AP&T Production solutions for High Strength Aluminum

2019-12-04

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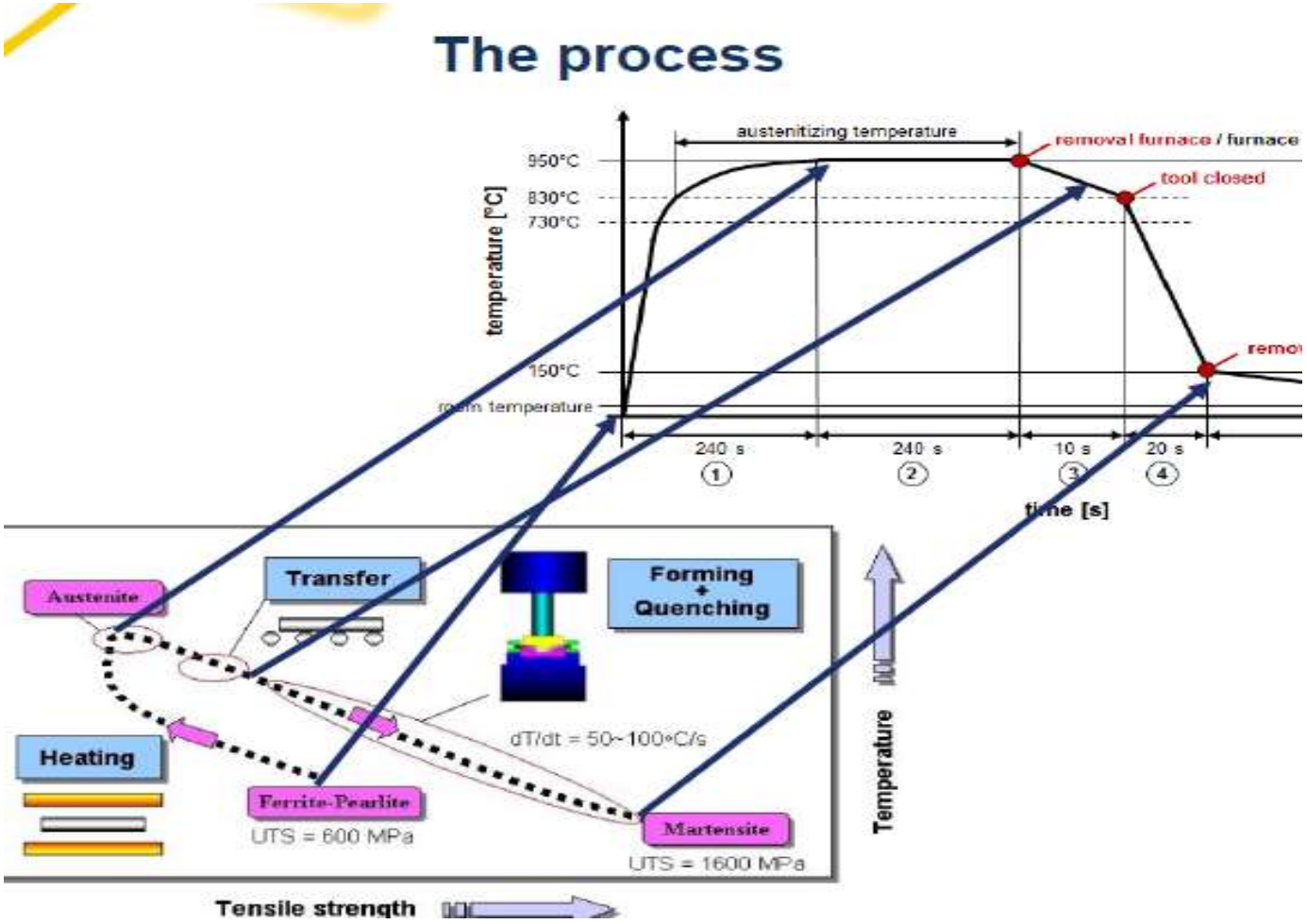
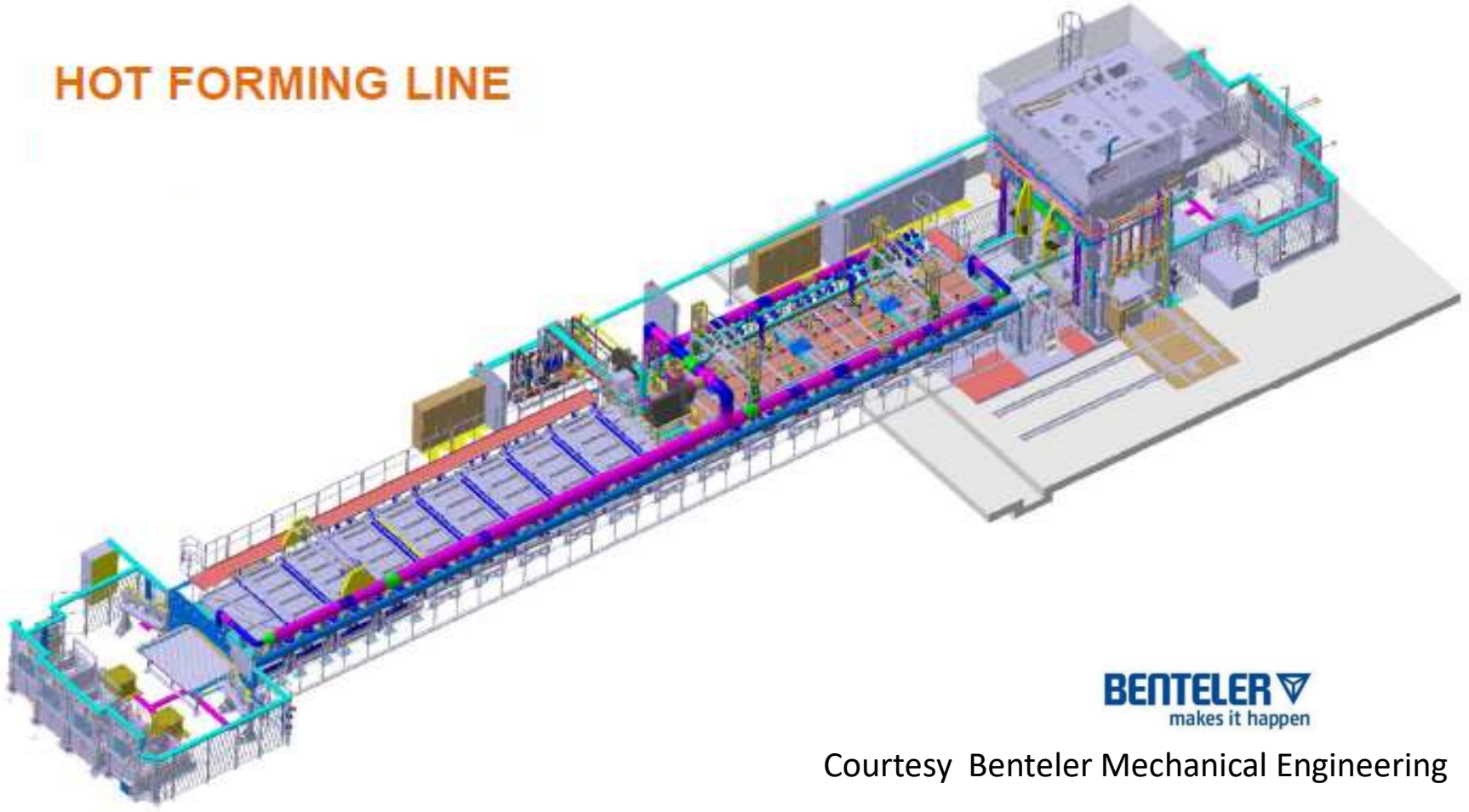
Agenda

- Introduction to Hot forming
- New trends in Hot forming
- Aluminium Hot forming
- Titanium Hot forming
- About AP&T …

Introduction to Hot forming



Introduction to Hot forming

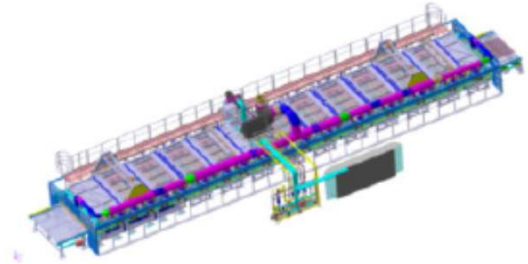


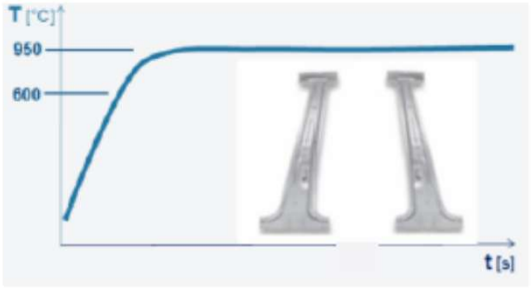
Courtesy Benteler Mechanical Engineering

