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A Study on the Development of Center Carrier Type Progressive Die for U-Bending Production Part

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KEY WORDS : Progressive die, U-Bending, Center Carrier, Clearance, Strip Process Layout, Pilot.

ABSTRACT : *The progressive die for U-bending production part is a very specific division. This study reveals the Sheet metal forming process with multi-forming die by Center Carrier type feeding system.*
Through the FEM simulation by DEFORM it was accepted to u-bending process as the first performance to design in strip process layout design.
The next process of die development was studied according to sequence of die development.

1. INTRODUCTION

Progressive die performs a series of fundamental sheet metal working at two or more stages during each press stroke to produce a piece part as the strip stock moving through the die. Press working from the optimum die design and its making has been the purpose by strip process layout with multi-stages.

So, this study needs a whole of press tool data, our field experiences, and theoretical instructions. According to upper factors, this study could be approached to the optimum die design through the FEM simulation and practical method of die making.

Furthermore the aim of least defects could be obtained mostly by revision through the tryout.

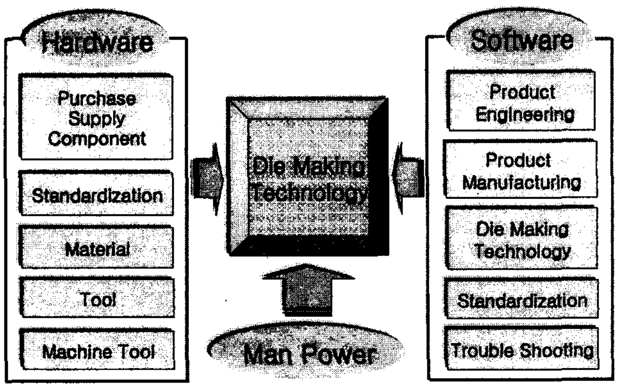


Fig.1 Network of the die developing system

2. DIE DESIGN

2.1 Die Developing System of Die

Fig. 1 shows the network of die development system. In this system, it can be known that the production engineering, die making technology, standardization, trouble shooting, man power, purchase, tool, material, etc. are connected with software and hardware, corresponded instructions of wide and deep technology and its theoretical background.[1~3)]

Fig. 2 shows one of die components drawing by existing program Auto-Lisp under the AutoCAD and Window environment. The other die components design were followed to this method experiences and related instructions.

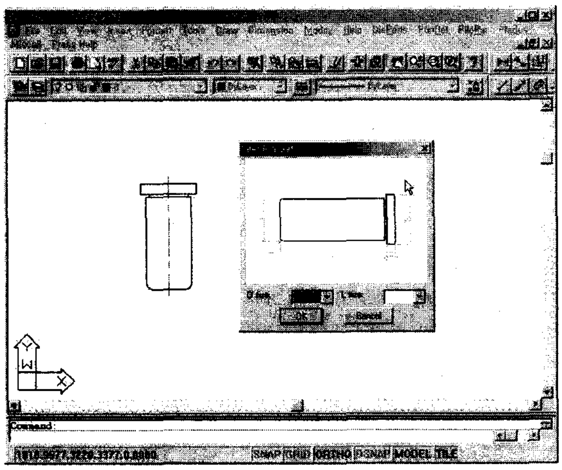


Fig.2 Die component drawing by Auto-Lisp

2.2 Strip Process Layout

The disposition of part on strip feed unfolding is the display with repeatedly area following part developing drawing and its web size.

Due to upper cause, it must be enough to the decision of strip feeding distance (advance, Pitch) and disposition of each stage on the strip lay out performing exactly.

Tool designer´s intention must consider that the best utilization ratio can be found the top of part arrangement.[4)]

This is the optimum method of initial die design . At this time it must be referred with the web size on the strip from database experience, and its related instructions.

