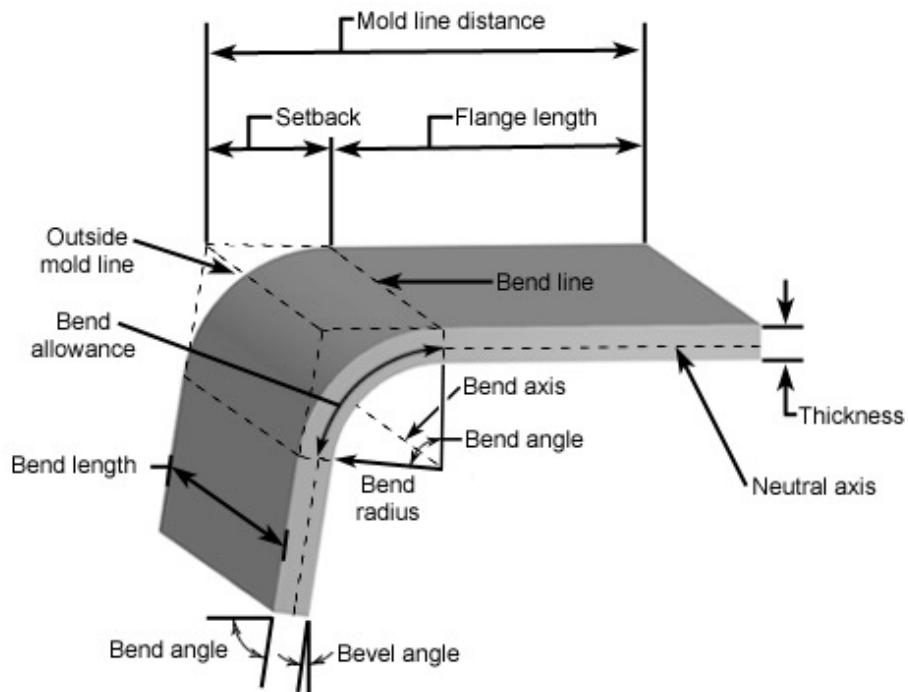
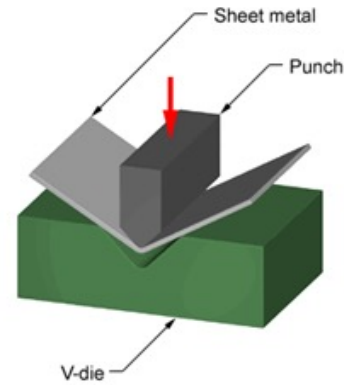


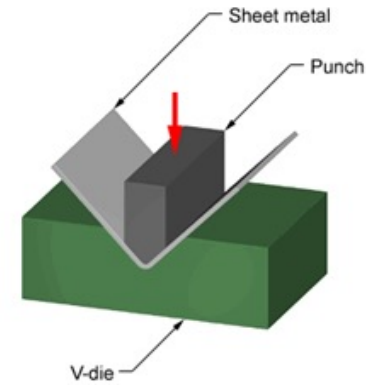
# Bending



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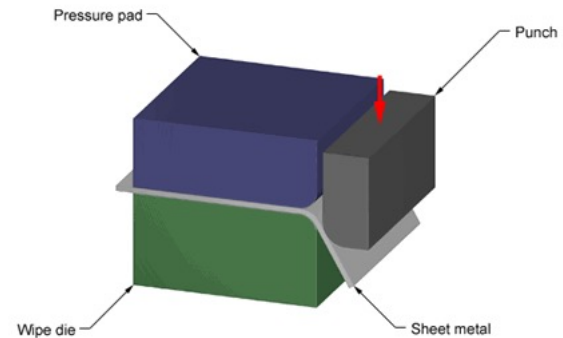


**Air Bending**



**Bottoming**

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<https://www.custompartnet.com/wu/sheet-metal-forming>



# Brake (sheet metal bending)

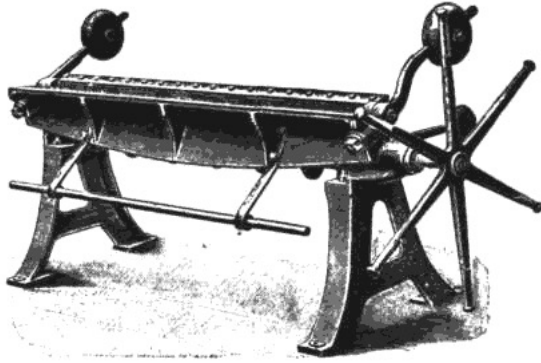


Fig. 7.

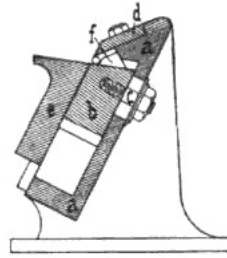


Fig. 8.

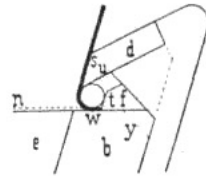
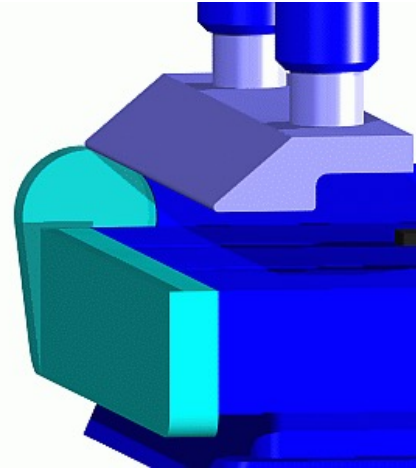


Fig. 9.

