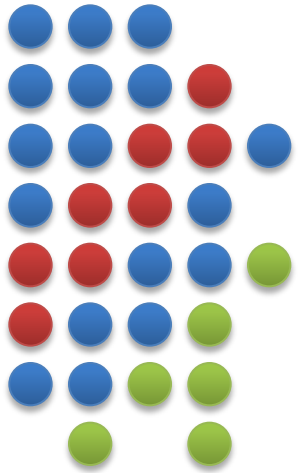
# HYBRIDIZATION IN TECHNOLOGY

## TRIZ CONFERENCE IN JAPAN, 2015

VALERIY PRUSHINSKIY

TRIZ MASTER



**Valeriy Prushinskiy,**

**Certified TRIZ Master**

Mail: vprushinskiy@idealmatrix.com
Tel: 248-986-3887

## Areas of expertise

•Valeriy Prushinskiy specializes in problem solving for research, manufacturing and translational projects, guiding problem solving, testing and implementation process, directing next generation and adapting products for various markets, including biomedical applications.
•Certified TRIZ (Theory of Inventive Problem Solving) Master with more than twenty years of application and development of TRIZ methodology.
•Author of the books “Hybridization: The New Warfare in the battle for the Market” and “Everyone Can Invent”.
•Developed and delivered of various TRIZ courses for engineers and researchers.

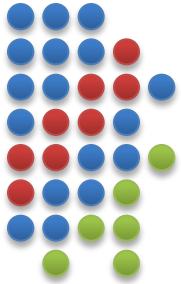
## Professional background

•Extensive Inventive Problem Solving (IPS) and Intellectual Property (IP) assessment and enhancement experience via applying Patent Deconstruction Process. Received “Most Popular Presentation” Award for the article “TRIZ patent deconstruction process: Apple’s “Slide-to-open” Patent Claim” at the Global TRIZ Conference 2013 at Seoul.

•Filed more than 50 patents and patent applications during his activity in Samsung Display Research Institute. CEO Certificate of Award and Prize for excellent achievement in 2011 foreign employee performance assessment. Best idea award during the 2013 Medici workshop.

•Inventive Problem Solving (IPS) and Directed Evolution (DE) project management experience from data collection to Innovation Situation Questionnaire, through Problem Formulation, Inventive Problem Solving, Concept Development and Evaluation of Results. Development and delivery of intermediate and final reports/presentations. Participation in 87 projects carried out by Ideation International Inc.

# AGENDA



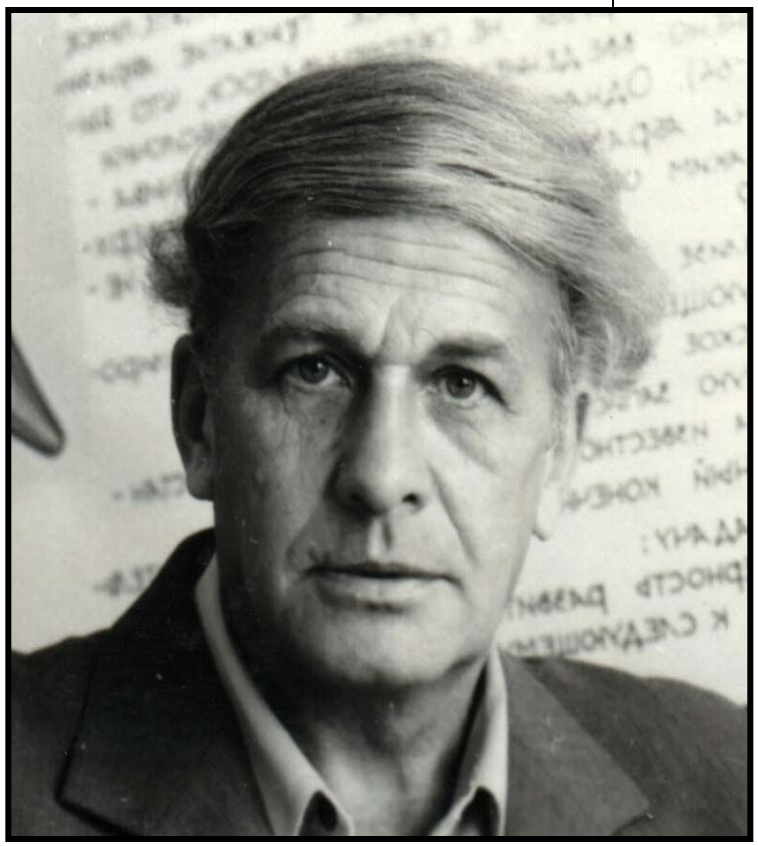
- TRIZ and Hybridization
- Hybridization of Alternative Systems
- Multi-Step Hybridization
- Basic Hybridization Schemes

