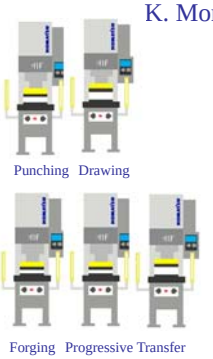
Application of servo presses to sheet metal forming

K. Mori, Toyohashi University of Technology

Flexible motion



Contents

1) Types of mechanical servo presses

2) Bending

3) Deep drawing

4) Hot stamping

5) Shearing and plate forging

6) Conclusions

Servo Presses

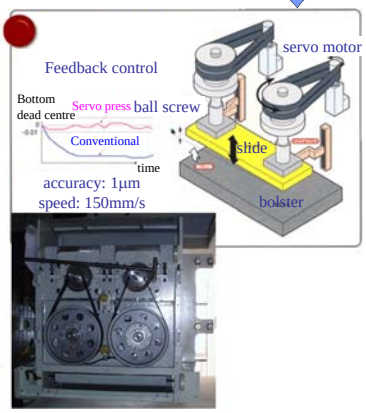
Mechanical servo press
- AC servo motor: fast
- Increase in power

Hydraulic servo press
- Hydraulic pump: slow

Direct driving type press

80tonf, Komatsu Industry

Expensive

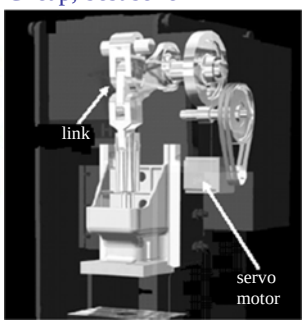


Mechanical link and toggle type press

Komatsu Industry

Conventional motor

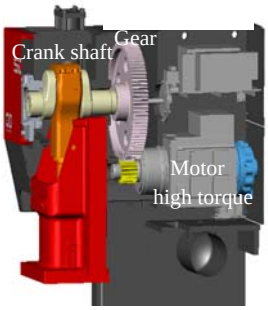
Cheap, best seller

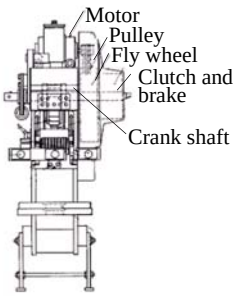


Crank type press

Aida Engineering, Amada

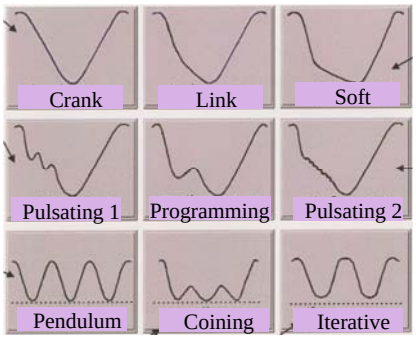
Easy maintenance





(a) Servo press (b) Conventional crank press

Motions of crank servo press



Amada SDE

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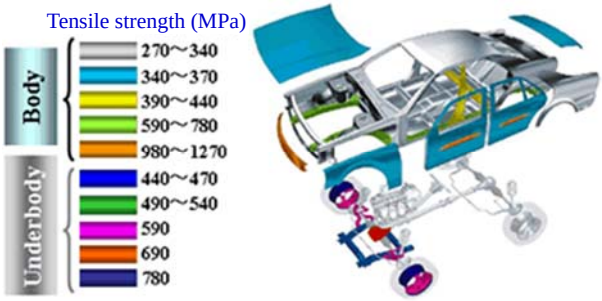
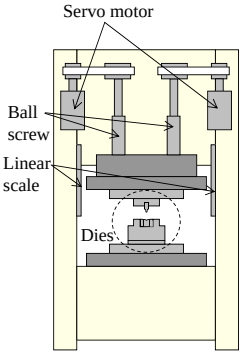
Application of high strength steel sheets to automobile body panel

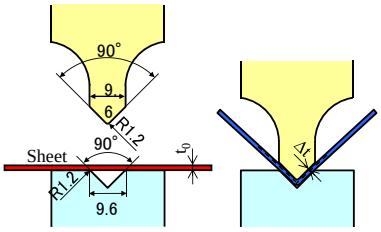
Reduction in car weight: high strength steel sheets