New trends in Hot forming

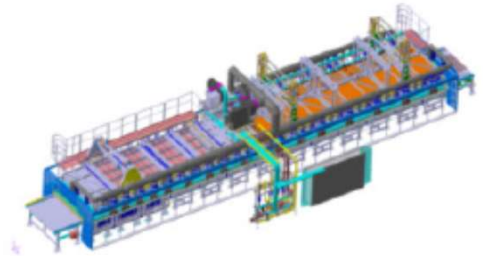
FURNACE TYPES – DIRECT HOT FORMING

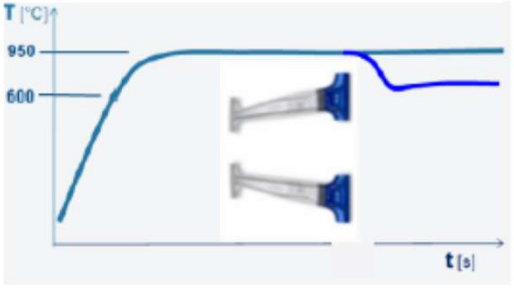
BENTELER
makes it happen





Homogenous Furnace



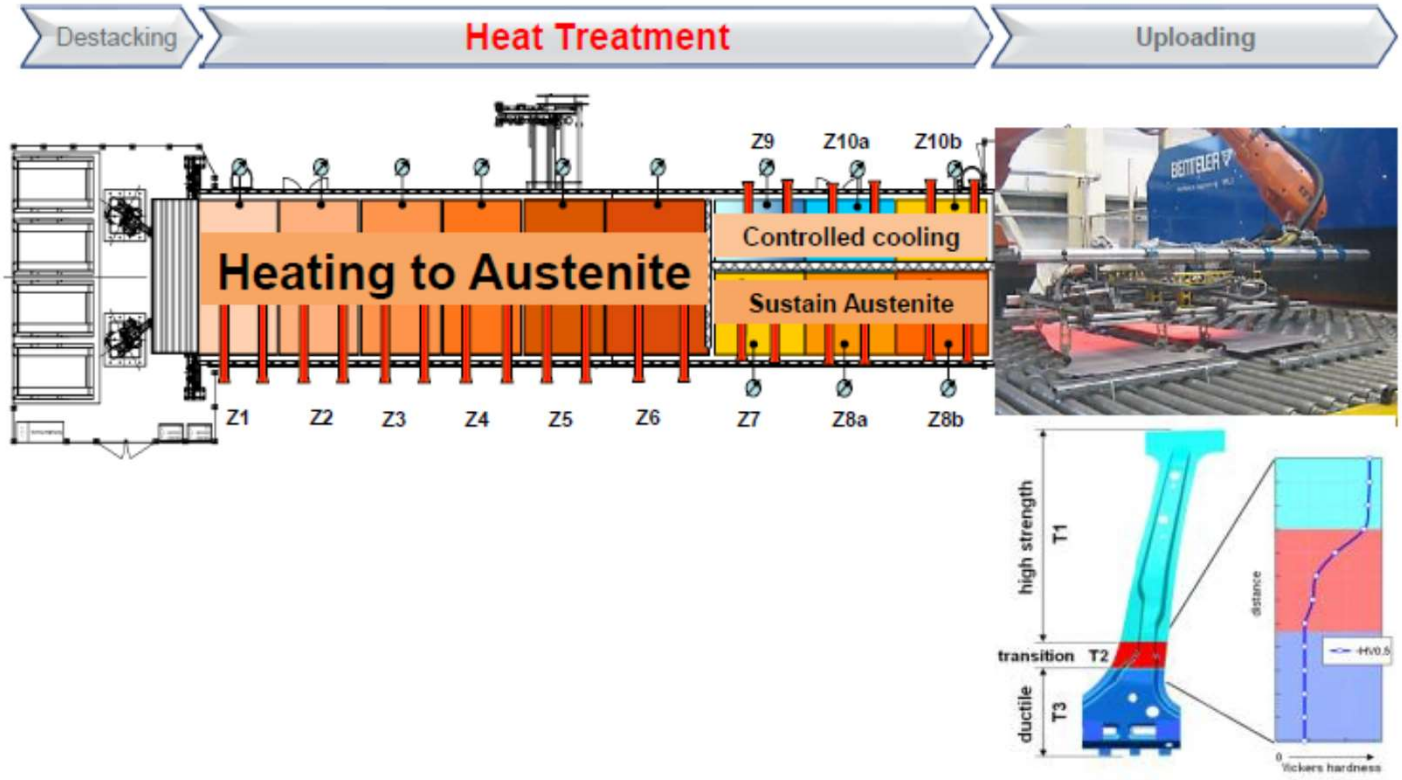


Partial Hardening Furnace

New trends in Hot forming

PARTIAL HARDENING

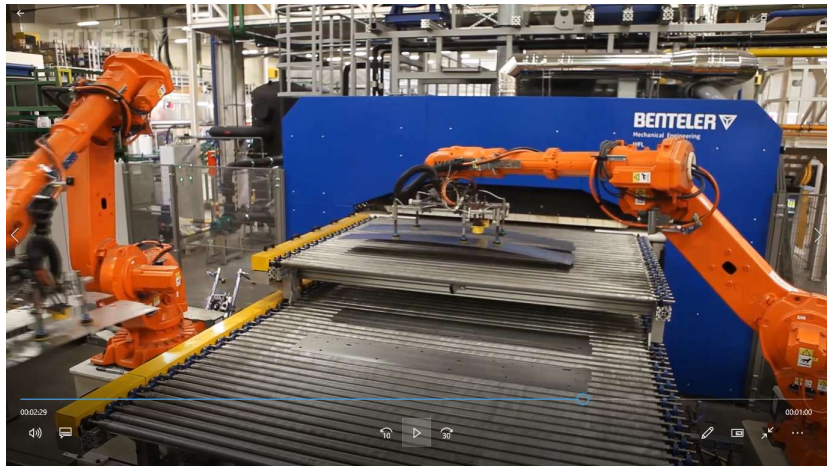
BENTELER
makes it happen



New trends in Hot forming:- Higher output

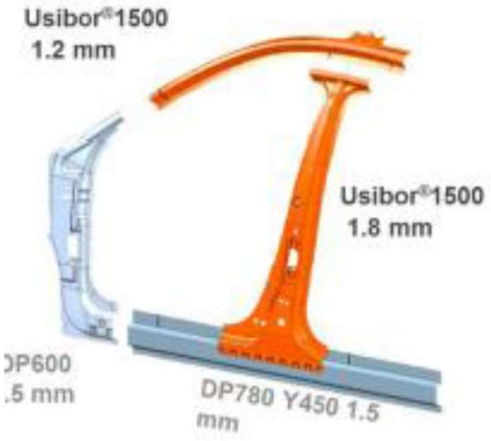
Large tonnage presses

Double Decker furnaces



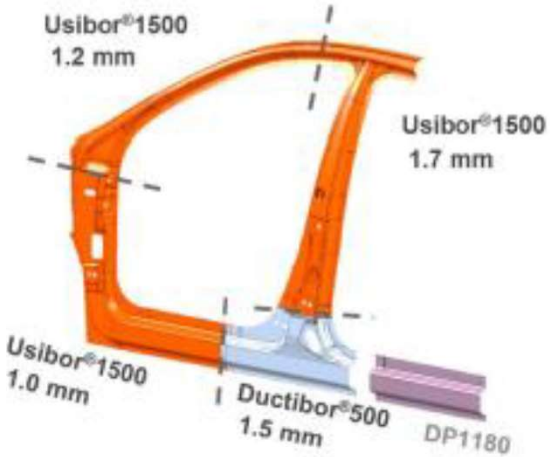
New trends in Hot forming

Current vehicles



Baseline:
15.8* kg

LWB Door Ring solution



Door Ring Solution:
12.7* kg **(-20%)**

1 part instead of 4

- ✓ One stamping tool
- ✓ One stamping operation
- ✓ No post assembly operations

Lightweight concept

- ✓ Hot stamping steel grades
- ✓ Optimized thickness distribution
- ✓ Laser weld continuous links (no overlap)

Hot-stamping geometry accuracy

Honda's Acura MDX

Materials, thicknesses and weldline positions can be tuned to optimize weight

Aluminium Hot forming

Why High Strength Aluminum ?

- Weight reduction
- Improved crash performance
- High corrosion resistance
- Recyclable and sustainable
- Internal Combustion Engine vehicles
  - Fuel efficiency
  - Future legal CO_2 - requirements
- Battery Electrical Vehicle
  - Range extension
  - Cost saving due to less battery capacity needed

USA	Europa	China
2025	**2020**	**2020**
101 g CO_2/km	95 g CO_2/km	5 l/100km

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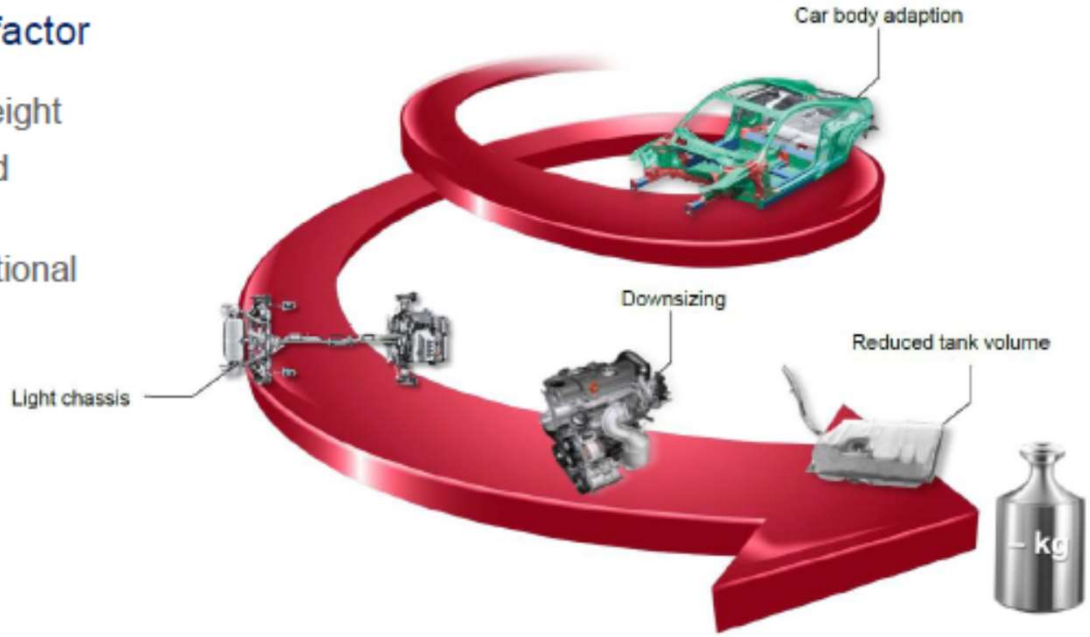
What does it take to go light weight?