# BASICS OF HYBRIDIZATION - VIDEO

Source: Madtv Spishak – Snoorpk accessed 10/21/2010

# TRIZ, THE THEORY OF THE INVENTIVE PROBLEMS SOLVING

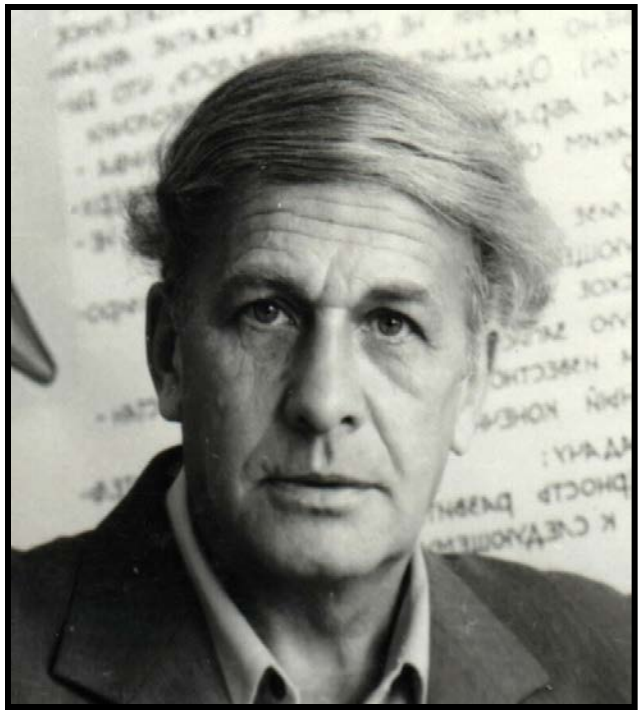
- Russian acronym for the Theory of Inventive Problem Solving originated in 1946 by Genrich Altshuller
- Systematic, structured way of inventing supported with numerous tools
- Science of technological evolution
- Results of analysis of millions worldwide patents within all engineering disciplines



Genrich Altshuller
10/15/26 to 9/24/98

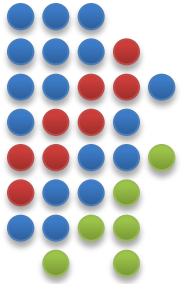
# INVENTIVE PRINCIPLES: COMBINING

One of the 40 Inventive Principles, proposed by Genrich Altshuller



- Principle # 5 – Combining (aka Merging)
  - A. Combine or merge identical or related objects, operations or functions.
  - B. Combine or merge related or associated operations so that they are carried out at the same time.

# FEATURE TRANSFER ALGORITHM



- Vladimir Gerasimov and Simon Litvin have defined their algorithm of feature transfer as set of following steps:

1. Identify main function of the system/component
2. Formulate key advantages and disadvantages in form of a contradiction
3. Identify Competing (Alternative) systems
4. Select alternative engineering system
5. Select base engineering system
6. Formulate feature transfer problem

# EXAMPLE: HYBRIDIZATION OF ICE CREAM


Chocolate Ice Cream Bar

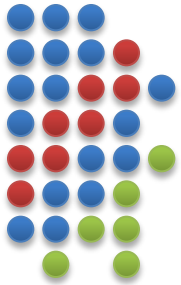
+


Chocolate Chip Cookie Sandwich

→

Chocolate Chip Cookie Bar

# HYBRIDIZATION OF ALTERNATIVE SYSTEMS

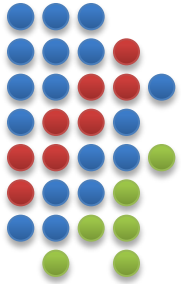


Definitions

- Hybridization of Alternative Systems is analytical tool for improvement the Base Engineering System by transferring relevant features from Alternative Engineering System.

- An alternative system is an object with the same main function as the base object. However, the advantages and deficiencies of the two systems are mutually opposite.

# MULTI-STEP HYBRIDIZATION APPROACH



Definition

- Multi-step Hybridization is analytical tool for improvement of Engineering System by transferring features from multiple systems.