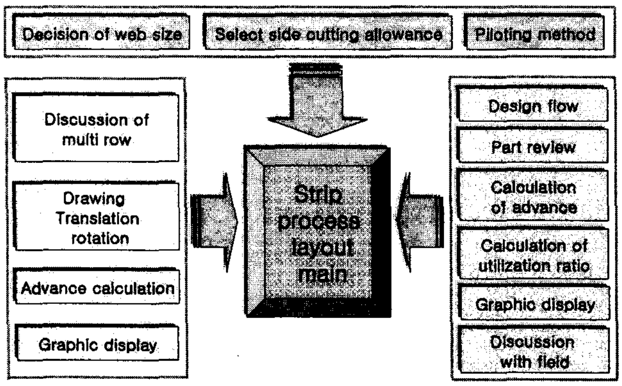


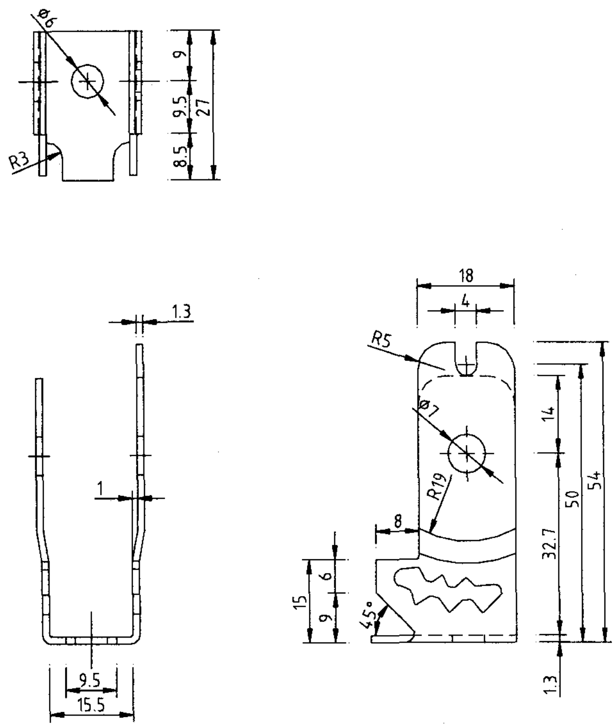
Fig.3 Flow chart of strip process layout design system

Fig. 3 shows the strip process layout design system. For the design of strip process layout, the first step is how to decide the feeding method which is according to the quantity of production part, material properties, and material thickness, the second step is same with a such as flow chart of Fig. 3

Fig.4 shows the production part and its developing length(99㎜) used to one of a thick sheet metal(material SPCC thickness 1.3㎜) product. From the strip process layout designing method, we designed the following strip process layout as the Fig.5 from the Fig.4 production part drawing. The strip process layout was considered that the proper size is strip width, web size, advance, side cutting allowance etc..[5)]

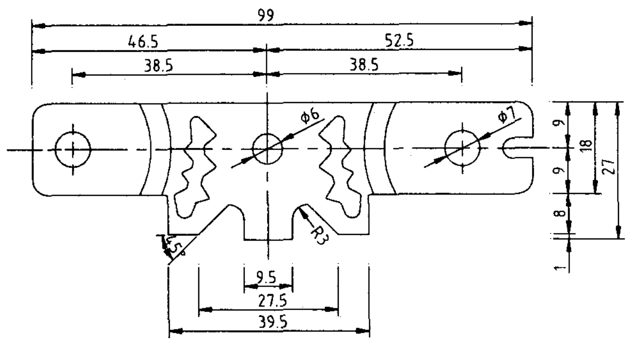
The first stage performs piercing, the second stage works piloting, the third stage works notching fourth stage works piercing, fifth stage performs piloting as a idle.

The sixth stage is bending stage, seventh stage works piercing.



