 1211 Geneva 20, Switzerland. Facsimile No. (41-22) 338 92 70.

For more detailed instructions, see PCT Applicant's Guide, International Phase, paragraphs 9.204 - 9.211.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) in that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to any protest against payment of (or) additional fees under Rule 41.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau, together with any applicant's request to forward it to the text of both the protest and the decision to the designated Offices;

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Specify after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the national examinations for international publication (Article 46.1 and 46.2).

Within 18 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed. The applicant wishes to request the entry into the national phase until 30 months from the priority date in some Offices even if no demand is filed within 18 months from the priority date, perform the prescribed steps for entry into the national phase before designated Offices in respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 18 months. For details about the applicable time limits, Office by Office, see www.wipo.int/patents/standards/standards.html and the PCT Applicant's Guide, National Chapters.

Within 37 months from the priority date, the applicant may request that a supplementary international search be carried out by a different International Searching Authority that offers this service (Rule 40.6a). The provisions for requesting supplementary international search is described in the PCT Applicant's Guide, International Phase, paragraphs 8.005-8.032.

Name and mailing address of the International Searching Authority
European Patent Office, P.O. Box 1015, 8001 Zurich, Switzerland
Tel. (41-22) 339 3949
Fax (41-22) 339 3919

Authorized officer
GRUBER, Ralph
Tel. +41 (0)59 239-7885

Form PCT/ISA/220 (July 2017)



Superplastic Forming

- ▶ Customer: BAE Systems (Typhoon/JSF)
- ▶ Description:
 - ▶ 2 off 2000T SPF/DB Press Lines
 - ▶ New Press Platen Ceramic Support Blocks
 - ▶ Innovative Hydraulic Load Application
 - ▶ Quick Change Hot Die Loading System
 - ▶ Patented Gas Pressure Compensation System



IIoT

- ▶ **Condition Monitoring**
 - ▶ Long Term Vibration and Temperature Monitoring
 - ▶ In-Process Analysis of Conditional Data
 - ▶ Predictive Failure and TPM Guidance
 - ▶ Cloud or App Based Development
 - ▶ Notifications/Alerts on Events
 - ▶ Live Status Reporting



Superplastic Forming/Diffusion Bonding

► Control Systems

► Improvements to:-

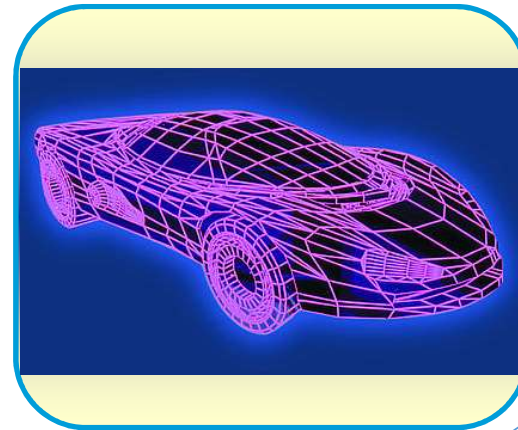
- Temperature Control
- Gas Control
- Load Application Control
- Data Logging



Superplastic Forming/Diffusion Bonding

▶ Key Benefits

- ▶ Extended design freedom
- ▶ Complex stiffened structures
- ▶ High accuracy forming
- ▶ Elimination of joining processes
- ▶ Reduced parts and fasteners
- ▶ Good surface finish



Superplastic Forming/Diffusion Bonding

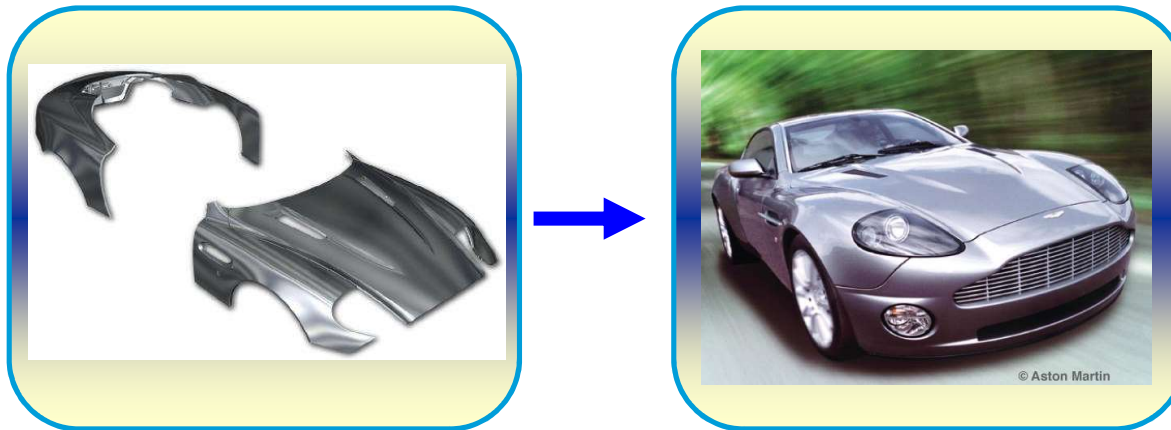
- ▶ **Key Benefits (continued)**

- ▶ **Excellent form freezing (no spring back)**
- ▶ **High component strength-to-weight ratio**
- ▶ **Reduction in material and machining**
- ▶ **Reduced tooling costs**
- ▶ **Single step forming process**