**HYBRID:**

**IPOD + PHONE + INTERNET BROWSING DEVICE**



iTunes player built-in

# SECRET PROJECT 1


- Hybrid: iPod + Cell phone

# SECRET PROJECT 2





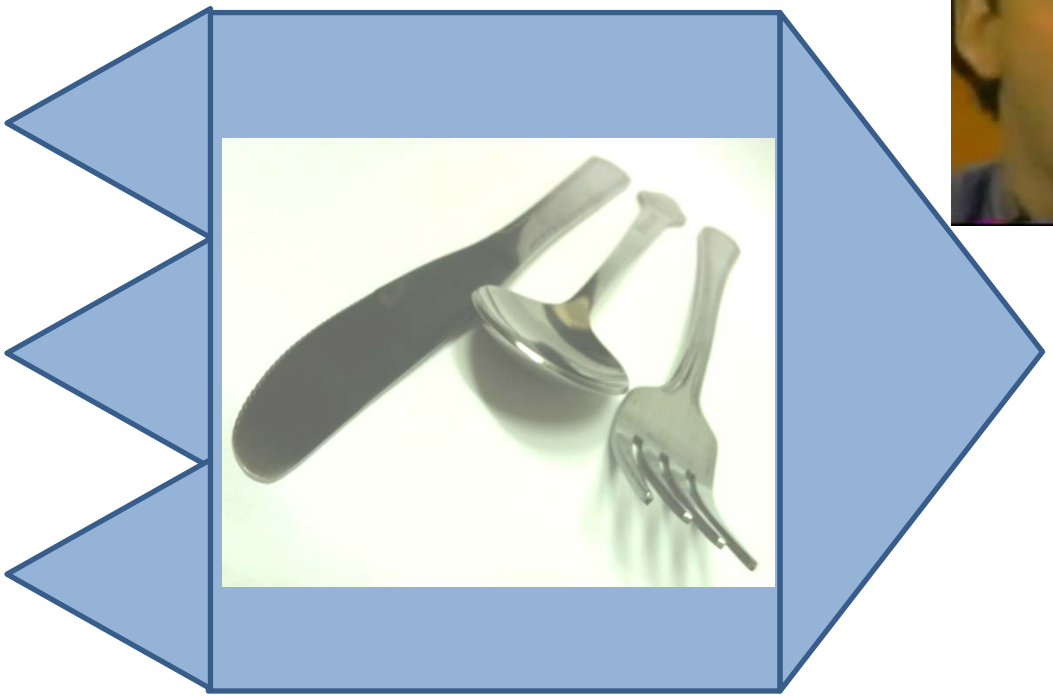


16

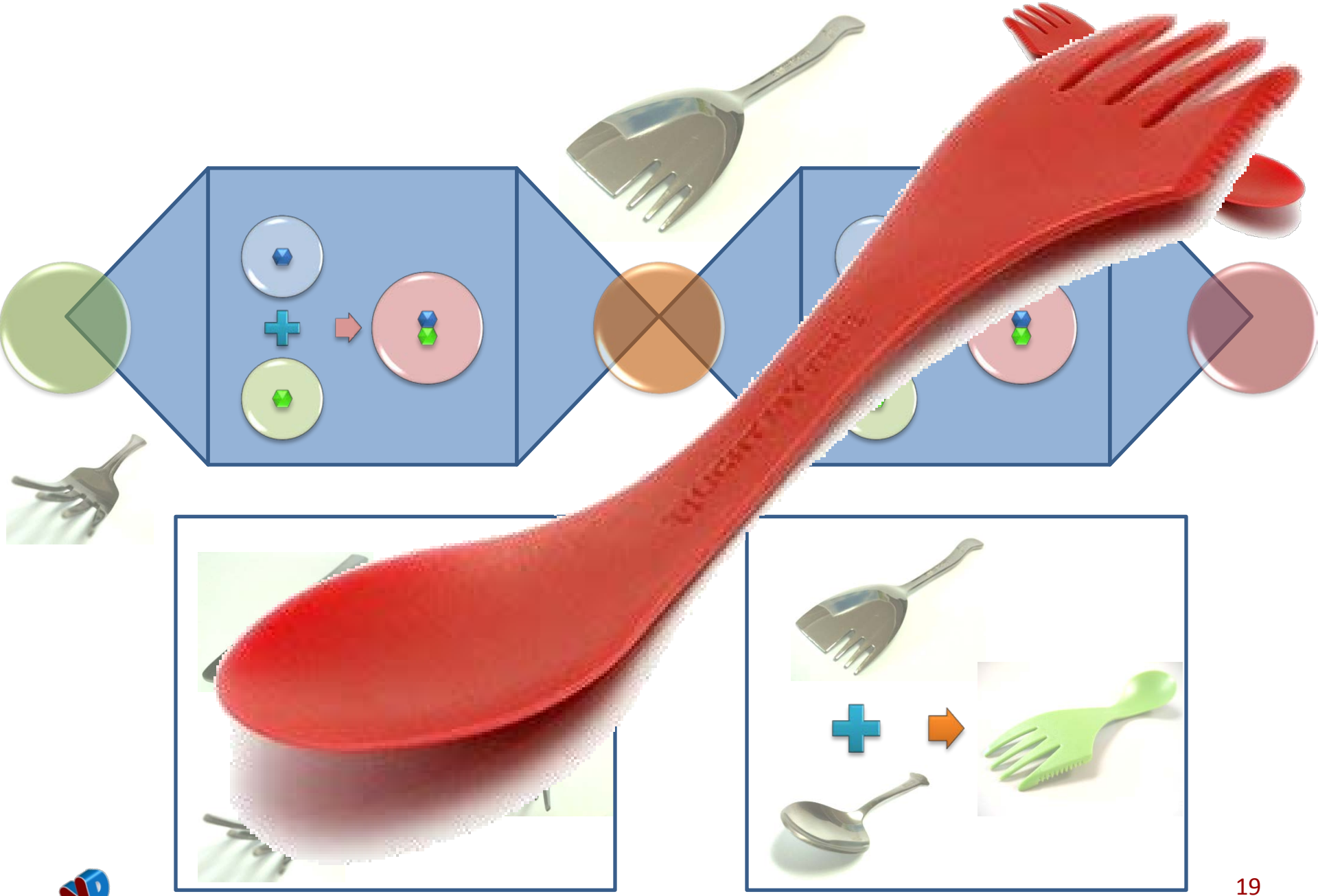
# HYBRIDIZATION OF MULTIPLE SYSTEMS

Source: Madtv Spishak – Snoorpk accessed 10/21/2010

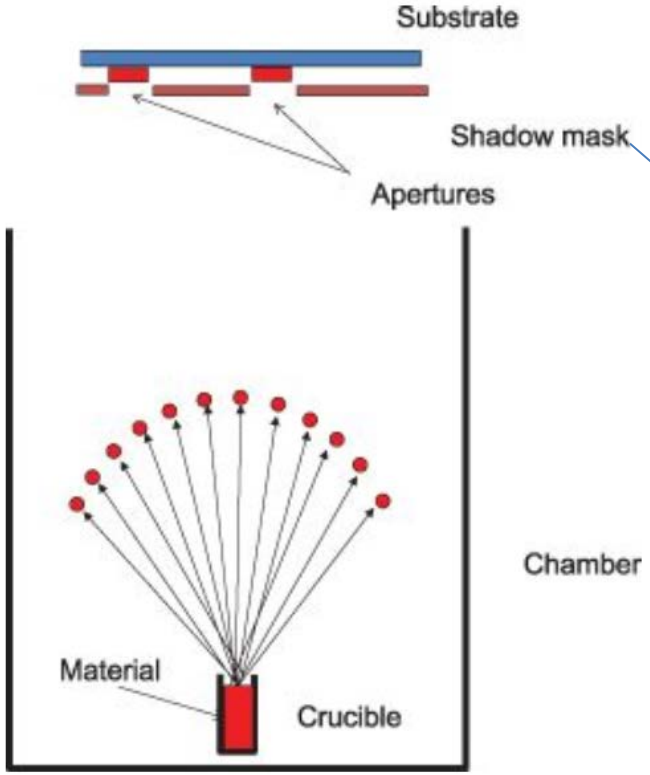
# HYBRIDIZATION OF MULTIPLE SYSTEMS

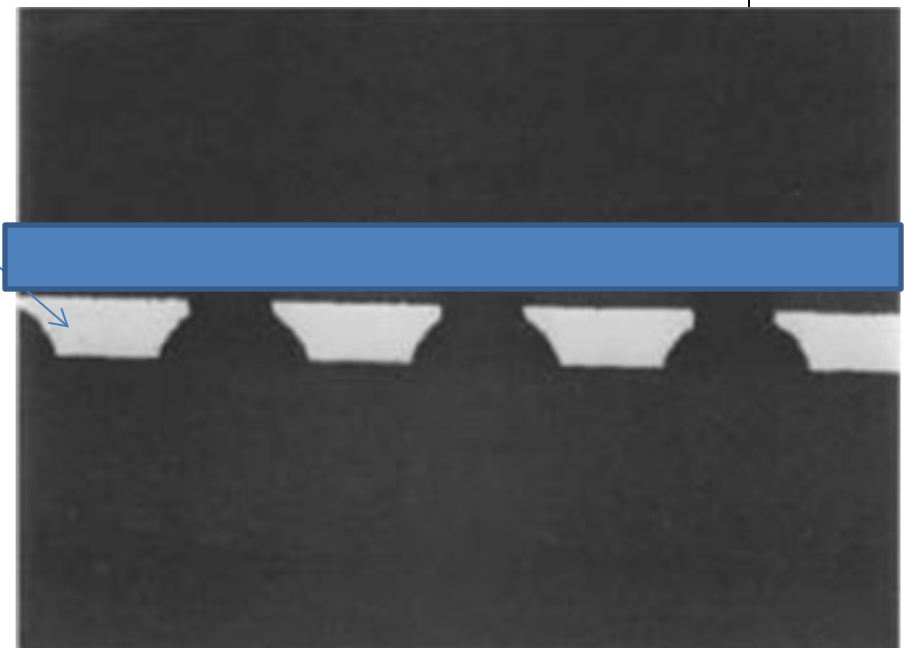


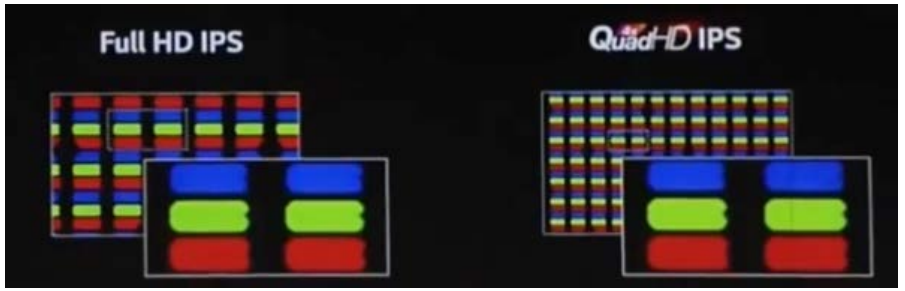




# CASE STUDY – CONSECUTIVE HYBRIDIZATION FOR MASK MANUFACTURING: INITIAL SITUATION

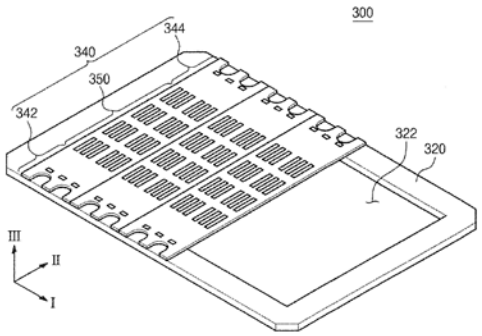


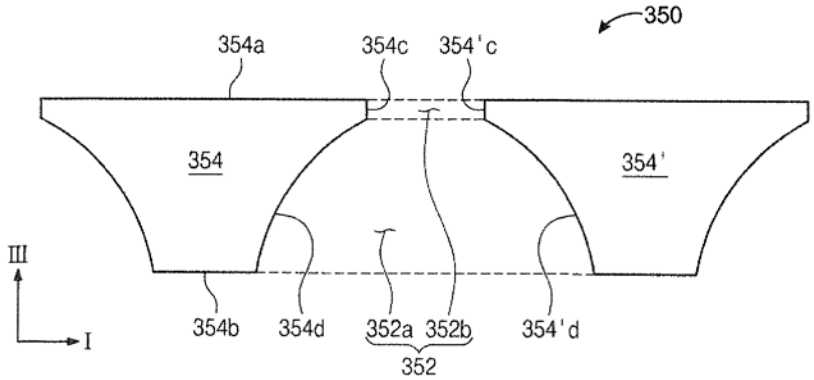


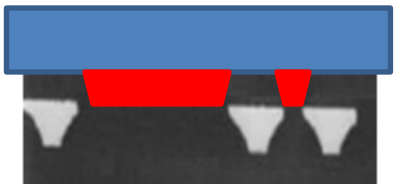

(Case study is based on US 20130071775 A1)

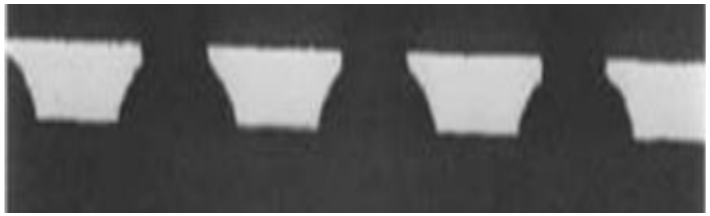
# CASE STUDY: INITIAL SITUATION

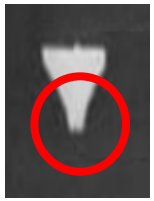