Material : SPCC, Thickness : 1.3mm

(a) Part drawing



(b) Part developing length

Fig. 4 Drawing of production part and its developing length

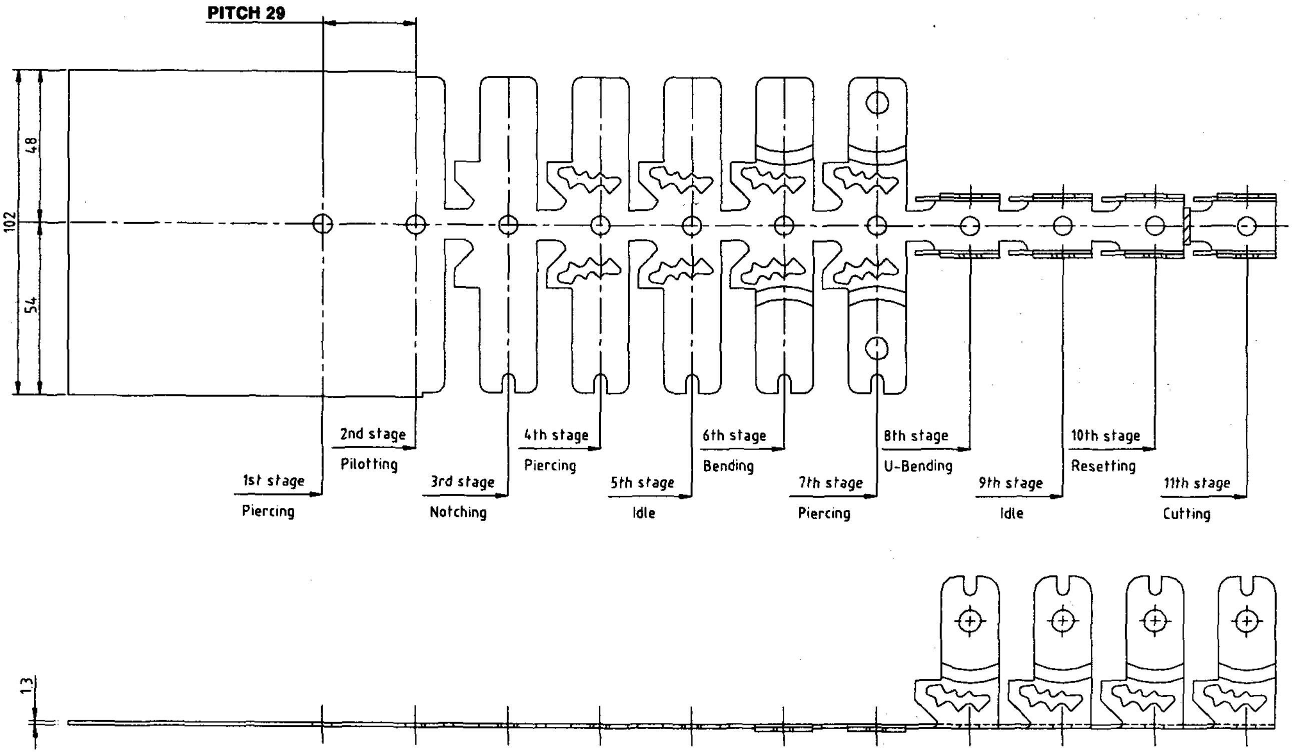


Fig. 5 Drawing of Strip Process Layout

The eighth stage works u-bending, in this stage, we must take care of pilot damage or fracture of the causes of dislocation and ninth stage is idle stage. The tenth stage is resetting stage. The eleventh stage works part cutting as a complete stage. Therefore the strip process layout was obtained in the result as Fig. 5.

2.3 Clearance

This experimental press working material is thick justly 1.3 ㎜(SPCC). Therefore, the clearance is large amount of 0.05mm between punch edge and die edge. At this time the burr at the punch cutting edge can occur minimizing in product tolerances.

2.4 FEM simulation

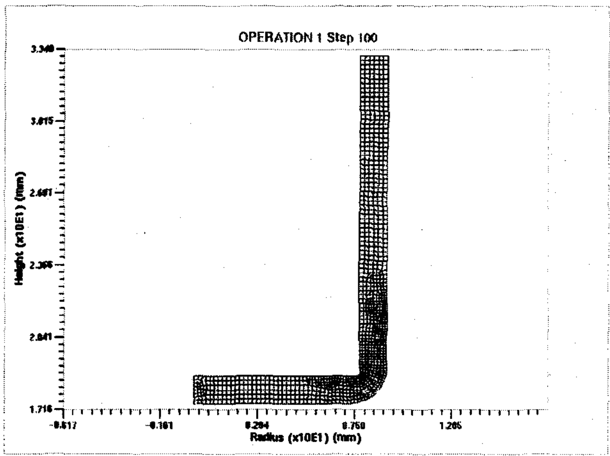
Fig. 6 shows the result of FEM simulation of u-bending corner by DEFORM programming.

At this time the parameter of supporting to FEM simulation by DEFORM programming is shown in table. 1.