Superplastic Forming/Diffusion Bonding

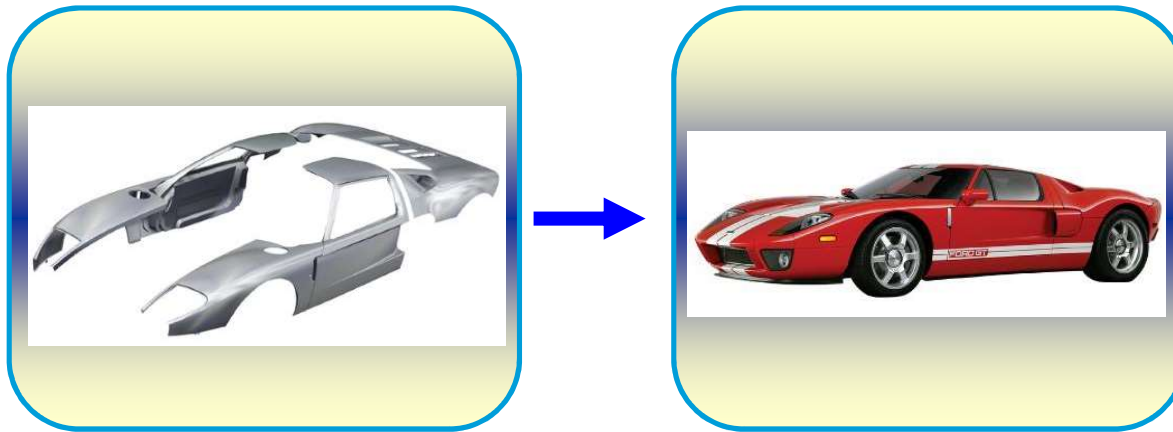
► Applications in the Automotive Industry



The Aston Martin V12 Vanquish has a range of super formed external body panels and stiffening panels.

Superplastic Forming/Diffusion Bonding

► Applications in the Automotive Industry



**Super formed aluminium exterior body panels
for the Ford GT.**

Superplastic Forming/Diffusion Bonding

- ▶ **Future Developments**
 - ▶ **Process Development**
 - ▶ Low cost alloys
 - ▶ Higher strain rates
 - ▶ Improved cycle times
 - ▶ SPF simulation
 - ▶ Condition Monitoring

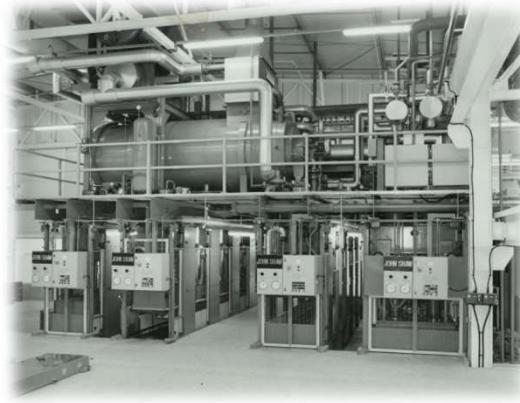
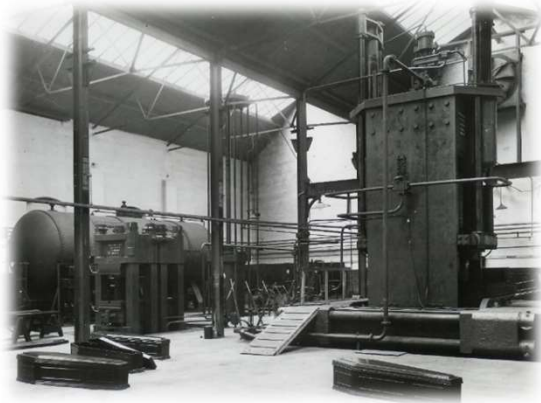


Superplastic Forming/Diffusion Bonding

- ▶ **Future Developments**
 - ▶ **Future Applications**
 - ▶ **Cutting edge design (automotive and aerospace)**
 - ▶ **Cost driven components**
 - ▶ **Vehicle weight reduction**
 - ▶ **Increased fuel economy**
 - ▶ **Reduced green house gasses**