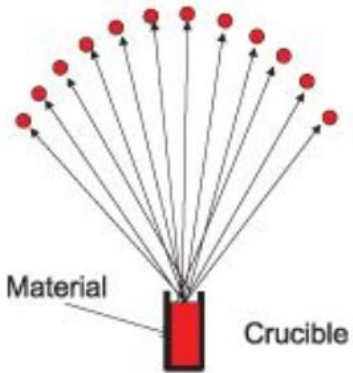











(Case study is based on US 20130071775 A1)

# 1ST ITERATION

Step 1. Identify initial engineering system (describe as a set of simple ideas with list of advantages and disadvantages)

*Existing Mask#1 with "big" ribs*

*+ The ribs are not bending and keep required shape*

*- Dimensions of the rib are too wide, so that there is no enough space for pixels*

Step 2. Describe candidate for crossing (describe as a set of simple ideas with list of advantages and disadvantages)

*Mask#2 with "small" ribs*

*+ Dimensions of the rib is small, so that there is enough space for more pixels*

*- Ribs are bending and cannot keep required shape, because bottom part of the rib is disappearing during manufacturing*

Step 3. Describe hybridization contradiction

*New hybrid mask has to be like Mask#1, so that it will have "big" ribs" that would not bent, and hybrid mask has to be like Mask#2, so that it will have "small" ribs, so that it will provide required space for smaller pixels.*

Step 4. Select dominant engineering system

*We select Mask#1, because we can produce it without bent ribs.*

Step 5. Reveal resources for hybridization

*Thin ribs of the Mask#2.*

Step 6. Describe portrait of hybrid

*Hybrid with "big" ribs, where there are "small" ribs.*

Step 7. Formulate ideal vision of hybridization problem

*Hybrid Mask#1 with minimal modifications should accommodate features of Mask#2.*

Step 8. Reveal resources of dominant engineering system

*Wide and strong ribs.*

Step 9. Describe intermediate hybrid

*Mask with hybrid ribs that will be strong enough to prevent bending: wide-and-narrow ribs.*

Fig. 3. First iteration.