Car body as key factor

- Design to leightweight
- New materials and processes
- High rates of functional integration



Source: Volkswagen AG, Audi AG

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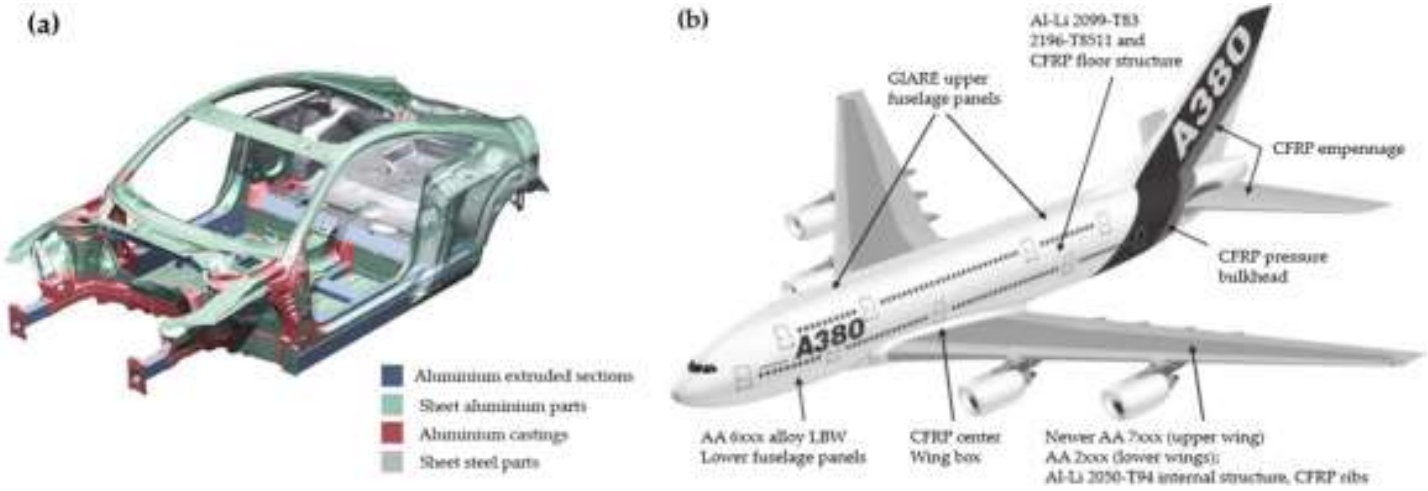
Use of Aluminium in Automotive



Applications of aluminium alloy panel structures in an automobile and aircraft: (a) Audi TT coupé and (b) Airbus 380

Aluminium Hot forming

Aluminum in cars - Parts

Best candidates to be made in Aluminum?

- Structure parts
- Cross members
- Floor
- Roof
- Skin parts
- Doors
- Hatches
- etc.

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Typical applications of different alloys in an automobile

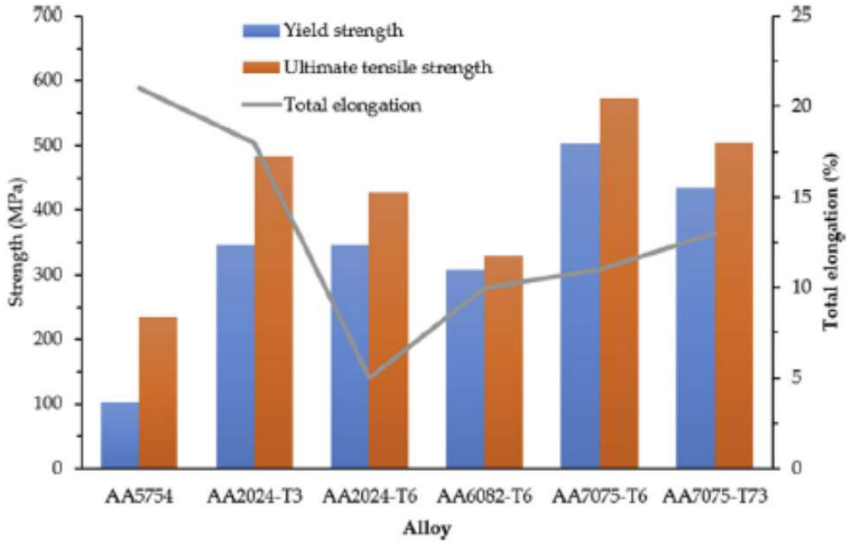
Industry	Alloy grade	Main chemical composition	Strength/Density (Pa/(kg.m3))	Applications
Automotive truck	AA5052	Al-Mg	72,000	Interior panels and components, and body panels, bumpers
heat	AA5754		86,000	Inner body panels, splash guards, shields, air cleaner trays and covers, structural and weldable parts, load floor
	AA6016-T4	Al-Mg-Si	81,500	Outer panels and structural sheets (Europe)
America)	AA6111-T4		103,000	Outer and inner panels (North
	AA7020-T6	Al-Zn-Mg	127,000	Potential applications for A pillar and B pillar

Type of alloys

Wrought aluminium alloys are the most widely used raw material candidates for panel structures. Nowadays, non-heat treatable AA5xxx, and heat treatable AA6xxx, AA7xxx and AA2xxx, are popular candidates for automotive and aircraft industries.

Main chemical compositions of some aluminium alloys (wt%).

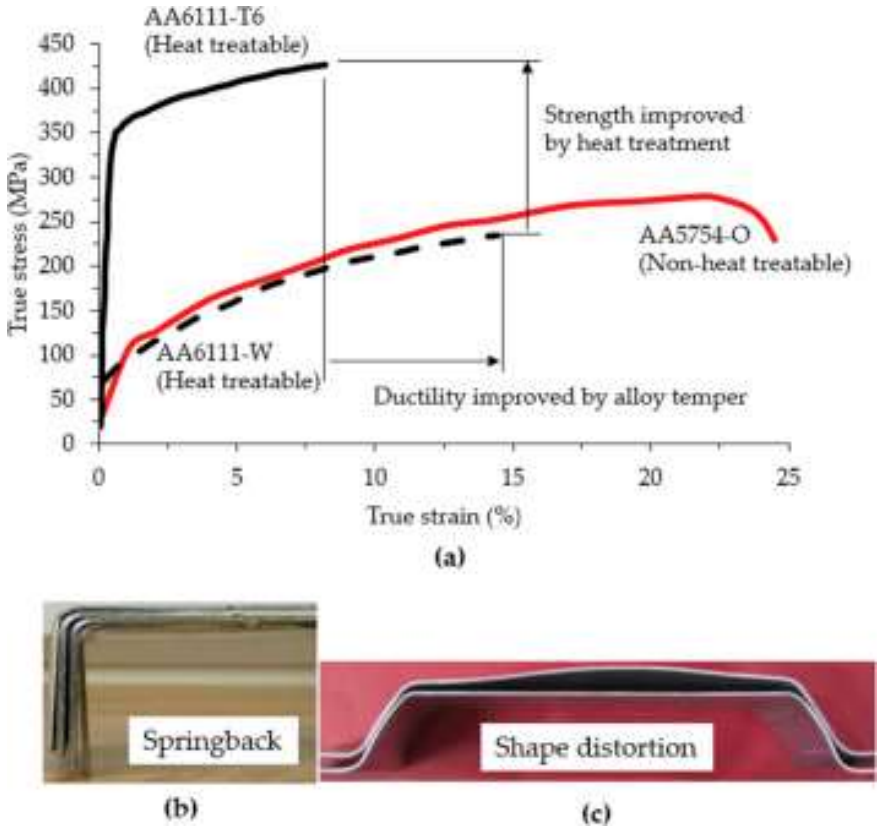
AA5754 [19]	Mg	Mn	Fe	Si	Cu	Ni	Ti	Zn	Al
	3.0	0.24	0.26	0.03	0.02	<0.01	<0.01	<0.01	Bal
AA2024 [20]	Cu	Mg	Mn	Si	Fe	Zn	Ti	Cr	Al
	4.5	1.5	0.5	0.41	0.40	0.20	0.12	0.07	Bal
AA6082 [21]	Si	Mg	Mn	Fe	Cu	Zn	Cr	Ti	Al
	1.05	0.8	0.68	0.26	0.04	0.02	0.01	0.01	Bal
AA7075 [22]	Zn	Mg	Cu	Fe	Cr	Si	Mn	Ti	Al
	5.4	2.2	1.4	0.22	0.19	0.07	0.04	0.02	Bal



Comparisons of mechanical properties of commonly used alloy and different heat treatment temper

Cold forming

- Typically used for non-heat treatable AA5xxx and heat treatable alloys, such as AA6111
- The ductility in T6 condition is very poor which is not beneficial for producing complex-shaped structures.
- To address this disadvantage, W-temper forming or stamping at T4 temper condition can be used.
- However, the strength of W-temper or T4 formed components needs to be increased by additional heat treatment, to restore the microstructure and mechanical properties.

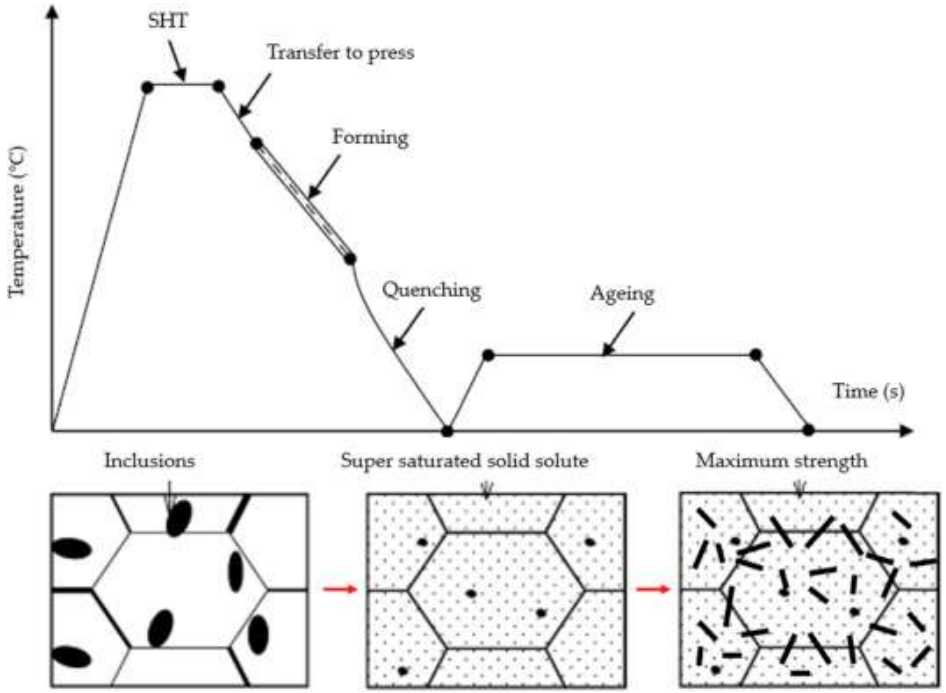


(a)Characteristics of cold stamping using rigid dies: Stress-strain curves of different alloys and different tempers
(b) Springback defect and (c) Shape distortion due to additional heat treatment