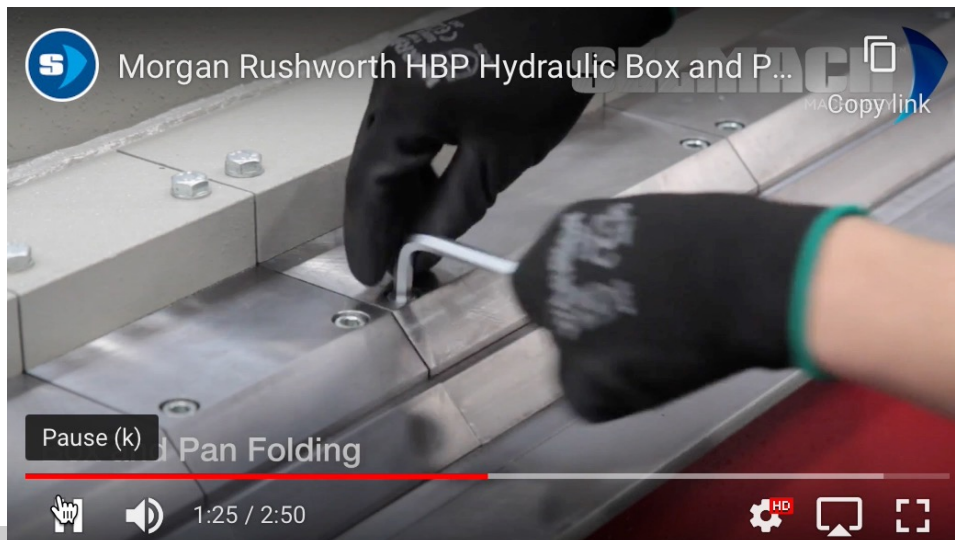


Finger brake

Cornice brake

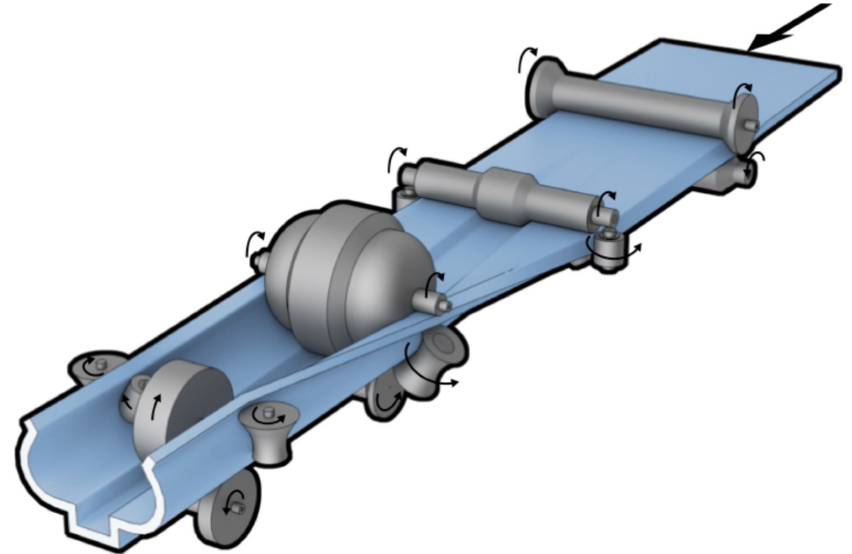
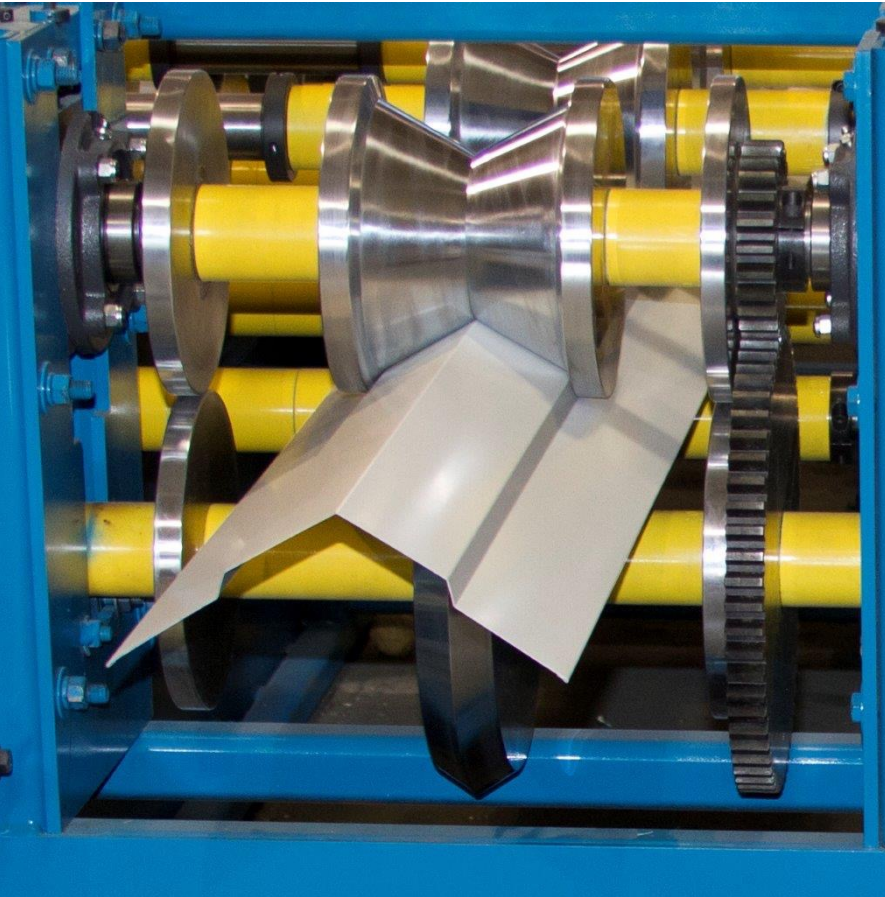