Reduction of springback in bending by bottoming

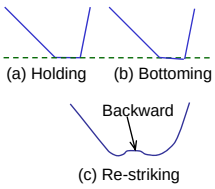


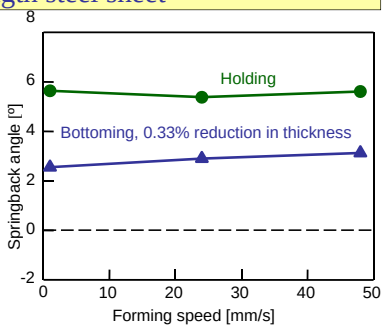
High strength steel sheets: large springback



K. Mori et al.

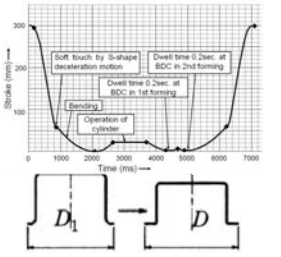
Reduction in springback by bottoming in V-bending of 980 MPa ultra high strength steel sheet



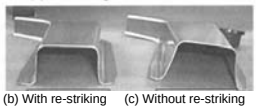


K. Mori et al.

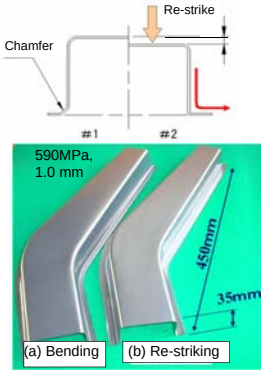
Prevention of springback and twisting by re-striking



(a) Re-striking of bent channel

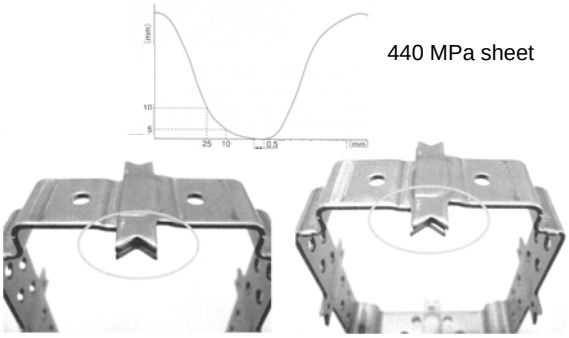


(b) With re-striking (c) Without re-striking



T. Suganuma et al.

Prevention of springback by holding at bottom dead centre



(a) Holding at bottom dead centre (b) No holding

Sakaguchi Seisakusho

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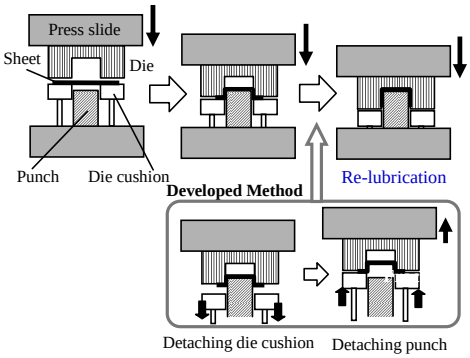
Improvement of deep drawability by detachment of tools from sheet

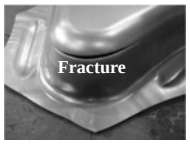


Y. Tamai et al.

Improvement of deep drawability by detachment of tools from sheet

590 MPa steel sheet

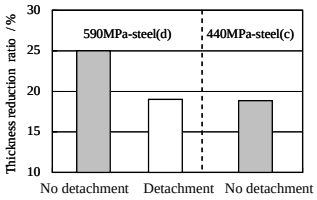
(b) Detachment



(c) No detachment

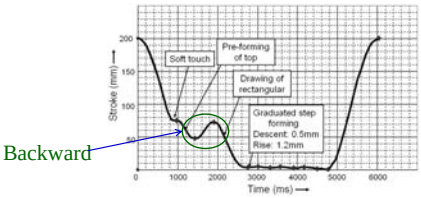
	Blank holding force /kN				
	300	350	400	450	500
No detachment	Good	Neck.	NG		
Detachment	Good	Good	Good	Neck.	Neck.