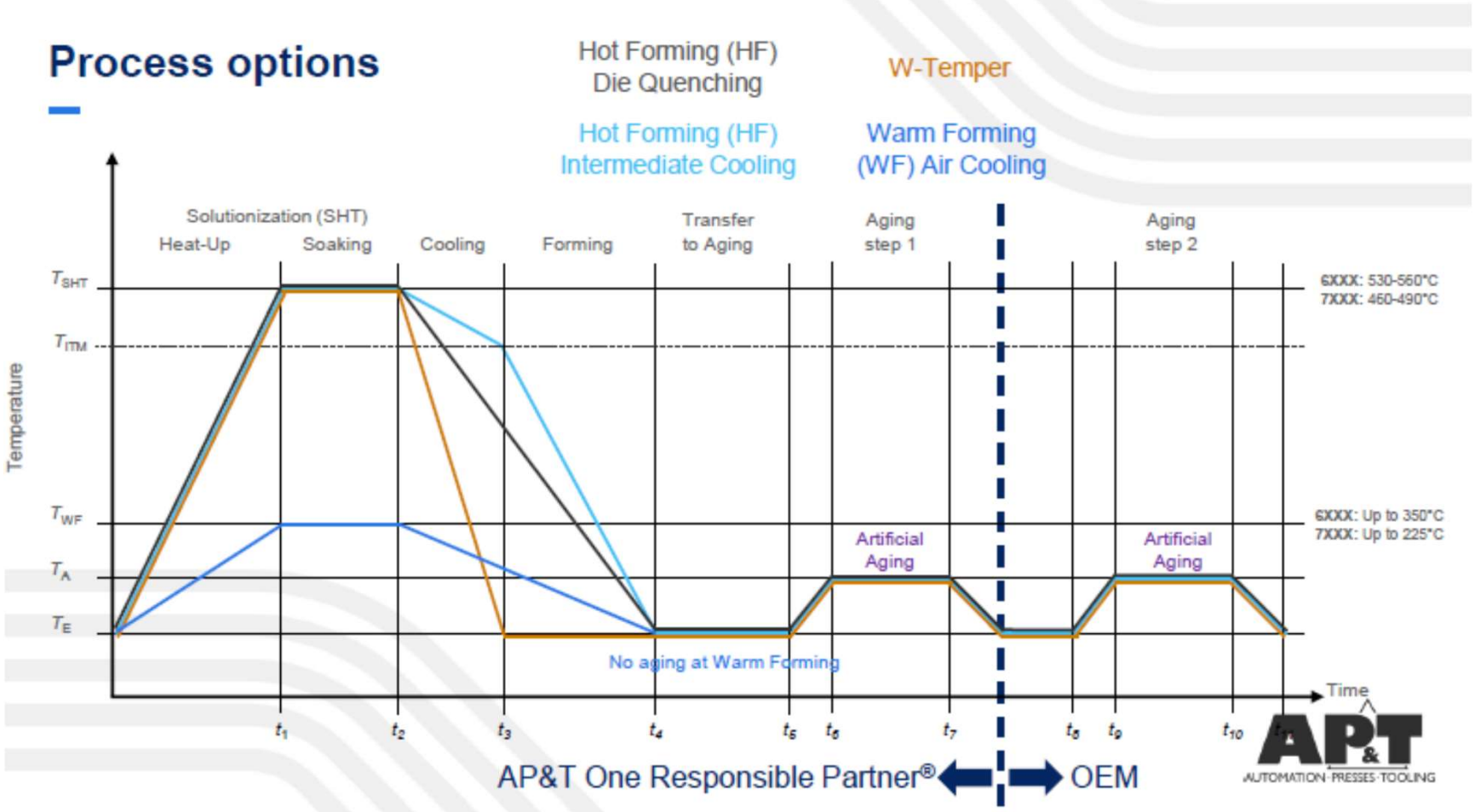
Review of sheet metal forming techniques

Hot Form and Quench (HFQ®)

- Initially a blank is heated to its Solution Heat Treatment (SHT) temperature and soaked for a specific time period to dissolve the original coarse precipitates and soluble inclusions within the α-Al matrix and obtain an optimum microstructure.
- Then the blank is quickly transferred to the press, stamped and held for a brief period between the cold dies which quench the blank to lower temperatures.
- The blank is more ductile at elevated temperatures, and using cold die quenching can achieve a cooling rate rapid enough to prevent the formation of coarse secondary phase at grain boundaries and obtain a super saturated solid solution state in the formed part.

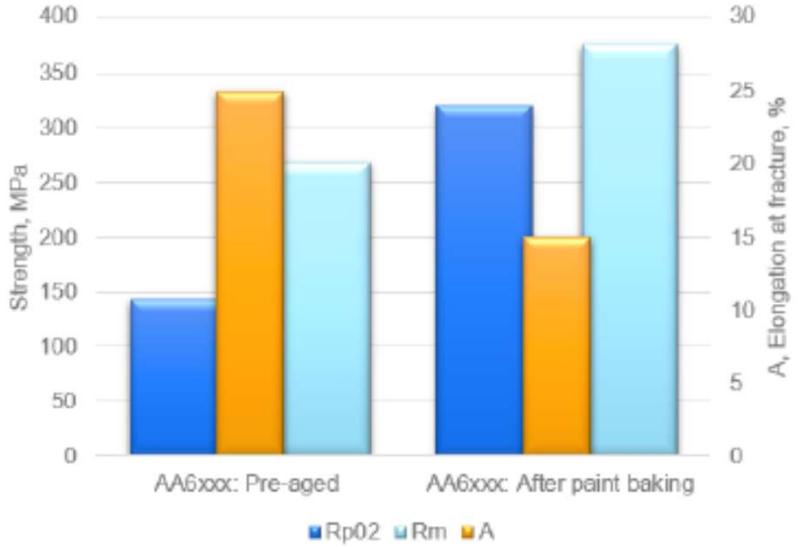


Aluminium Hot forming :- The process



Aluminium Hot forming

AA6xxx – Mechanical properties after pre-aging and paint baking



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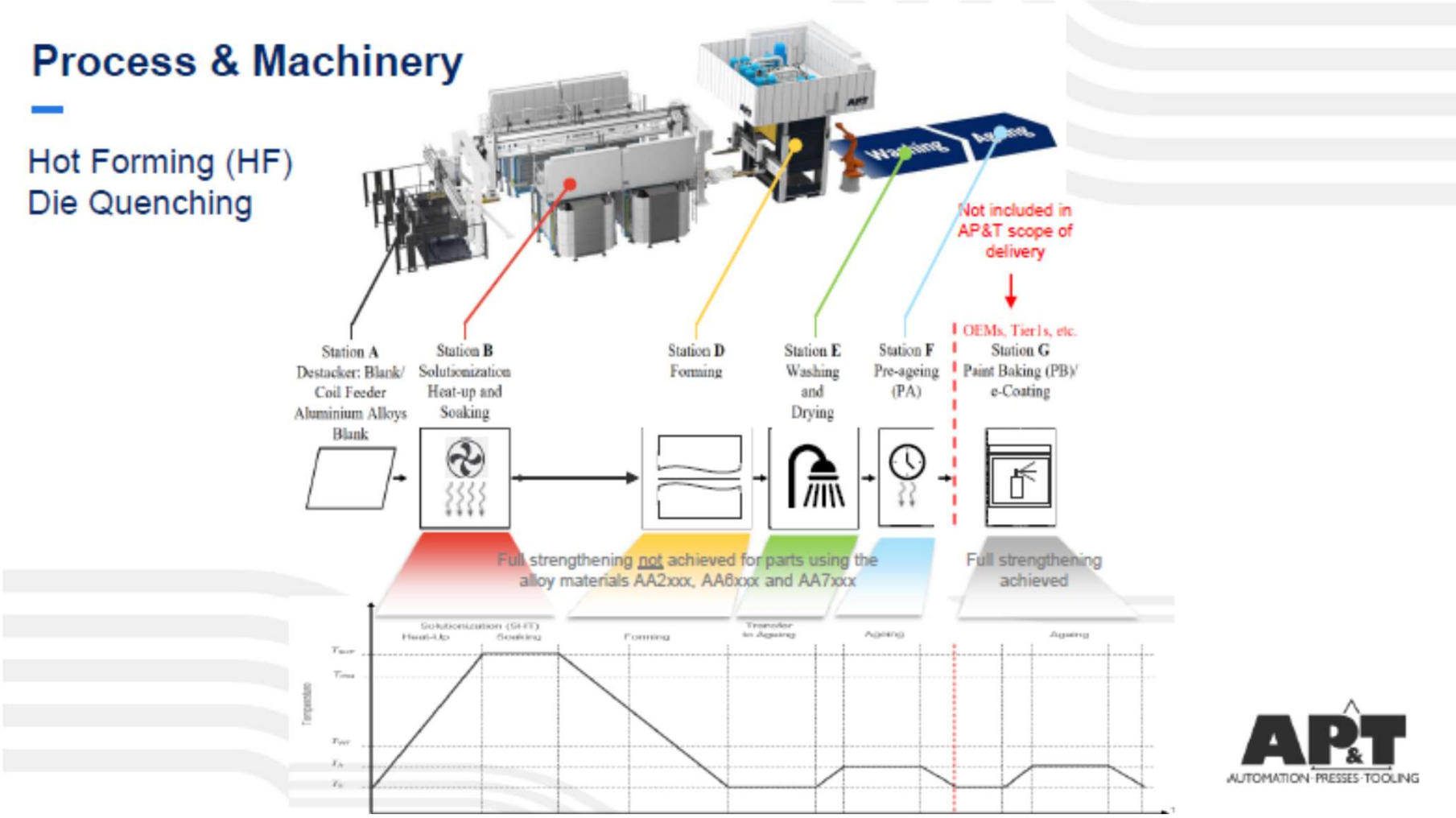
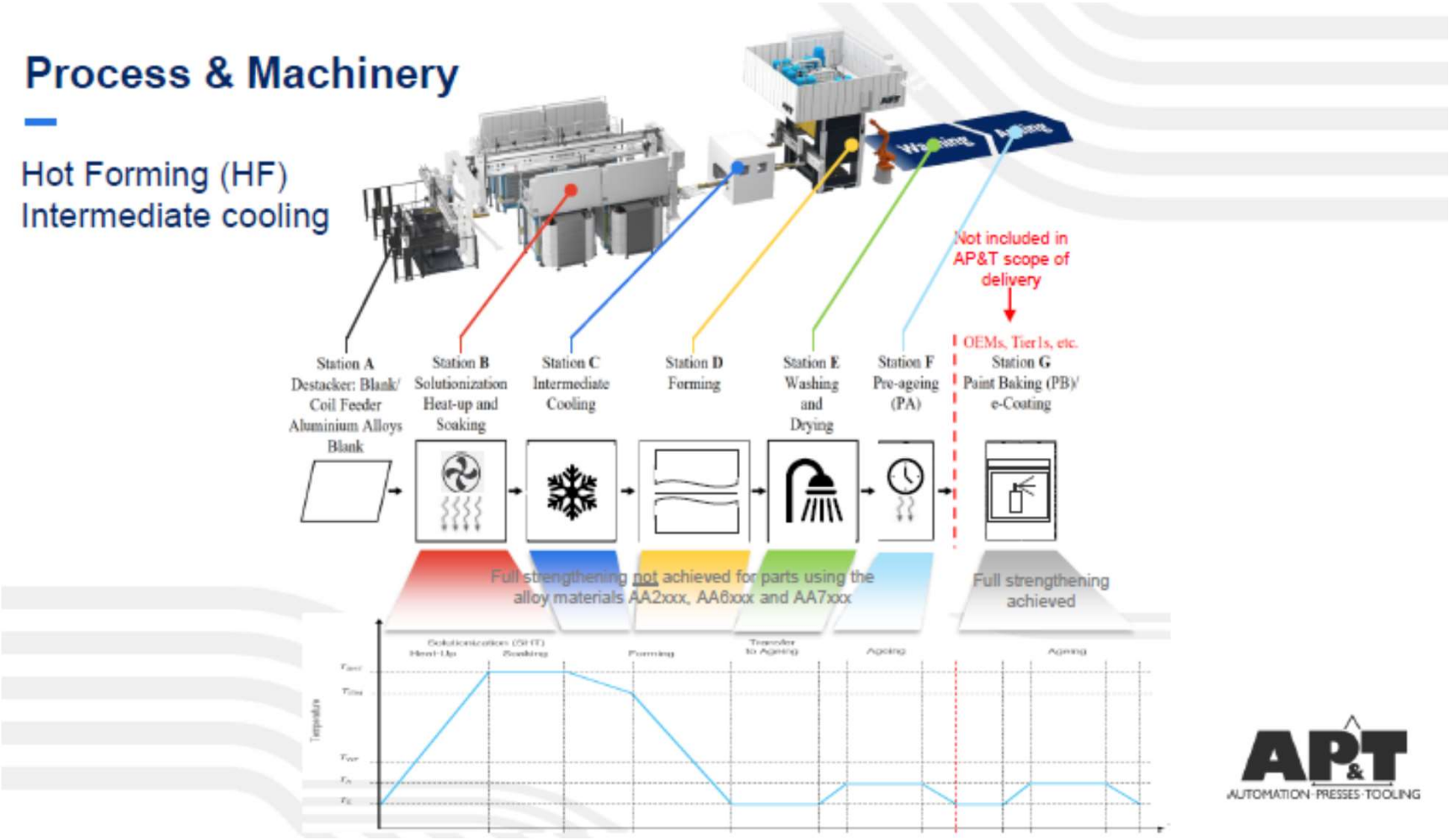
Aluminium Hot forming:- Die Quenching