Pan&Box brake



# Roll former

<https://bradburygroup.com/Products/Trim-Shop-Equipment/Trim-Rollforming-Lines>



 **MANUFACTURINGGUIDE**

<https://www.manufacturingguide.com/en/roll-forming>



# Flange and flanging



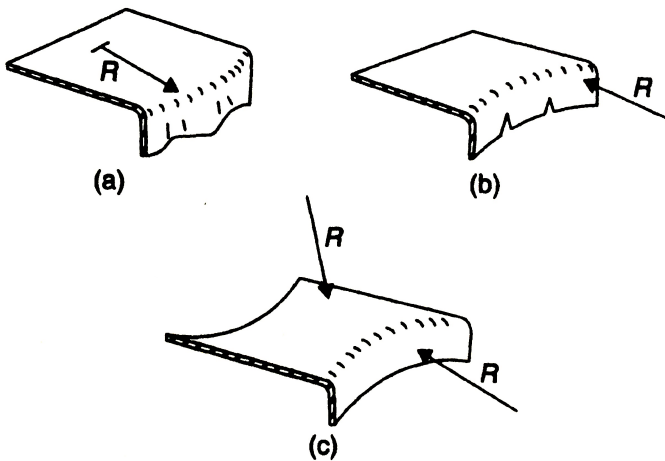
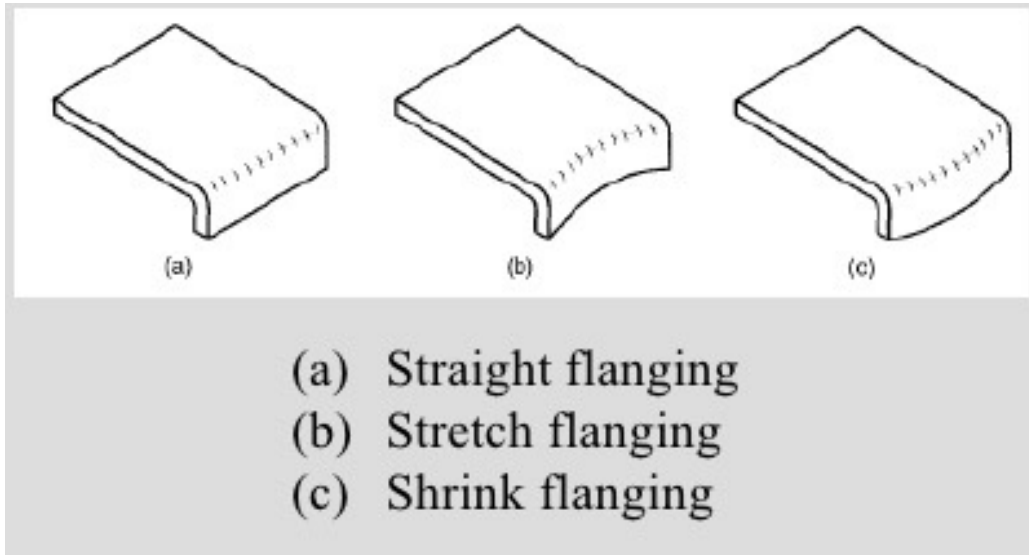
- 축이나 관(pipe) 따위의 끝에 테처럼 돌출시킨 이음 부분.
- 철도용 바퀴의 한쪽 끝에 돌출시킨 턱 같은 부분. 탈선을 방지함.