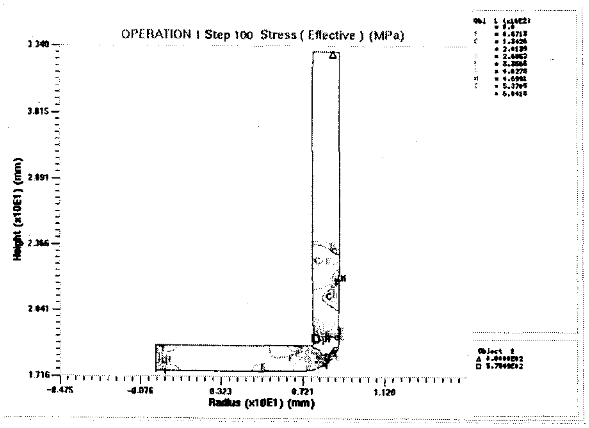
Through the Fig. 6 (a) (b) (c) (d), it was predicted that the u-bending crack is not created by the parameter of sheet metal of SPCC as shown in table.1 and the other data.

Table. 1 The parameter for FEM simulation

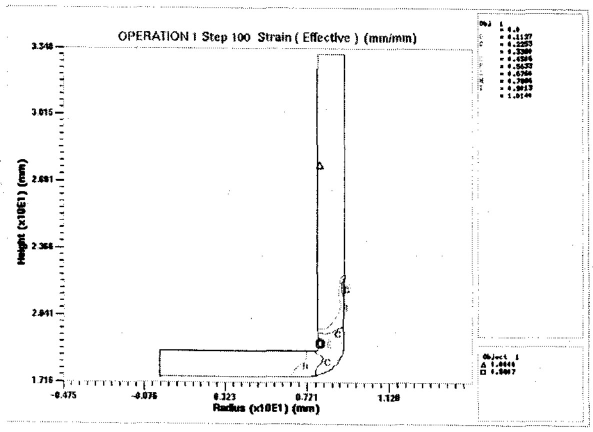
	Unit	Value
Young modulus	GPa	200
Poison ratio		0.3
Tensile Strength	MPa	760
Yield Strength	MPa	380



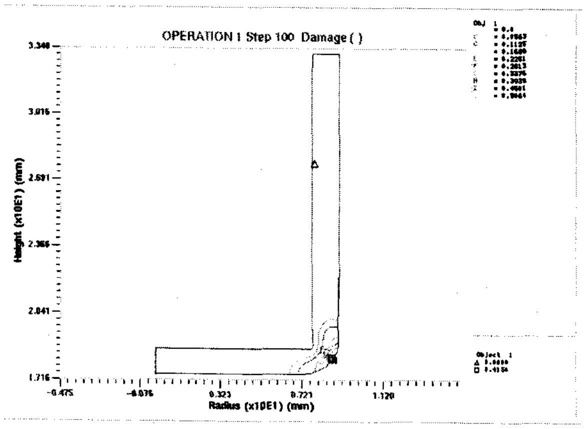
(a) Operation 1 step 100 meshing



(b) Operation 1 step 100 stress line contour



(c) Operation 1 step 100 strain line contour



(d) Operation 1 step 100 damaged line contour

Fig. 6 Result of FEM Simulation by DEFORM

Also, we considered that the result of FEM simulation u-bending in production part never occurred the crack phenomena. Therefore, it could be well done to the strip process lay out design as a Fig. 5.

2.5 Die Set Selection

There are several kinds of die set in the data base according to the die making standards. Some time in particular field, they make special type steel dieset for high precision die assembling function. In this study, we considered the automatic roll feeding of strip that the causes are mass production above one hundred thousand of production part and necessary to precision production, therefore we selected special type steel die for high precision production part. Also the guide post must be installed in the die shoe block size allowance in the accurate guide bushing fit. It was selected that the die set is 6 guide posts type for a precision working and high load of production part. These stage's pilots receive the bending force easily with a former pilot similarly. Fig.7 shows the result of die design, as a die drawing.