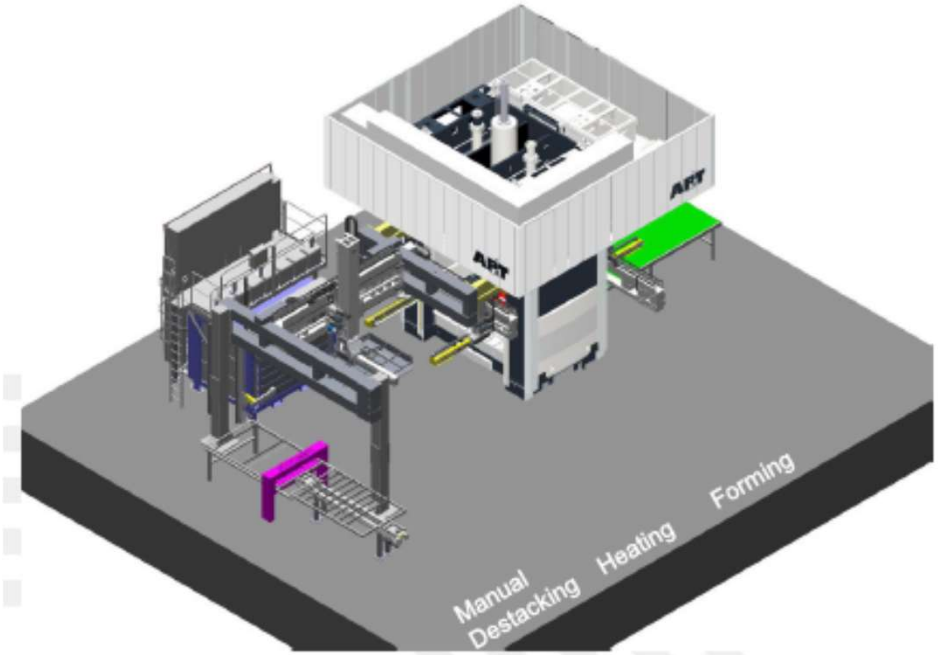
Aluminium Hot forming:- Intermediate cooling



Aluminium Hot forming

AP&T Scalable Production Lines for High Strength Aluminum

Entry line for tryout and low volume production



Approx. 50-60 sec/cycle
(based on thickness 1,5 mm)

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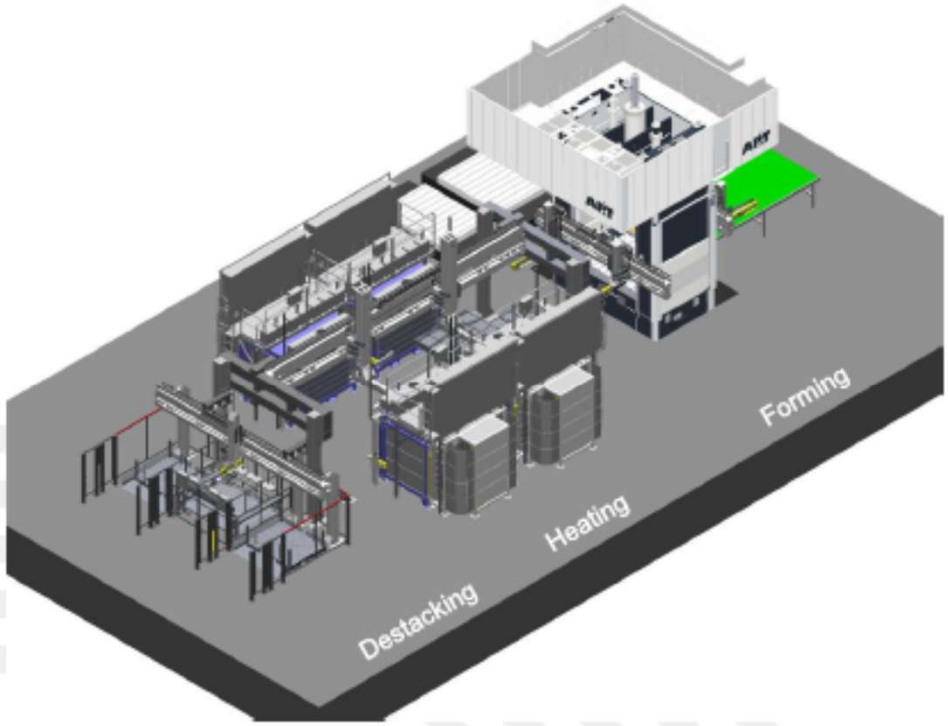
Aluminium Hot forming

AP&T Scalable Production Lines for High Strength Aluminum

Full capacity production line



Approx. 10-12 sec/cycle
(based on thickness 1,5 mm)

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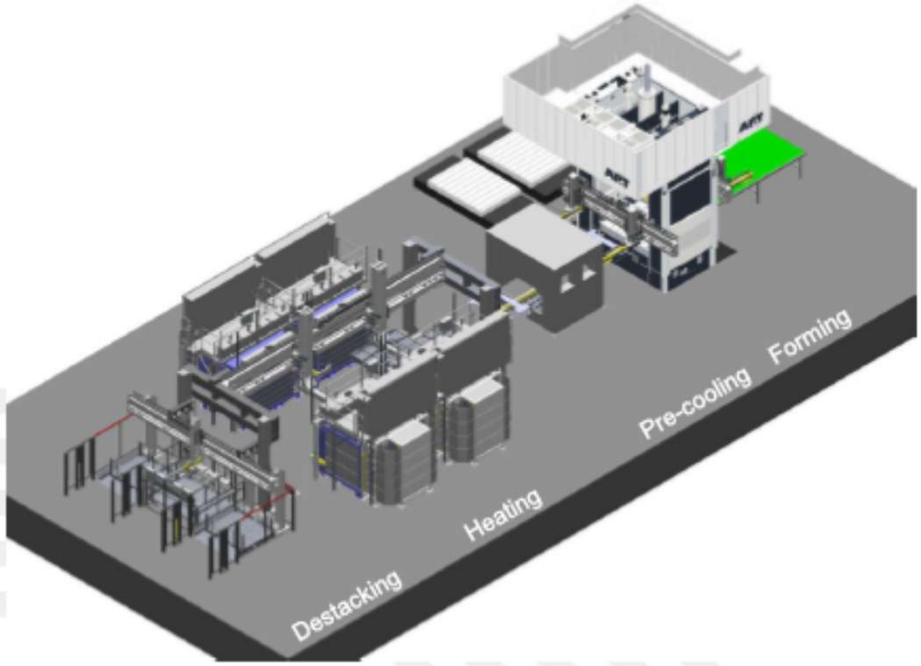
Aluminium Hot forming

AP&T Scalable Production Lines for High Strength Aluminum

Full capacity production line with pre-cooling



Approx. 10-12 sec/cycle

(based on thickness 1,5 mm)