Flanging: flange를 만드는 가공법





# Stretch or Shrinking flange

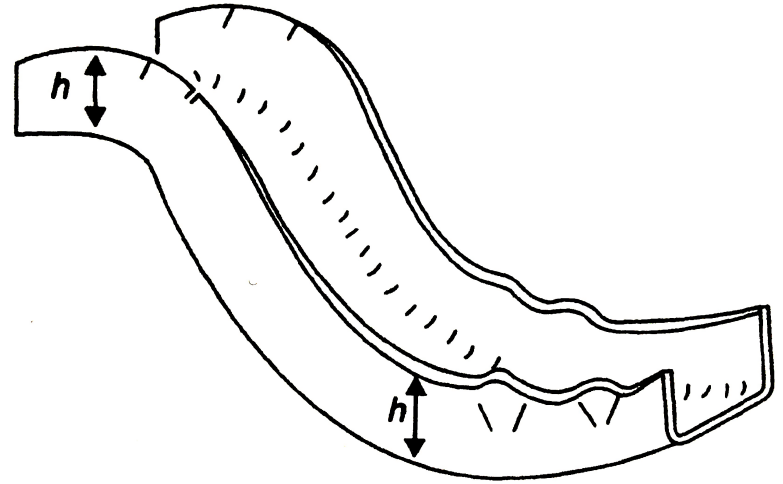


**Figure I.4** (a) A shrink flange showing possible buckling.  
(c) Flanging a curved sheet.

From Marciniak, Duncan, Hu



# Slide

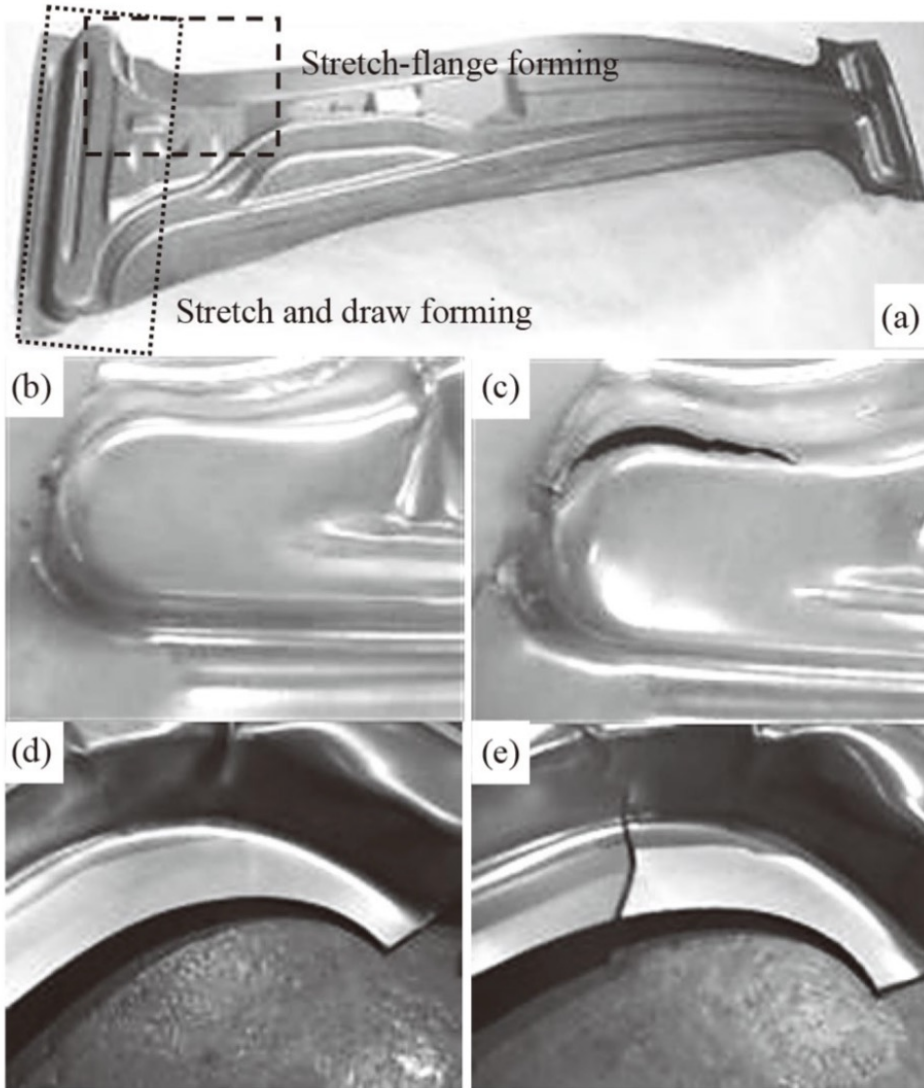


From Marciniak, Duncan, Hu



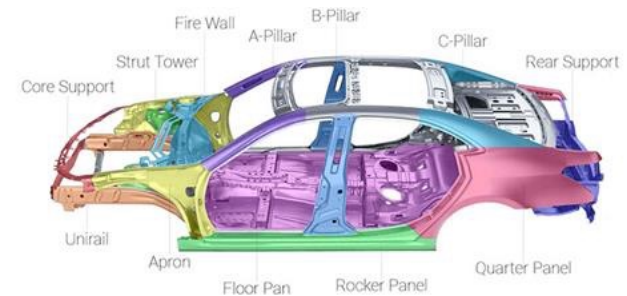
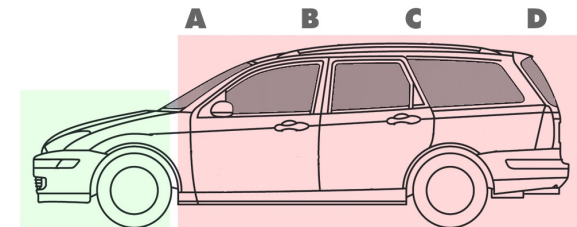
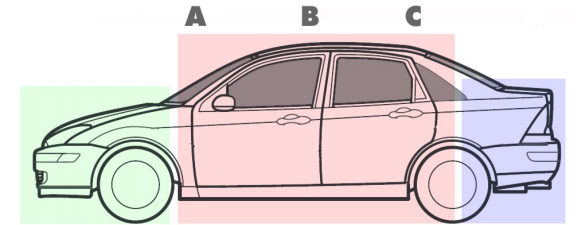
# Flange cracking in B Pillar