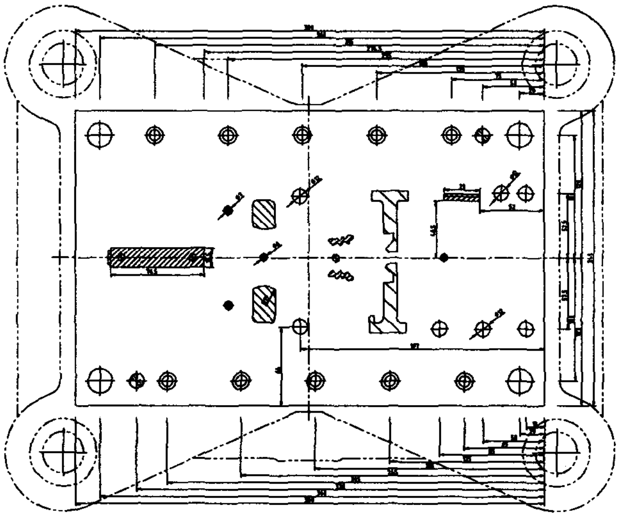
3. DIE MAKING

3.1 Die Making

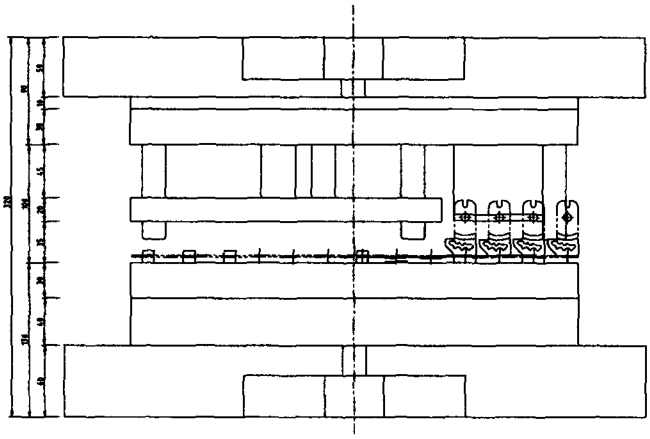
In this study, we decided the size of punch and die block depending on data base, theoretical background and our own field experiences.[6] The machining of punch and die block can belong to the precision machine tool working, continually raw material cutting, milling, turning, drilling, shaping, profiling, and then heat treating, electronic discharge machining (EDM, Wire-Cut), jig grinding, especially, CNC machining and mirror machining. Fig. 8 shows the progress of CNC machining center working. Fig. 9 shows the press die working system. Fig. 10 shows the CNC machining center for a representative of die making machine tools.

In this study, we used ordinary machine tools, CNC machine tools and EDM etc..

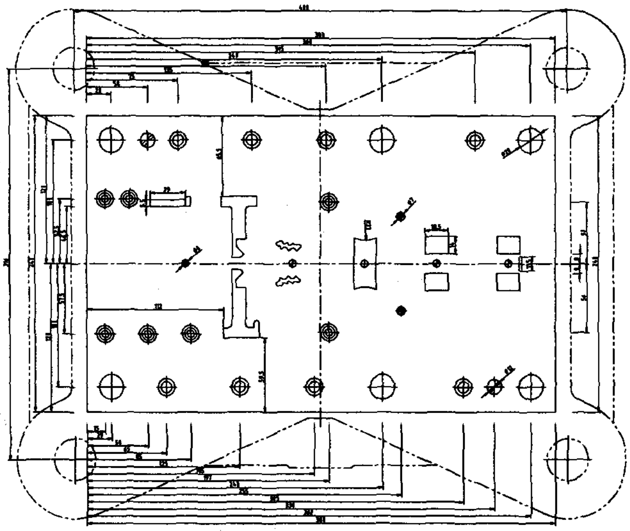
On the accuracy of each fitting component, Namely, with combination of the following tolerances, the first is guide bush and guide post(outer or inner) tolerance H7(hole) h6(shaft) for a sliding fitting and die set and guide post tolerances are H7(hole) p5(shaft) for a tight fitting. Punch plate and punch tolerance are H7(hole) m6(shaft) for a tight fitting with minor interference. The second is stripper and punch tolerance are H7(hole) h6(shaft) for a slide fitting. Die inserting hole and die insert button are H7(hole) m6(shaft) for a minor tight fitting. These fitting tolerances are very careful factors for die making because whole of die setting method must be within fine central punch and die activities for the symmetrical equalized clearance to the left and right side each other.