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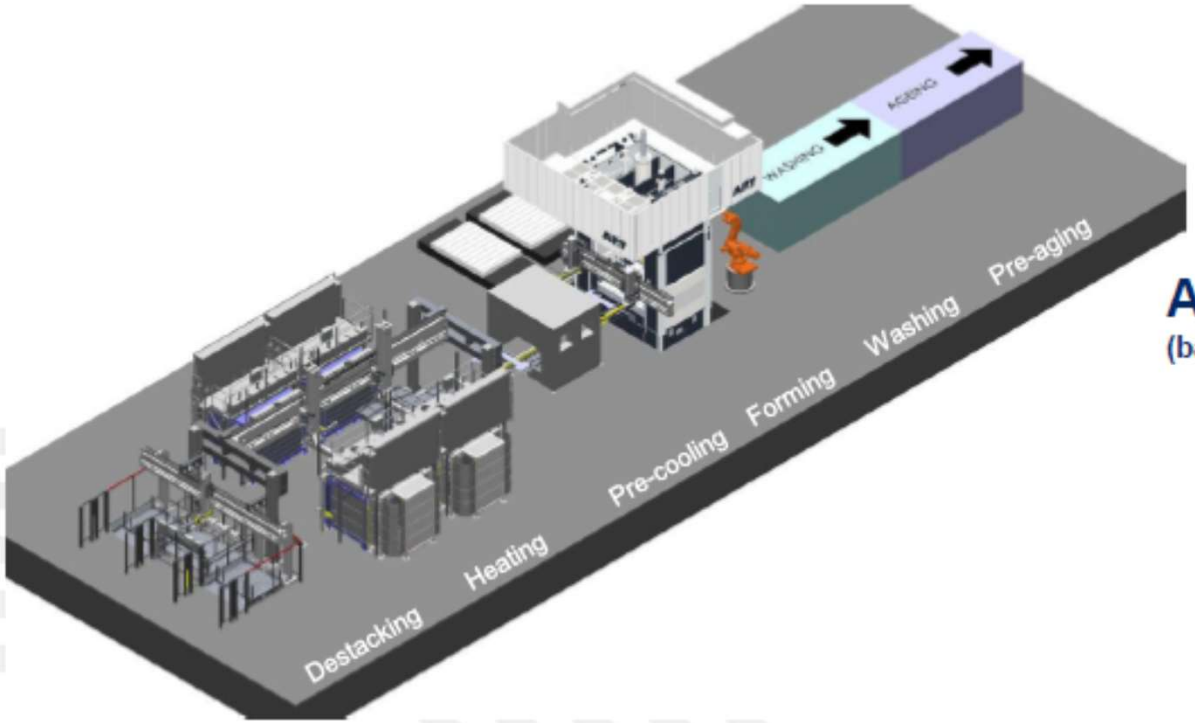
Aluminium Hot forming

AP&T Scalable Production Lines for High Strength Aluminum

Full capacity production line with pre-cooling + washing + pre-aging



Approx. 10-12 sec/cycle
(based on thickness 1,5 mm)

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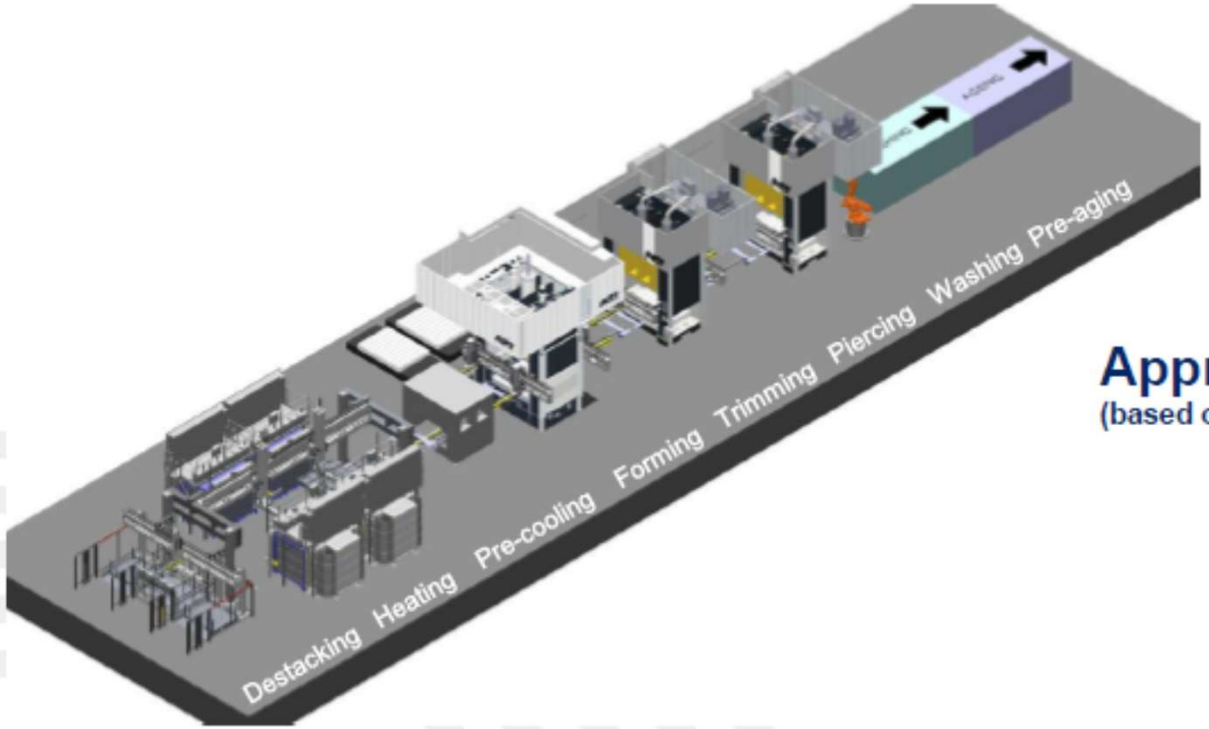
Aluminium Hot forming

AP&T Scalable Production Lines for High Strength Aluminum

Full capacity production line with pre-cooling + 2 x trimming/piercing + washing + pre-aging



Approx. 10-12 sec/cycle
(based on thickness 1,5 mm)

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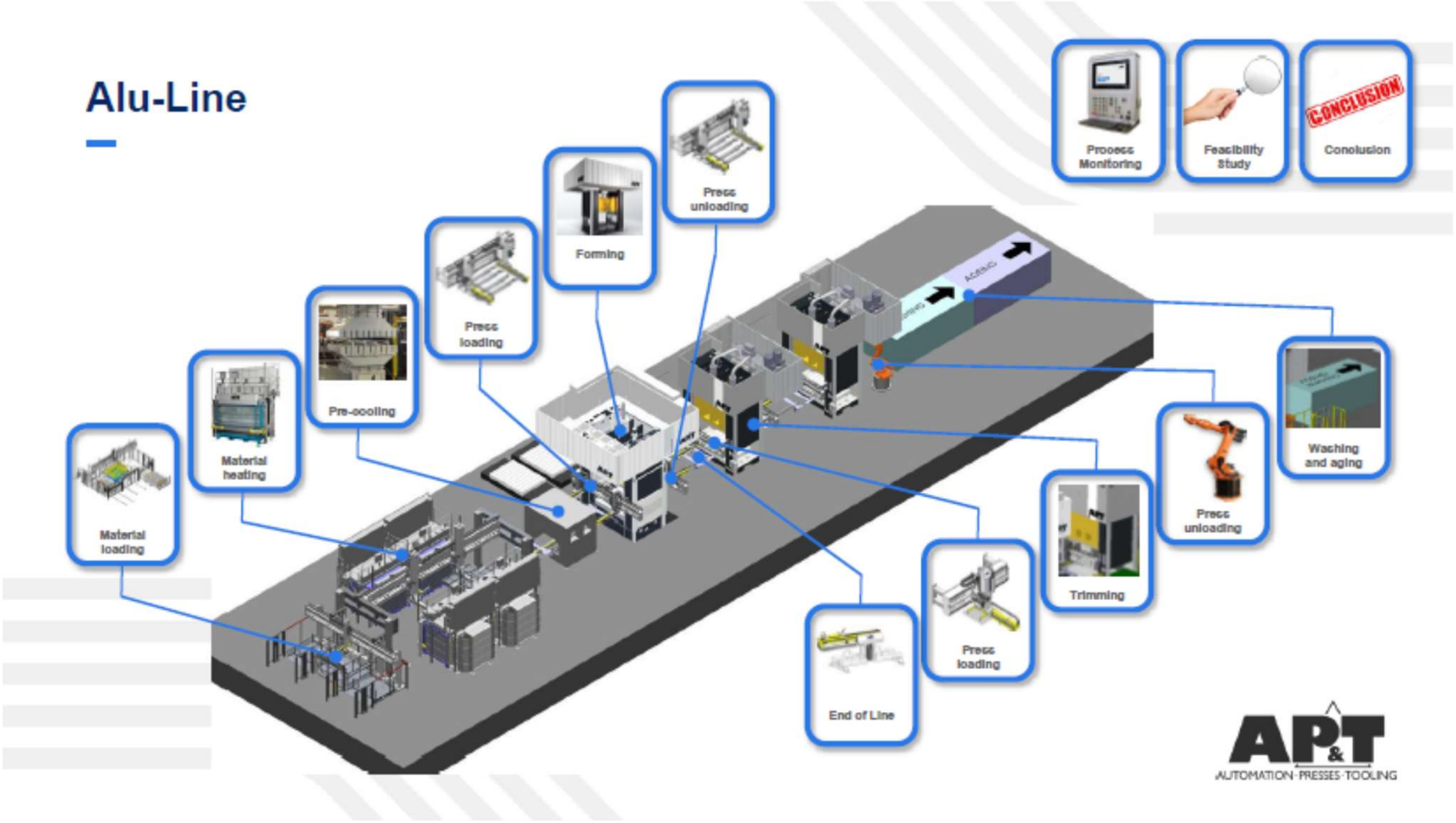
Aluminium Hot forming:- Equipment



Aluminium Hot forming:- Equipment

Forming

AP&T Hydraulic Servopress ODEN-FTS 6000-10000 kN

- Electric servo controlled hydraulic pump technology - no conventional valve system
- Forming curve with high precision and absolute repeatability
- Active parallelism control
- High output
- Freely programmable speed and force control
- 50 – 60% lower energy consumption
- Low maintenance cost
- Option: Servo cushion