<https://www.jfe-steel.co.jp/en/research/report/018/pdf/018-15-2.pdf>



## Cold-Rolled and Galvannealed (GA) High Strength Steel Sheets for Automotive Cabin Structure

K. KAWABATA, T. KAWABATA, T. KAWABATA, T. KAWABATA, T. KAWABATA

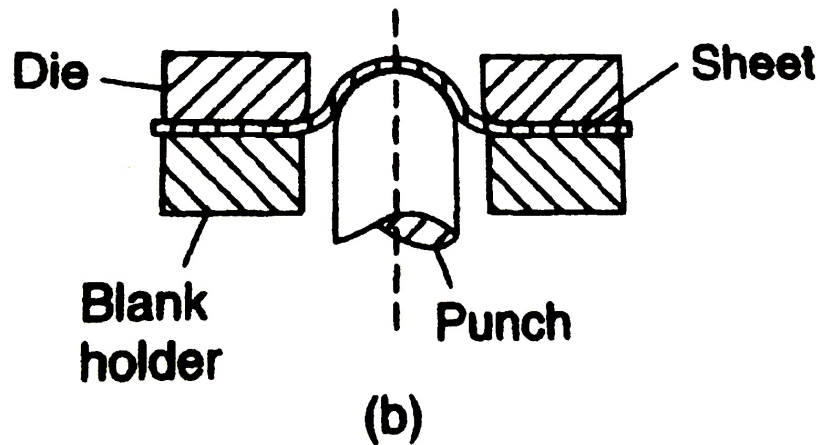
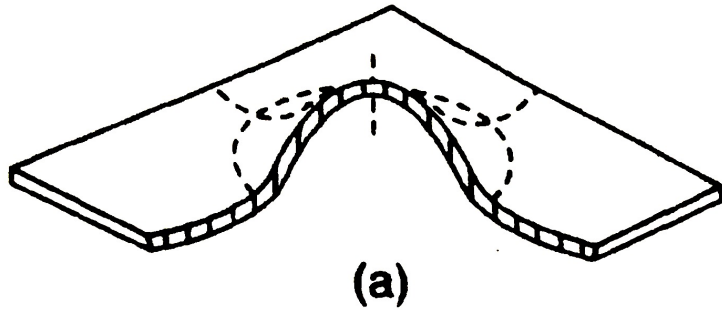


[https://www.imoa.info/download\\_files/sustainability/IMOA\\_Automotive-Case-Study.pdf](https://www.imoa.info/download_files/sustainability/IMOA_Automotive-Case-Study.pdf)

<https://carbrain.com/Blog/what-is-frame-damage>

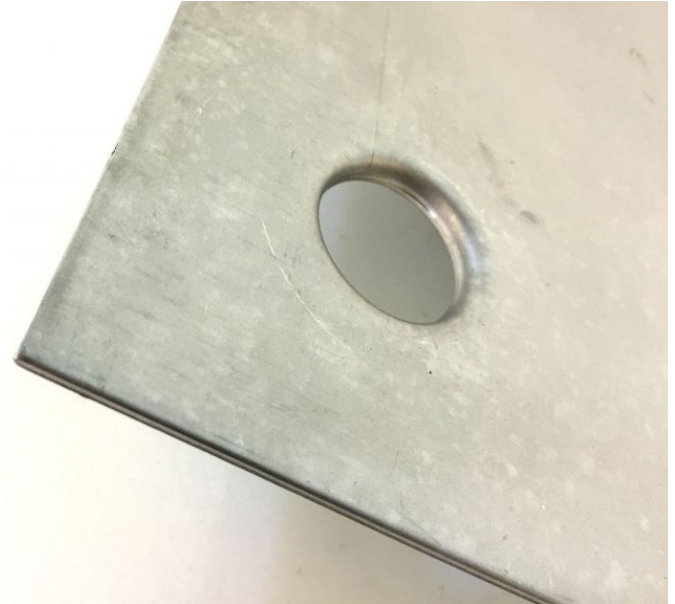
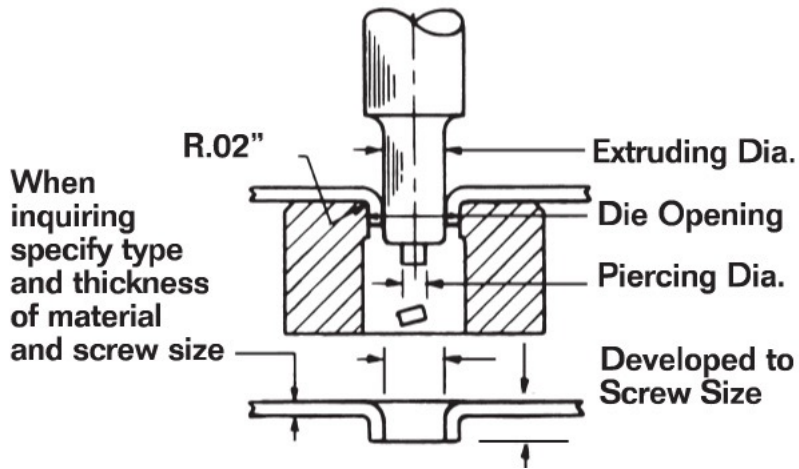