(a) Upper die plate



(b) Side view drawing



(c) Lower die plate

Fig. 7 Die assembling drawing

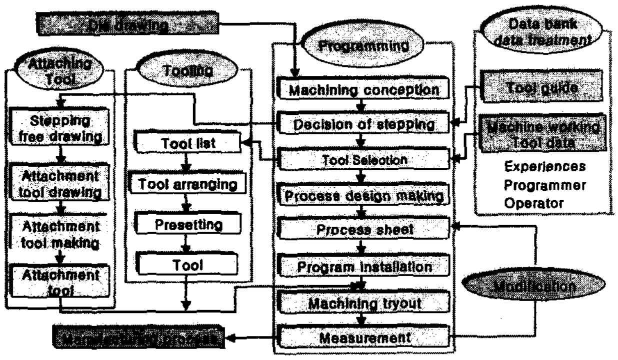


Fig. 8 Progress of CNC machining center working

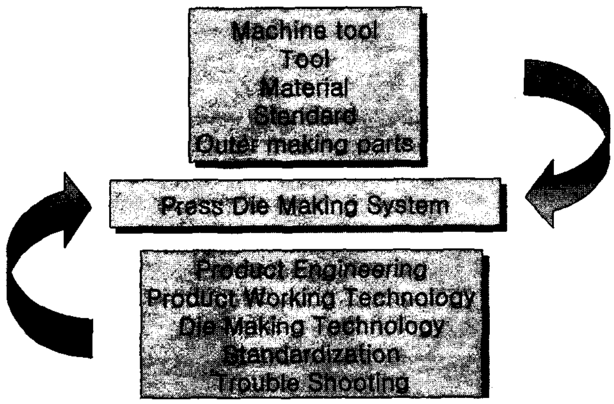


Fig. 9 Press die making system

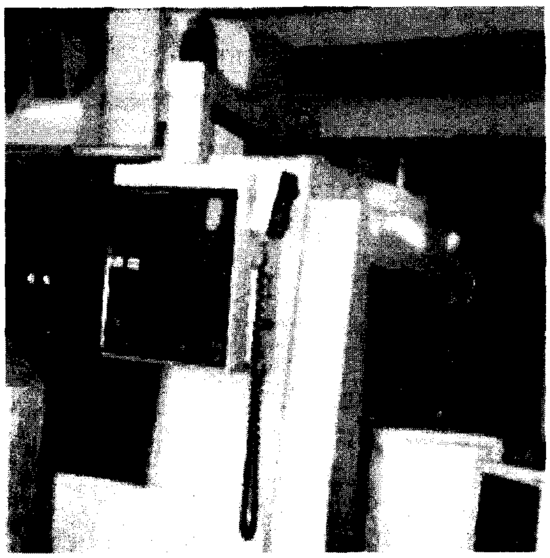


Fig. 10 CNC machining center for die making

4. Try out

Fig. 11 shows the actual strip process result from tryout working(200ton power press, 100㎜ stroke, 40 SPM). In this actual process strip, we could confirm the real process for making the production part.

Also we checked the every size of production part with tolerance control.

We could find the jamming problem such as the material strip through the guide tunnel on the die block surface. Also, when the material strip through the die tunnel, the roll feeding device operation must be checked very exactly.

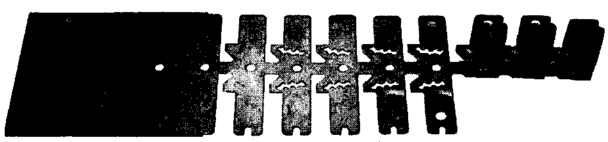
The trouble shooting of this problem has come from die setting skill and technology.

At this time, the check of die failures was performed through the production part and strip of every stage with punch and die edge by the survey and fine instruments.

We considered that all of the failure cause are associated with stresses present in the die, which are generated during either its manufacturing, or during its service life or both.[7]

Further more, the production part from tryout was very fine by inspection, too.

(a) Actual production part



(b) Actual strip by tryout

Fig. 11 Actual part and strip by tryout

5. CONCLUSION

In order to prevent the defect of die design and making, this study developed the practical and adaptive die assembling and components. This method could be taken from the theoretical back ground, data base and our field experiences.

The results are as follows

1) FEM simulation of strip process layout by DEFORM was obtained successful result.

2) The die design was performed as optimum result with the least defects in the die developing.

3) The trouble shooting was performed as a success method of tryout after die making.

ACKNOWLEDGEMENT

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