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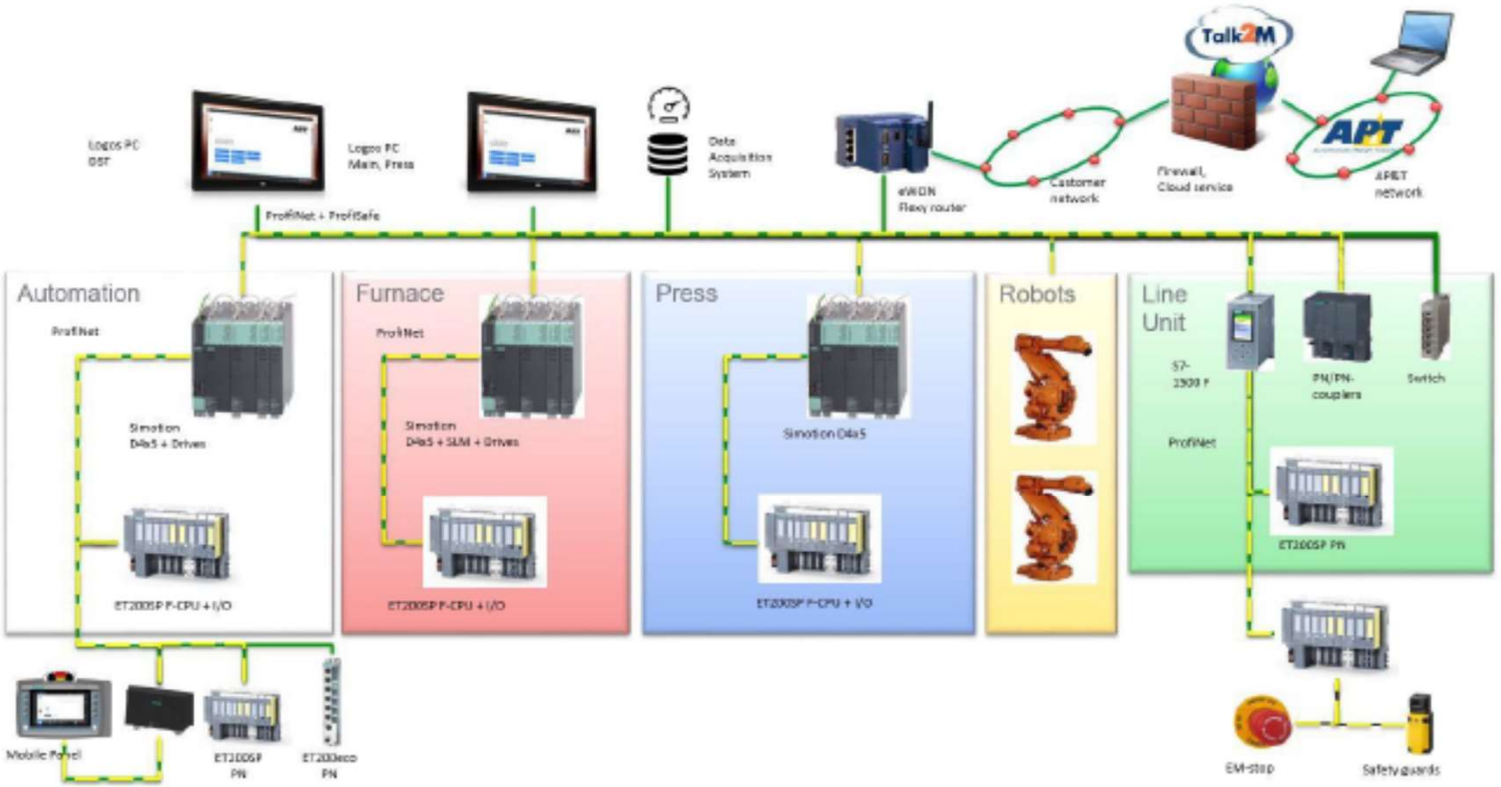
Aluminium Hot forming

Control system structure



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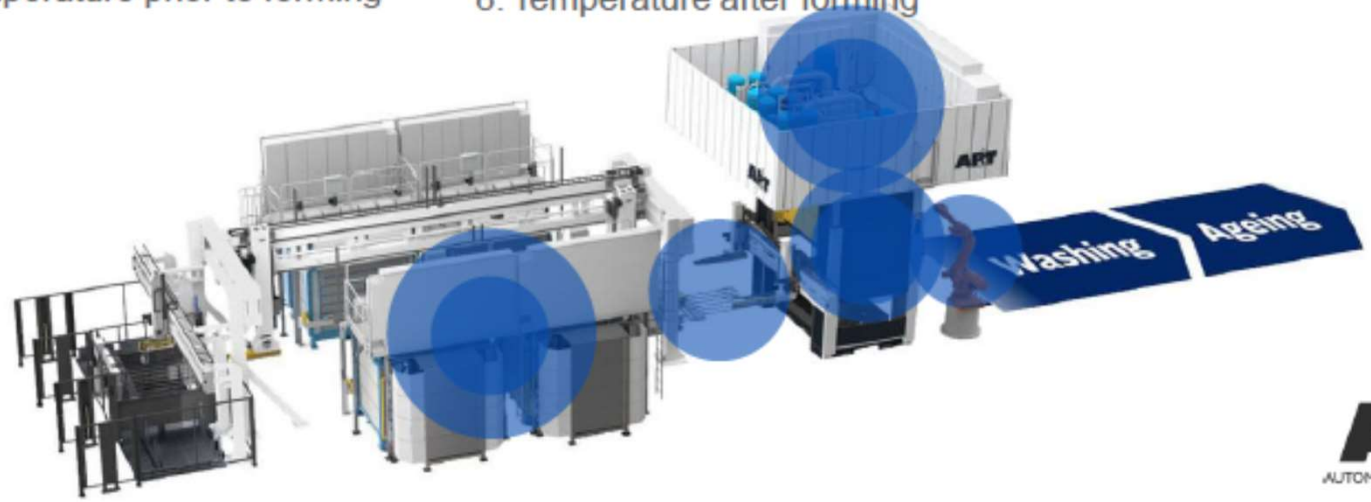
Aluminium Hot forming

Important parameters for process control

1. Time in furnace
2. Temperature in furnace
3. Time from furnace to start of forming
4. Temperature prior to forming
5. Press force
6. Quenching time
7. Coolant water flow and temperature
8. Temperature after forming



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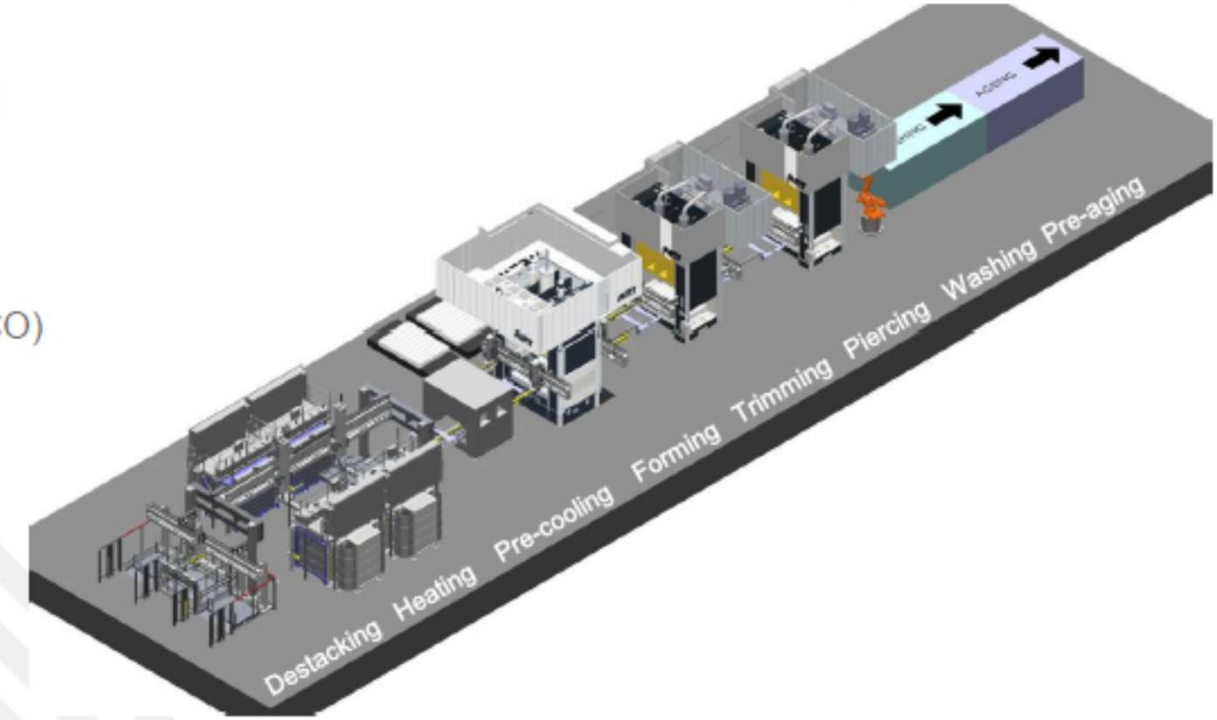
Aluminium Hot forming:- Conclusion

One responsible partner for High Strength Aluminum

- Scalable Production Lines
- Fast installation and startup
- Launch support and training
- Experience in hot forming
- Process knowledge
- AP&T Partner network
- Total Cost of Ownership (TCO)



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About AP&T ……..

OUR MISSION

To make our customers more competitive in the global market

OUR BUSINESS

AP&T provides sheet metal industries worldwide with complete production systems as well as with stand-alone presses, automation, tooling and related aftermarket services

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About AP&T ……..


Modular based system
Competence in-house
One Responsible Partner®
AP&T
Personal contact at all levels
Market leader in defined niches
Follow our customers globally

About AP&T ……..

OUR FOCUS

Energy efficiency

Lightweight

Safety

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About AP&T ……..