Neck.: Necking, NG: Fracture

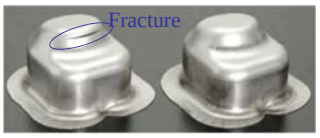


Y. Tamai et al.

Prevention of fracture in deep drawing of step cup



(a) Controlled ram motion



(b) Crank motion (c) Controlled motion

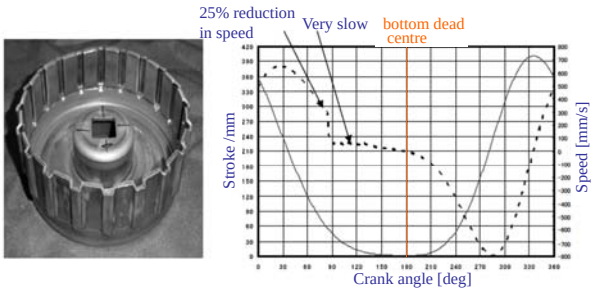
Aida Engineering

Prevention of fracture in deep drawing of step cup

Aida Engineering

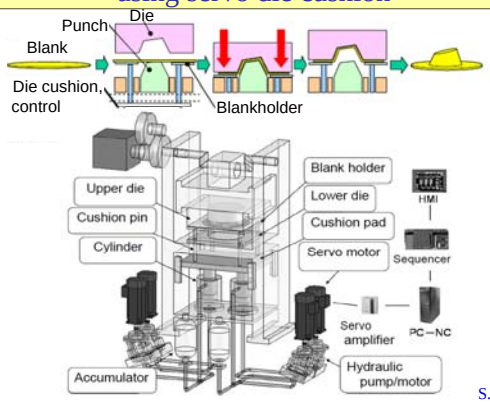
Control of forming speed in plate forging of gear drum

Prevention of seizure: decrease in temperature



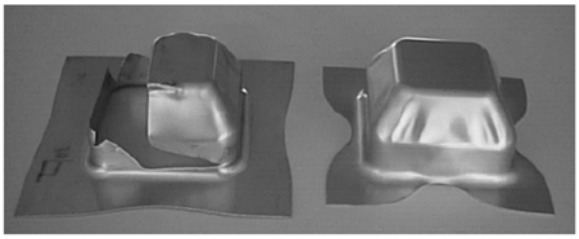
H. Ando et al.

Improvement of deep drawability using servo die cushion



S. Matsuno et al.

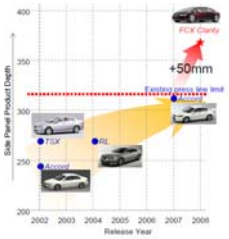
Prevention of fracture by control of blankholder force



(a) Conventional die cushion (b) Servo die cushion

Control of blankholder force in deep drawing of automobile panel

(a) Crank press

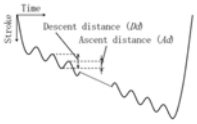


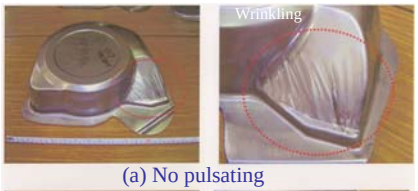
(b) High speed servo press and die cushion control

Honda Motor

Prevention of wrinkling in deep drawing by pulsating motion

Pulsating motion





(a) No pulsating

(b) Pulsating

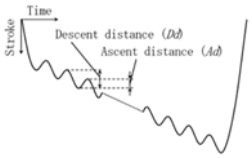
Iiyama

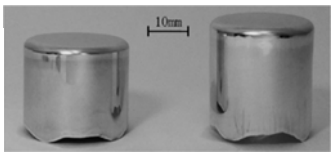
Reduction of friction in pulsating ironing

SUS 304

Increase in limiting ironing ratio

Pulsating motion

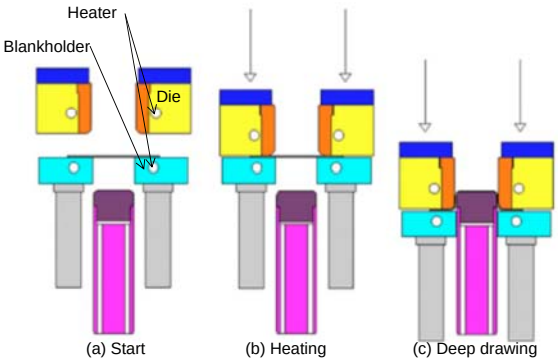




(a) Conventional (b) Pulsating

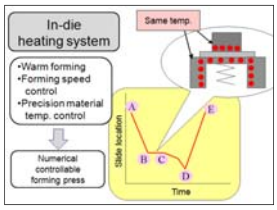
Koga et al.