# Stretching

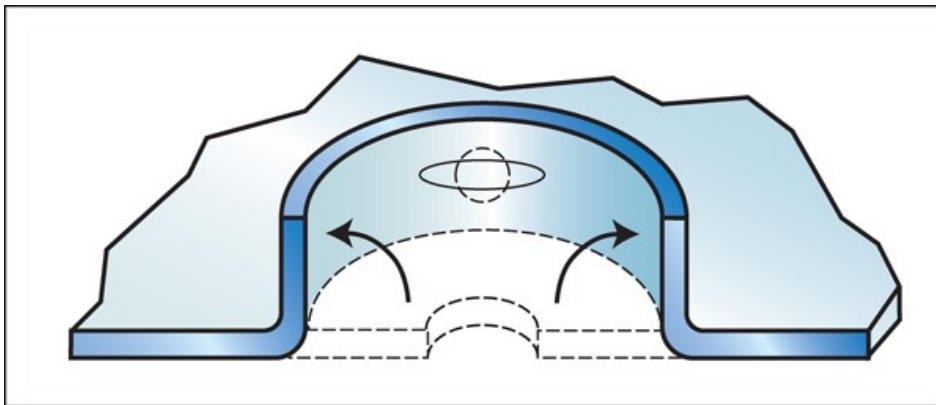




# Hole extrusion



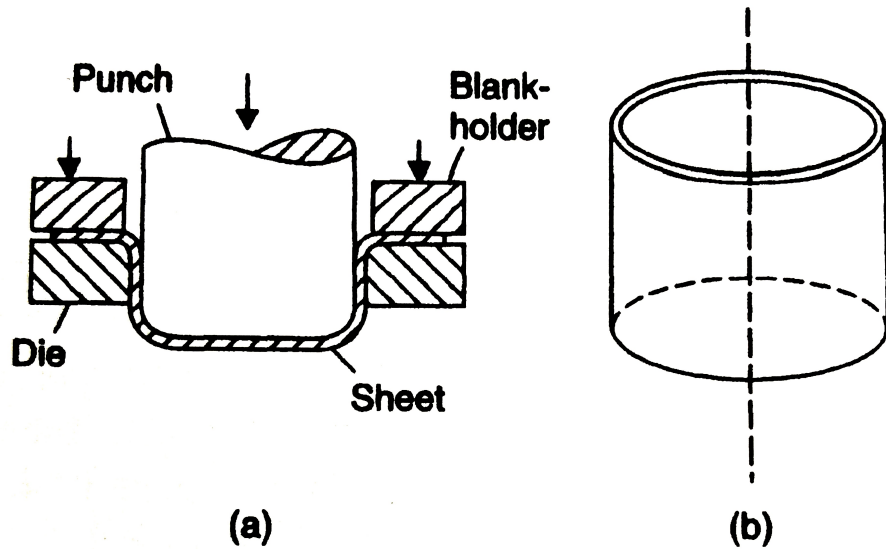
<https://www.unipunch.com/system-capabilities/typical-work-done/extruded-holes/>



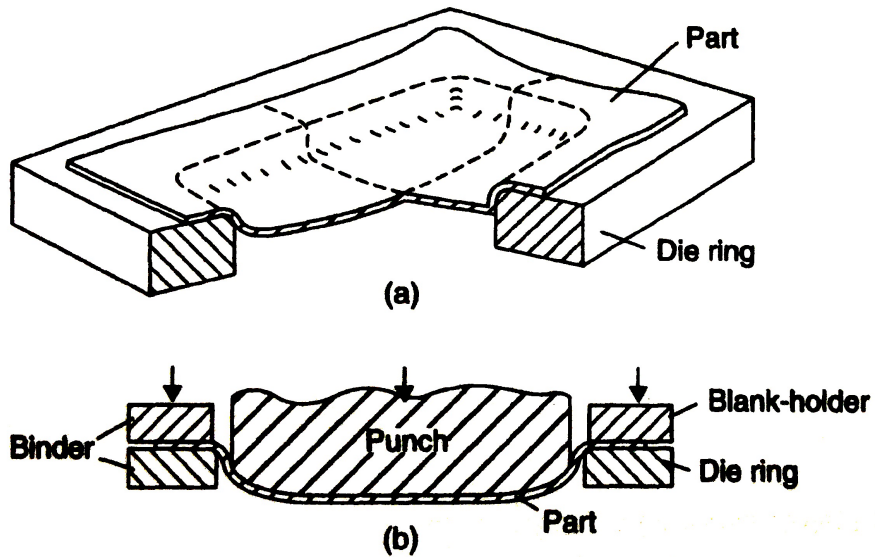
[https://www.metalformingmagazine.com/magazine/article/?/2011/10/1/Hole\\_Extrusions--Part\\_1](https://www.metalformingmagazine.com/magazine/article/?/2011/10/1/Hole_Extrusions--Part_1)