Step 10. Reveal drawbacks, not addressed by intermediate hybrid

*Intermediate hybrid concept was generated very straightforward, as ribs with small and big cross-sections one after another, providing strong ribs (fig. 3). But, drawback is non-uniform edges of the pixels, that is why this concept cannot be accepted.*

Step 11. Select next engineering system for hybridization

*Due to drawbacks of the initial concept, additional resources have to be revealed for second iteration of hybridization. OLED display manufacturing chamber was considered as one of the candidates for follow-up hybridization. It was revealed, that after evaporation, evaporated organic material in the central part of the mask is passing through the mask nearly without any inclination angle. On the edges of the mask (right and left sides), inclination angle value far from optimal straight angle.*

Step 12. Repeat hybridization process

- Now we continue hybridization, and use concept of the first intermediate hybrid for further hybridization.

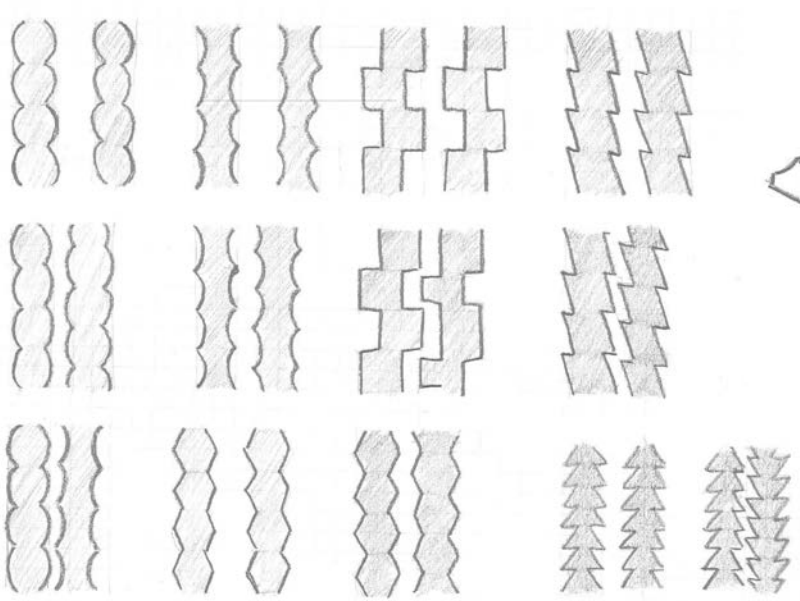


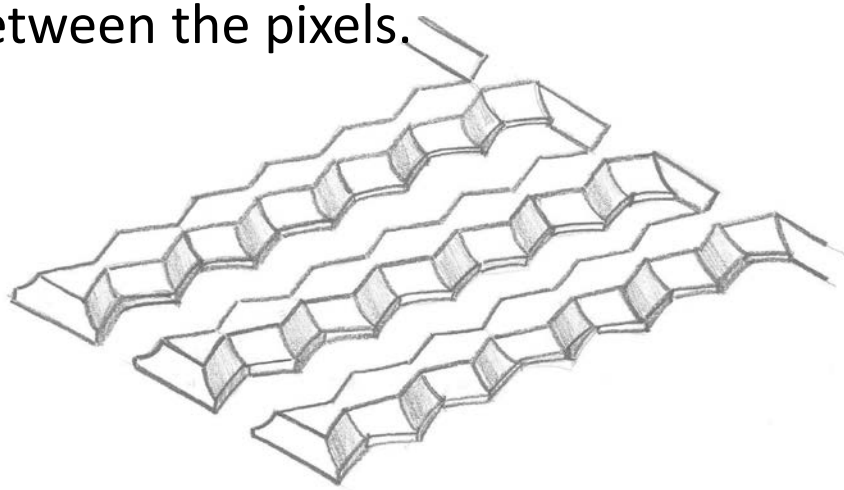
(Case study is based on US 20130071775 A1)

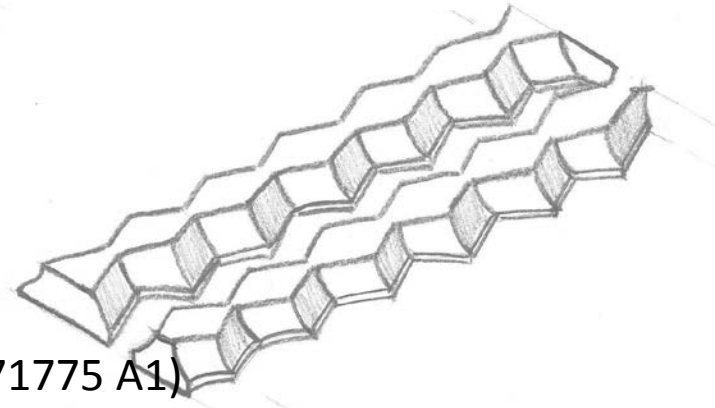
# 1ST ITERATION

Contradiction

- Cross-section of the rib has to be big, in order to maintain the strength and shape, and cross-section of the rib has to be small, in order to reduce distance between the pixels.