Inclusion of heating process of magnesium alloy sheet in warm deep drawing



T. Altan et al.

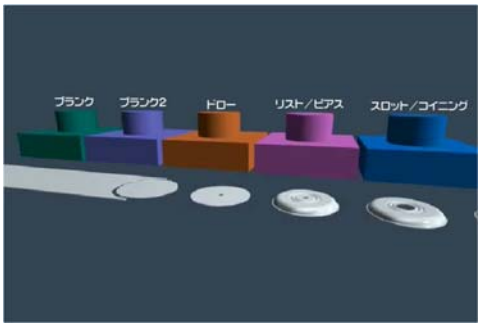
Warm forming of magnesium alloy laptop computer case



I. Komatsu et al.

1 shot press for controlling ram motion

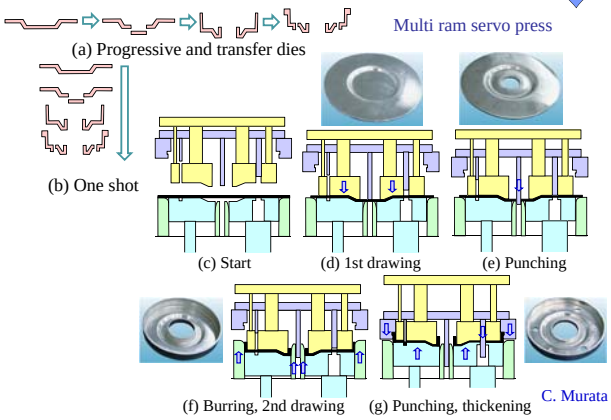
Progressive dies



Yutaka Giken

1 shot press for controlling ram motion

Multi ram servo press



C. Murata et al.

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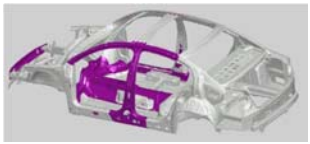
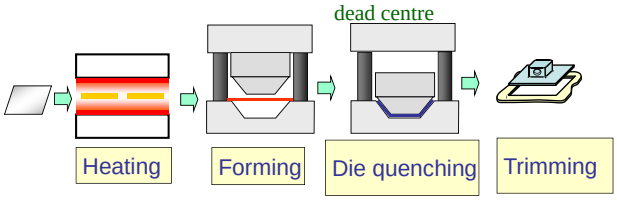
Hot stamping for producing ultra high strength steel products

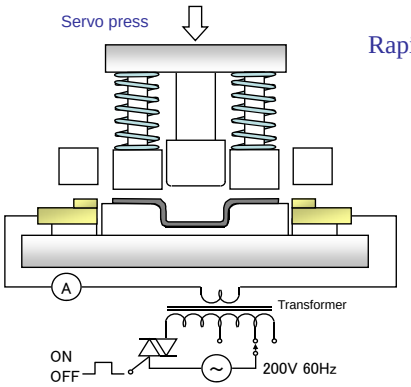


- Decrease in forming load
- Prevention of springback
- Increases in formability
- 1.5GPa strength

Holding at bottom dead centre



Hot stamping having resistance heating



Rapid stamping

Heating: 0.96s

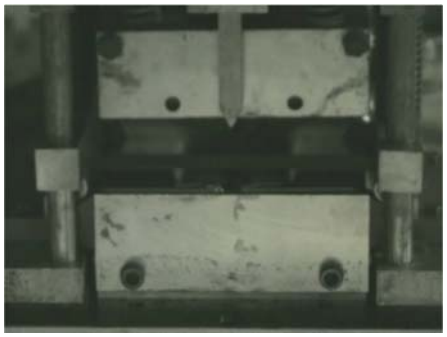
0.26s

Forming

Holding: 3.5s

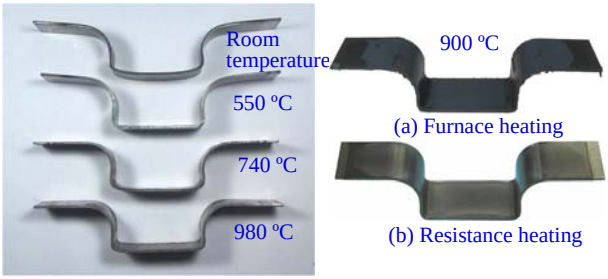
K. Mori et al.