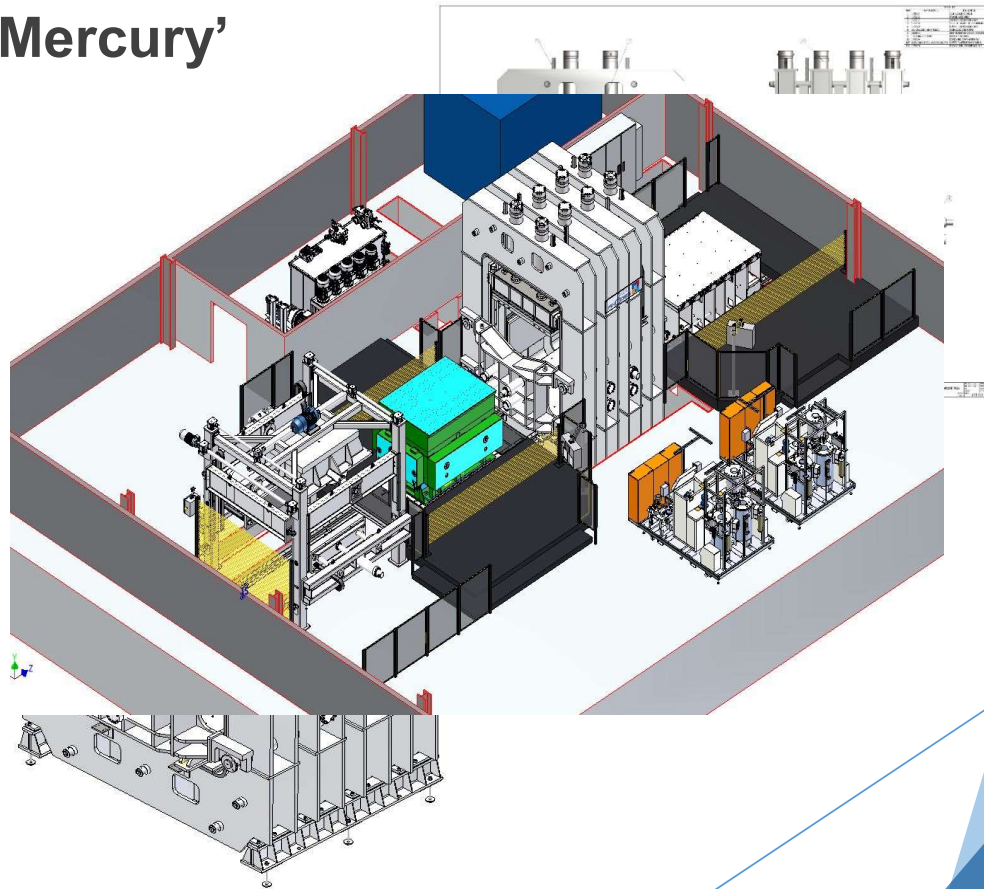


Composites Moulding Presses



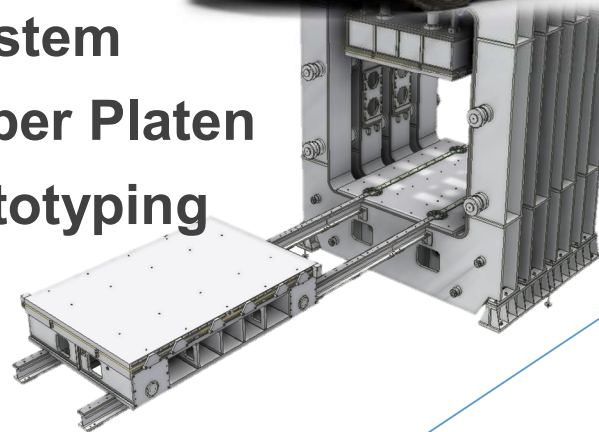
Composites Moulding Press - 2018

- ▶ AMSCI 'LX' + AMRC 'Mercury' Programme
- ▶ Multi Frame Design
- ▶ 3 Axis Pressing:-
 - ▶ 1000 Ton Vertical
 - ▶ 250 Ton Sides
 - ▶ 140 Ton Ends



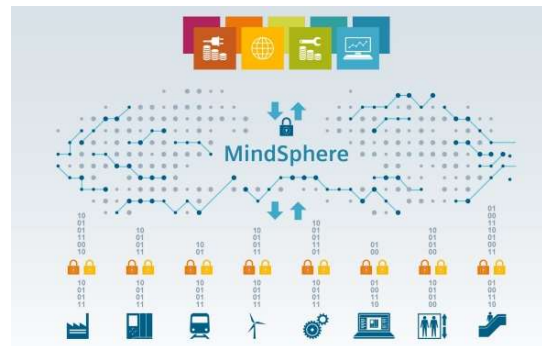
Composite Forming

- ▶ Customer: AMRC
- ▶ Description:
 - ▶ 1000T 3 Axis Composite Hot Forming Press
 - ▶ 300°C Oil Heated Platens
 - ▶ 20T Die Splitter
 - ▶ Resin Transfer Moulding System
 - ▶ Precision Positioning of Upper Platen
 - ▶ Designed with Versatile Prototyping Capability



IIoT

- ▶ **Condition Monitoring**
 - ▶ Long Term Vibration and Temperature Monitoring
 - ▶ In-Process Analysis of Conditional Data
 - ▶ Predictive Failure and TPM Guidance
 - ▶ Cloud or App Based Development
 - ▶ Notifications/Alerts on Events
 - ▶ Live Status Reporting





Thank you

谢谢

शुक्रिया

Obrigado

спасибо

Q&A: Composites Press - Time Lapse





Thank you

谢谢

शुक्रिया

Obrigado

спасибо