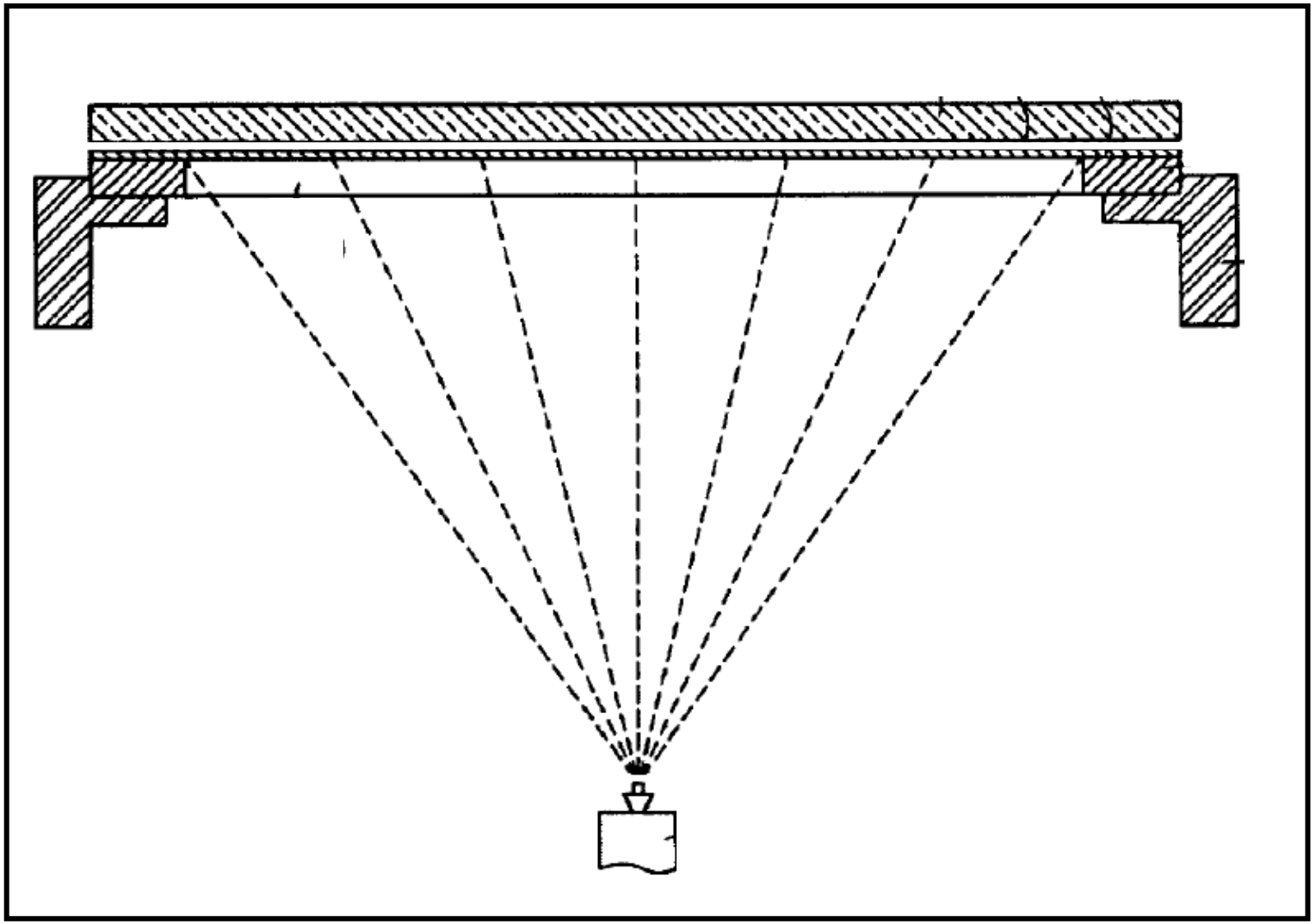






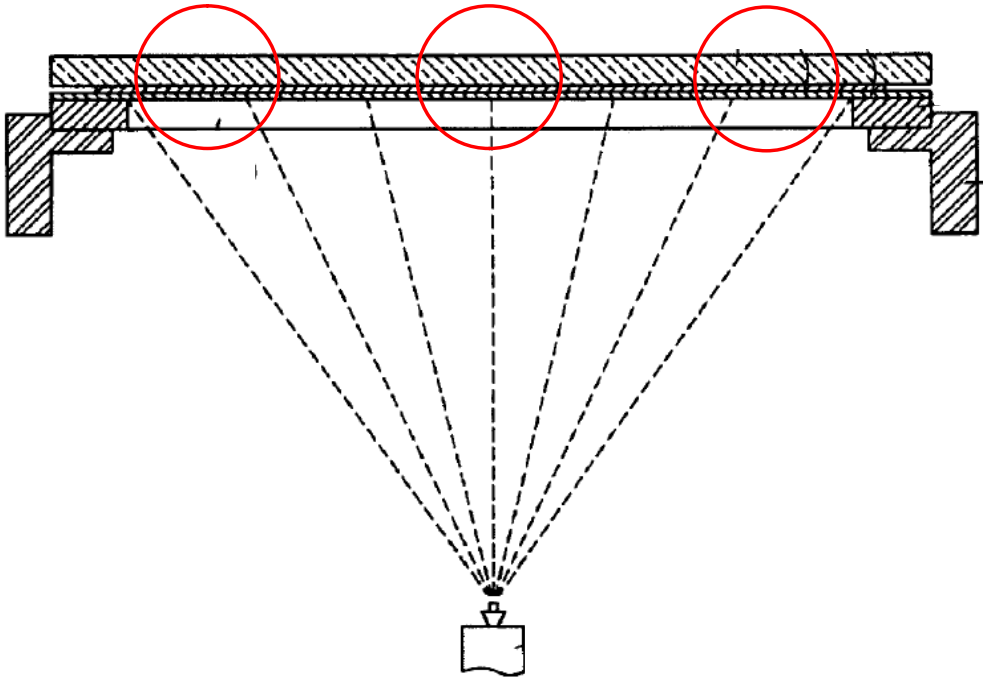
(Case study is based on US 20130071775 A1)

# SEARCH OF RESOURCES FOR NEXT CYCLE OF HYBRIDIZATION



(Case study is based on US 20130071775 A1)

# SEARCH OF RESOURCES FOR NEXT CYCLE OF HYBRIDIZATION



- Conditions for deposition from single source evaporator at the left part, center part and right part of substrate are different.



(Case study is based on US 20130071775 A1)

# 2ND ITERATION

Step 2-1. Identify initial engineering system (describe as a set of simple ideas with list of advantages and disadvantages)

Mask with hybrid ribs that will be strong enough to prevent bending: wide-and-narrow ribs.

+Ribs would not bent

- Difficult manufacturing

-Uneven edges of pixels are unacceptable for production

Step 2-2. Describe candidate for crossing (describe as a set of simple ideas with list of advantages and disadvantages)

Mask with "specialized" ribs accommodated for evaporation in central part and on the edges (left and right parts).

Step 2-3. Describe hybridization contradiction

New hybrid mask should be like mask with wide-and-narrow ribs, and it should be as "specialized" mask accommodating different conditions of evaporation.

Step 2-4. Select dominant engineering system

"Specialized" mask selected dominant system as simpler one.

Step 2-5. Reveal resources for hybridization

Ribs with "wide" base, accommodating evaporation on the left and right sides.

Step 2-6. Describe portrait of hybrid

Mask with expanded "widened" base and ribs, depending of its position on the mask.

Step 2-7. Formulate ideal vision of hybridization problem