Hat-shaped bending of 980MPa steel sheet using resistance heating at 980 ºC



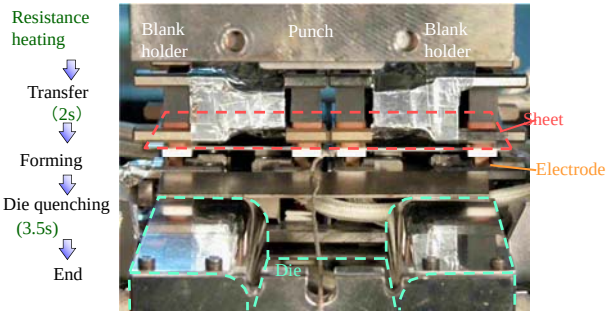
K. Mori et al.

Hat-shaped bending of 980 MPa steel sheet at different heating temperatures



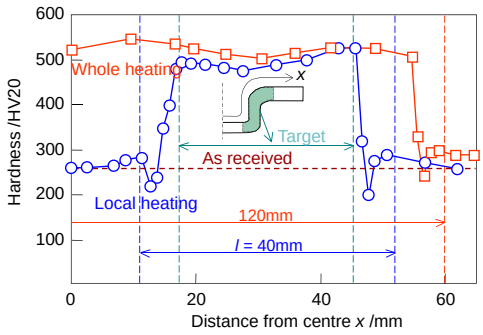
K. Mori et al.

Tailor die quenching for producing part having strength distribution



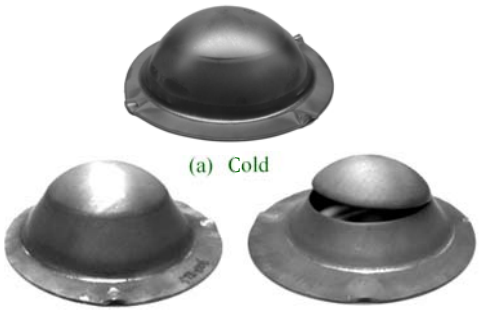
K. Mori et al.

Hardness distribution by tailor die quenching



K. Mori et al.

Effect of speed on formability



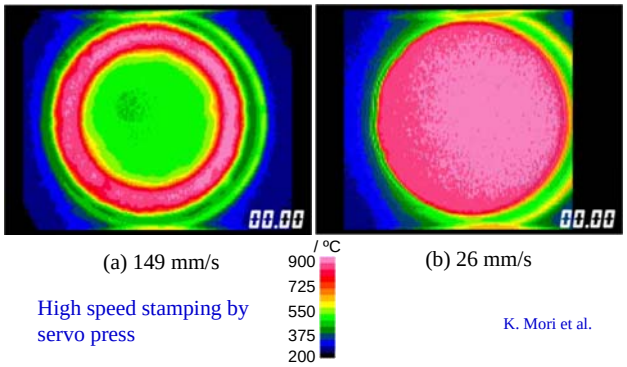
(a) Cold

(b) Hot, v = 149 mm/s

(c) Hot, 26mm/s

K. Mori et al.

Temperature distribution in hot stamping



(a) 149 mm/s (b) 26 mm/s

High speed stamping by servo press

K. Mori et al.

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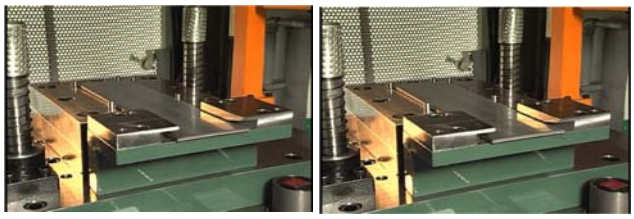
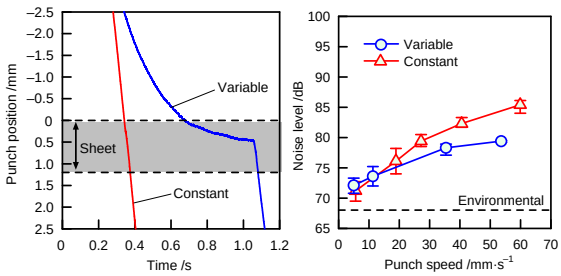
Reduction of noise in shearing