CORE VALUES

Believe in people

Business committed

Curiosity

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TECHNICAL ALLIANCE WITH AP&T FOR HOT STAMPING TECHNOLOGY

ISGEC

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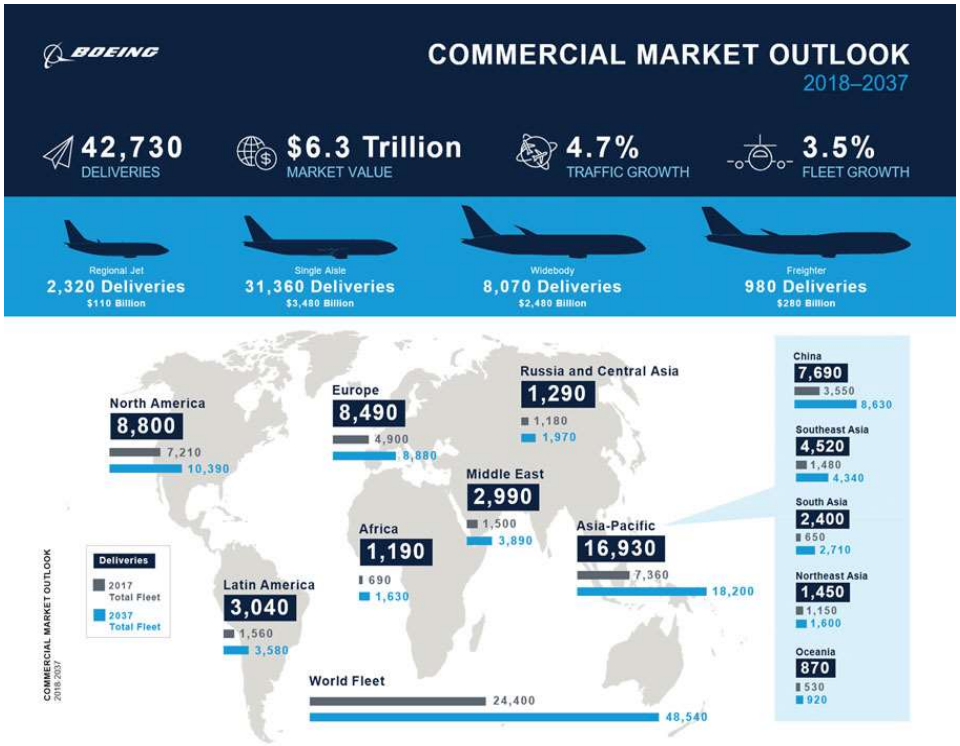
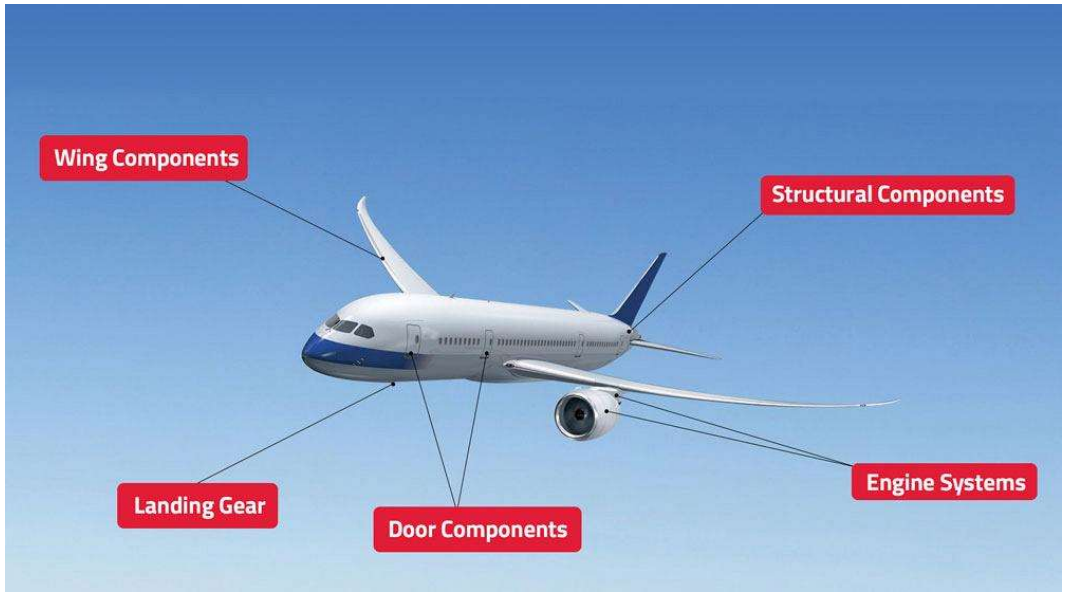
Why Titanium Hot forming?



Projections for the aerospace segment are that it will grow at a rate of 3.5 percent over the next two decades, doubling in size by 2037. Commercial Market Outlook infographic courtesy of Boeing, Chicago.

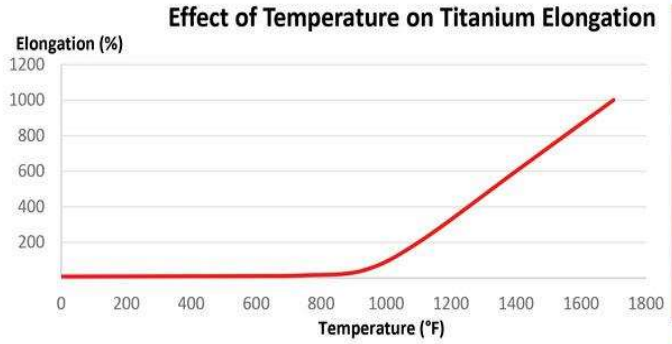


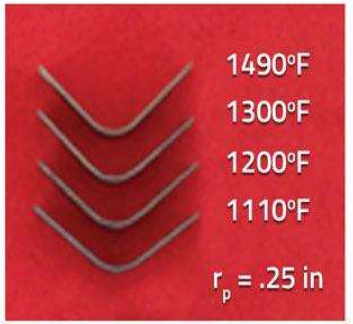
Titanium usage in aerospace is expanding. It is used in manufacturing control surfaces and mechanisms, doors, assemblies, and the wings and propulsion assemblies.

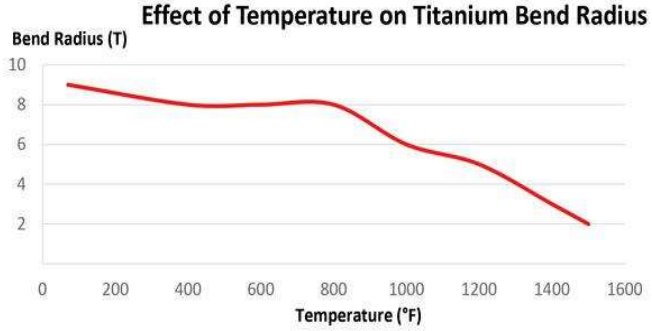
Infographic courtesy of Beckwood Press Company.

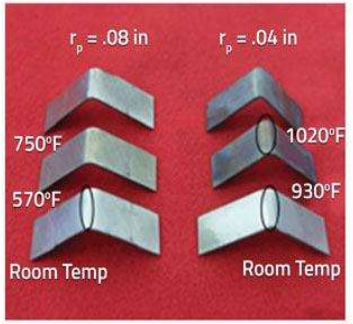
Titanium Hot forming

- During the hot forming process, titanium and other high-strength alloys are heated to extreme temperatures (500 degrees C or higher) and formed in a press.
- The introduction of heat increases titanium's malleability so that complex shapes can be formed at lower tonnages without springback or fracturing.





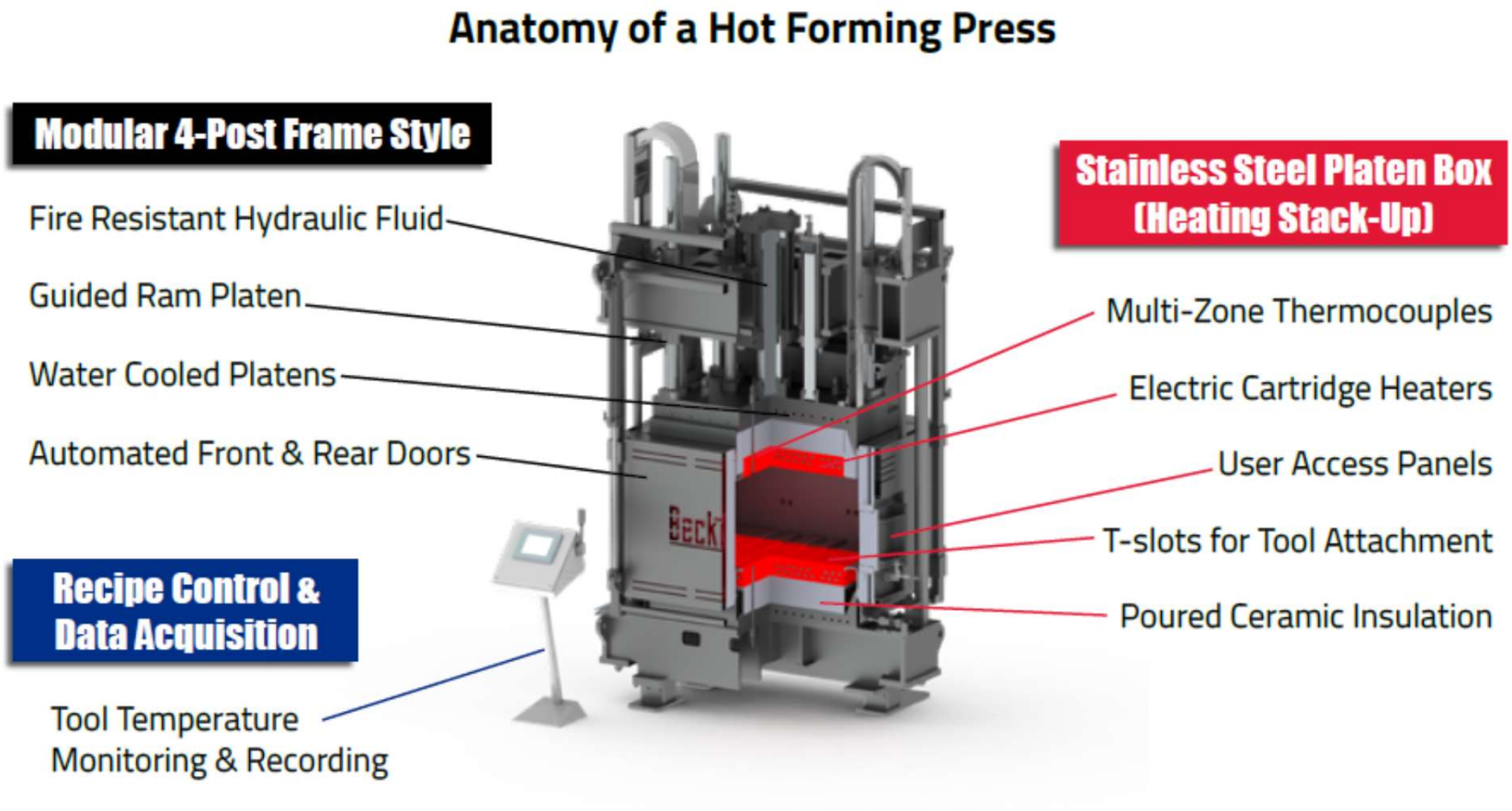




Titanium Hot forming

- The process of hot forming differs in a couple of ways.
  - First, in hot forming, the press, tooling, and blank are heated, while in hot stamping only the blank is heated.
  - Second, in hot forming, the titanium or other high-strength alloy starts and ends as the same or similar microstructure

Titanium Hot forming



Titanium Hot forming :- Typical parts

Temp: 1350°F
Approach: 90 IPM
Forming: 7.5 IPM
Dwell: 5 min
Slow retract: 40 IPM
Fast retract: 120 IPM
Total part-to-part: 7 min

Temp: 1350°F
Approach: 90 IPM
Forming: 5 IPM
Dwell: 6 min
Slow retract: 20 IPM
Fast retract: 120 IPM
Total part-to-part: 8 min

Thank you