# Deep drawing



# Stamping

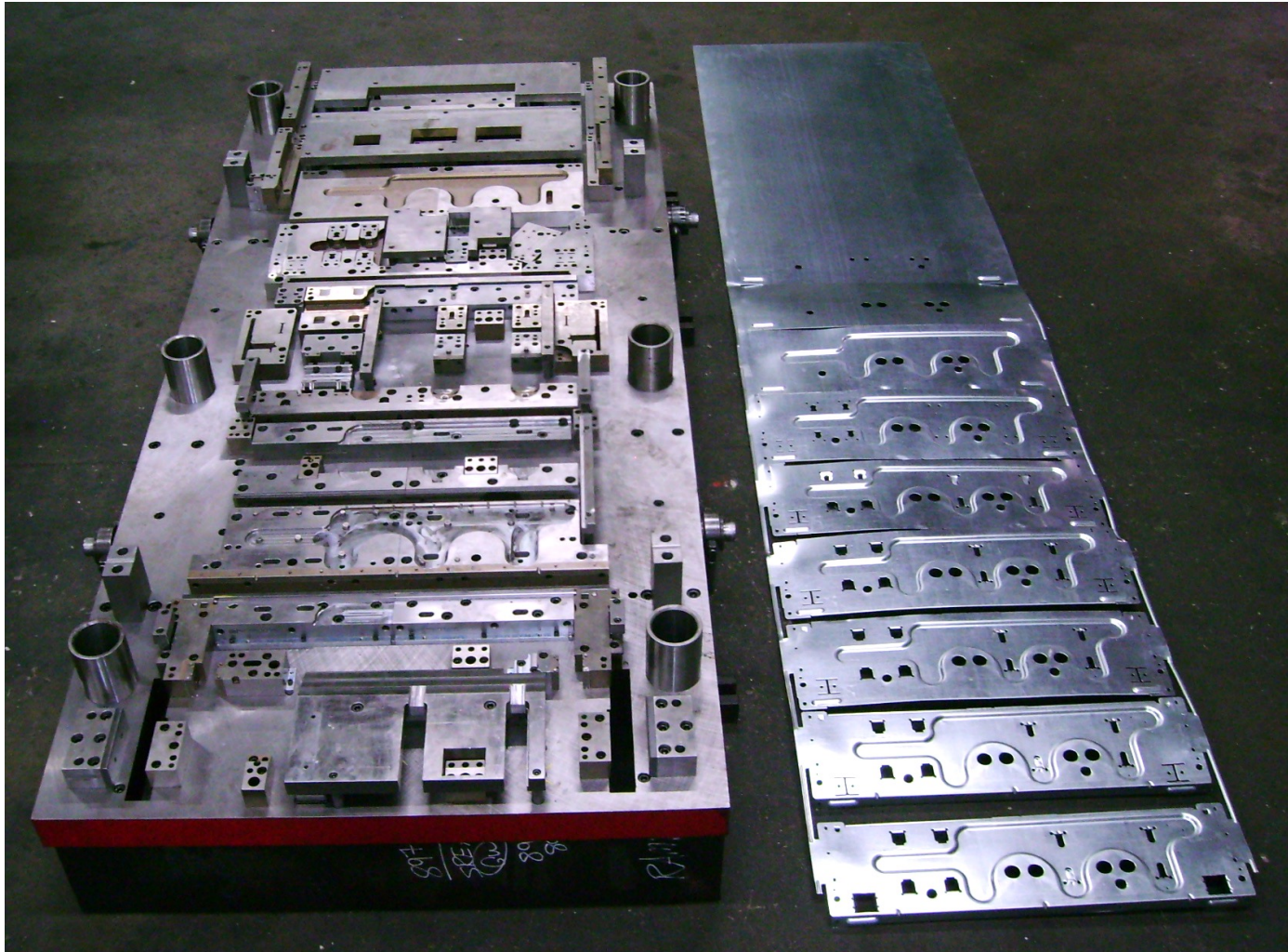


Modern stamping allows successive operations of various forming processes. We'll see more examples in a few slides.