(a) Crank motion, 101 bB (b) Variable motion, 75 dB

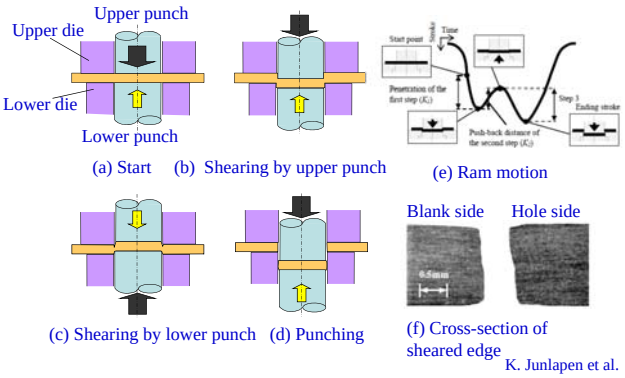
Aida Engineering

Reduction of noise in shearing



K. Osakada et al.

Improvement of quality of sheared edge by push-back punching



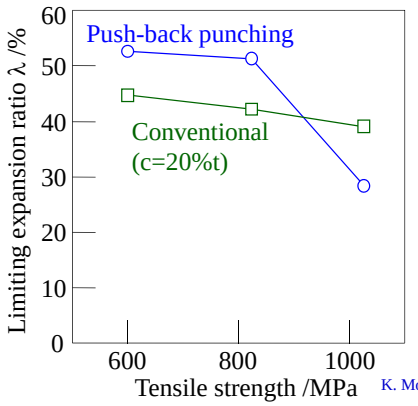
(a) Start (b) Shearing by upper punch (e) Ram motion

(c) Shearing by lower punch (d) Punching (f) Cross-section of sheared edge

K. Junlapen et al.

Relationship between limiting expansion ratio and tensile strength of steel sheet

Hole expansion

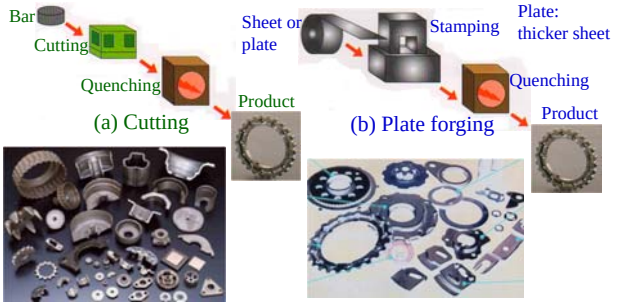


K. Mori et al.

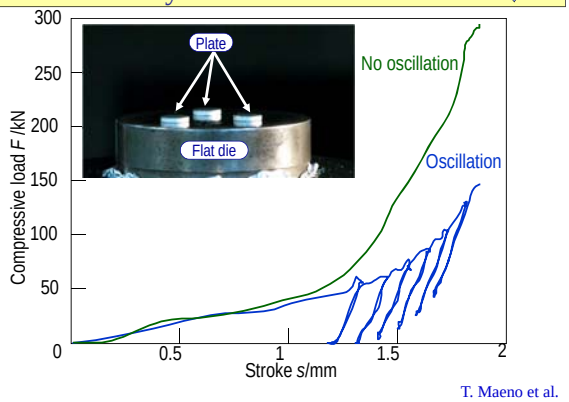
Plate forging

Reduction in cost → To forging from cutting

Reduction in thickness of plate → Large increase in load



Reduction of load in compression of plate by load oscillation



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Contents

1) Types of mechanical servo presses

2) Bending

3) Deep drawing

4) Hot stamping

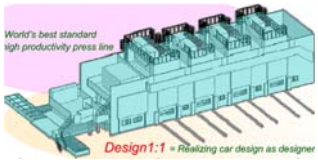
5) Shearing and plate forging

6) Conclusions

Fast servo press system: Honda Motor

23000 kN 4-point servo press, high speed robots, 19 spm

Tandem press



Advantages of servo presses

1. Free motion for development of novel forming processes
2. Local slide movement for high productivity
3. Improvement of dimensional accuracy and stability due to feedback control
4. Digital linkage with other machines
5. Easy maintenance due to simple structure

Application of servo presses

Formability

Accuracy

Productivity

Digital production

How to use the servo presses