# Successive stamping

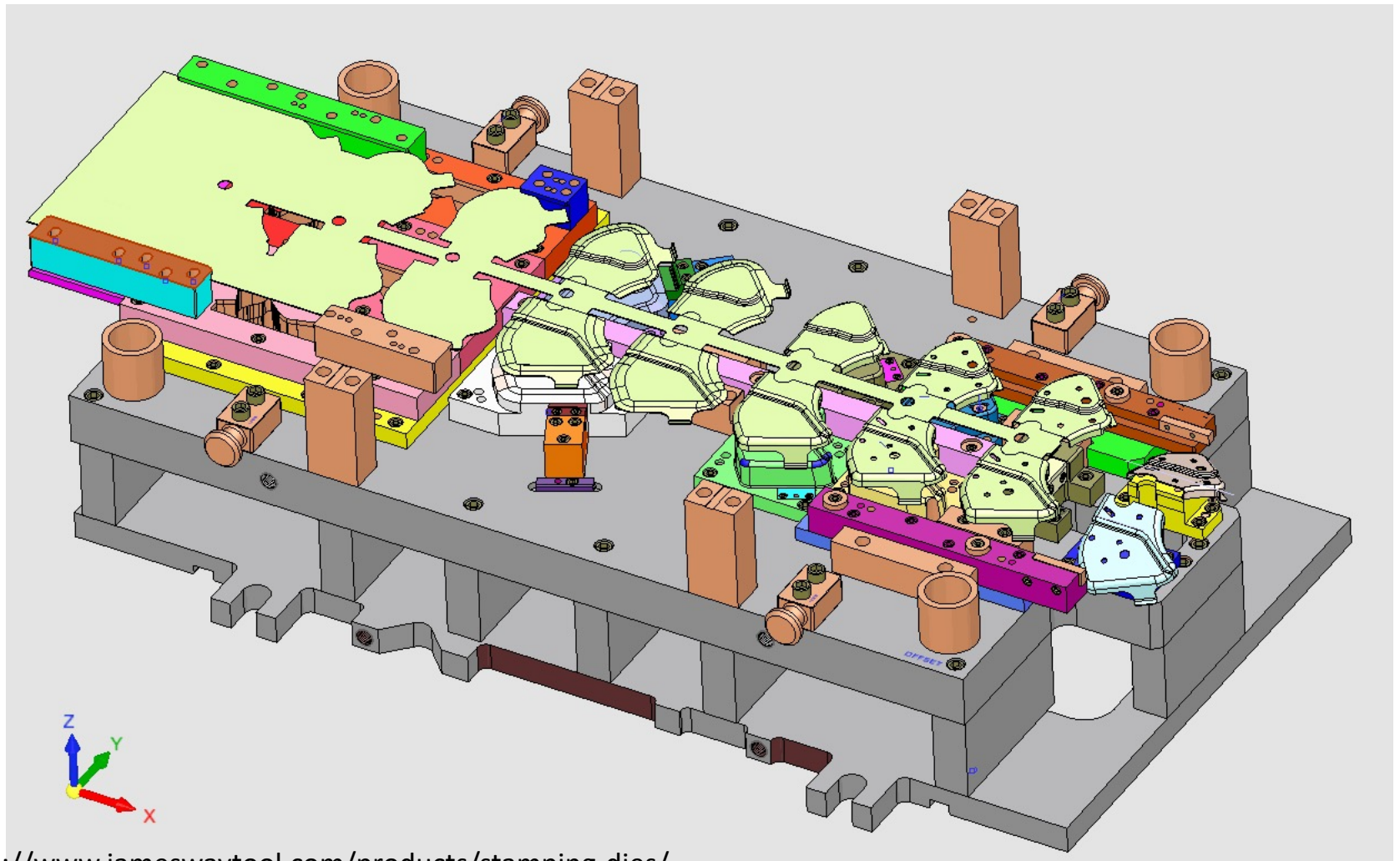


<http://www.jameswaytool.com/products/stamping-dies/>





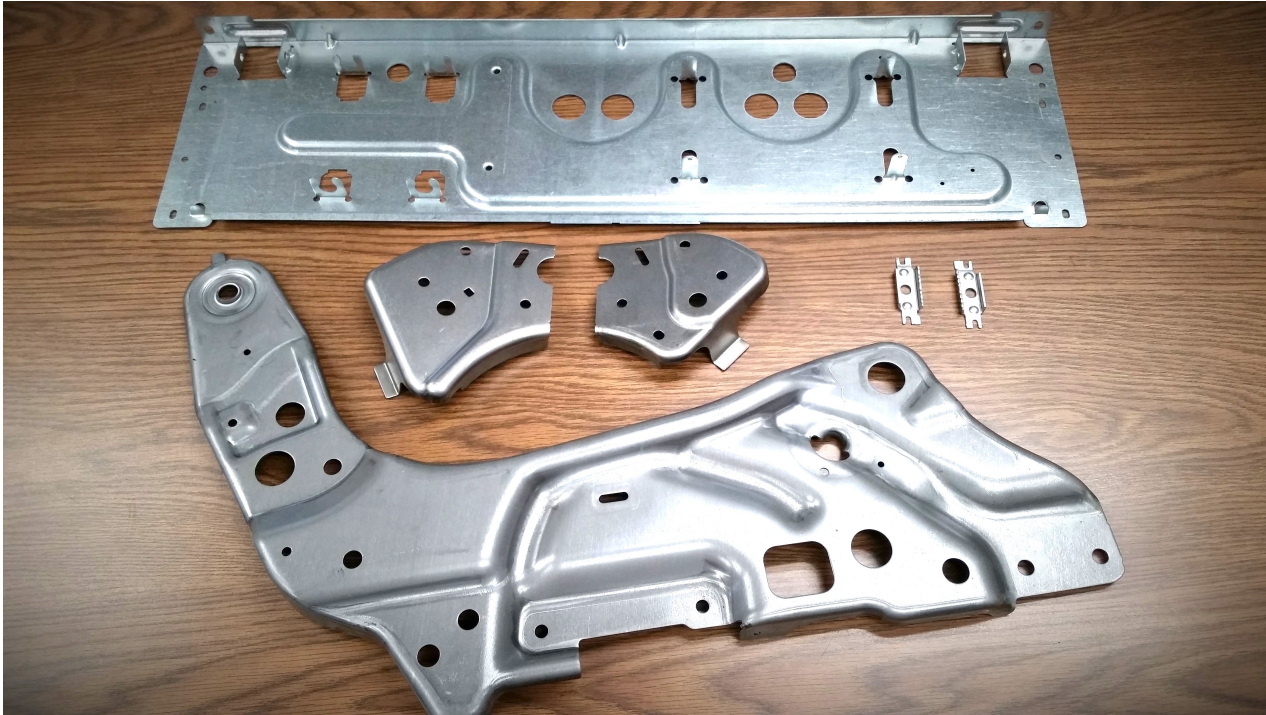
# Successive stamping



<http://www.jameswaytool.com/products/stamping-dies/>



# Stamped products



<http://www.jameswaytool.com/products/stamping-dies/>





# Modern Stamping lines



# 설계와 제조 공정의 조합

- 복잡한 형상의 설계물(designed product)을 제조하기 위해서는 앞서 다룬 여러 공정의 적절한 조합이 필요.
- 하지만 당기고 싶은 만큼, 누르고 싶은 만큼, 원하는 만큼 당길 수 있을까?
- 재료가 가진 고유의 성질에 기인하여 늘리거나, 구부리거나, 누를 때 제한이 있다.
- 재료가 가진 본래적 제한을 적절히 이해하고, 그 한계를 정량적으로 표현할 수 있어야 제조 공정에 드는 불필요한 비용 발생을 최소화할 수 있을 것이다.
- 재료가 가진 기계적인 특징을 잘 이해함으로써 최적의 제조 공정 조건을 찾을 수 있고, 공정상에 문제가 발생했을 때라도 적절한 대처를 할 수 있다.
- 발생한 문제에 대해 경험에 미루어 직관적으로 대처할 수도 있겠지만, 좀 더 과학적인 토대를 바탕으로 적절한 계산 결과에 기대어 decision-making을 한다면 더욱 효율적인 결과를 얻을 수 있을 것이다. 또한 그 결과를 다른 비슷한 공정 혁신에도 적용이 가능할 것이다.
- The ability to be shaped in a given process is often called 'formability'.
- We learn to describe the behavior of sheet in a precise way and express properties in a mathematical form.