Hybrid Mask#3 with minimal modifications should accommodate features of concept of Intermediate Hybrid Mask.

Step 2-8. Reveal resources of dominant engineering system

Wider base part of the ribs on the edges, and wider "tail" part of the ribs in central part.

Step 2-9. Describe intermediate hybrid

Mask#3 should be asymmetric with expanded base part in the left part and in right part. Also, in central part the bottom part of the ribs can be expanded. These modifications would make the mask stronger and prevent bending.

Fig. 5. New intermediate hybrid concept.

Step 2-10. Reveal drawbacks, not addressed by intermediate hybrid

In areas between the central part and edges the ribs still will be too thin, so bending and waving is possible in these zones. Concept of Mask#3 will require too many mask sticks, which have to have "special" shape in "special" place, so manufacturing is more complex.

Step 2-11. Select next engineering system for hybridization

Current mask manufacturing process was studied as next candidate for hybridization. Existing mask manufacturing process is schematically illustrated by following steps (fig. 6):

1. Patterning mask substrate (usually metal sheet) by forming first photoresist pattern on a top surface of the mask substrate
2. Forming a second photoresist pattern on a bottom surface of the mask
3. Etching mask to form first recess
4. Forming a third photoresist pattern to cover the first photoresist pattern and the first recess
5. Etching the mask substrate using the second photoresist pattern to form sidewalls of the ribs.
6. Stripping of photoresist and obtaining mask.

Fig. 6. Existing mask manufacturing process.

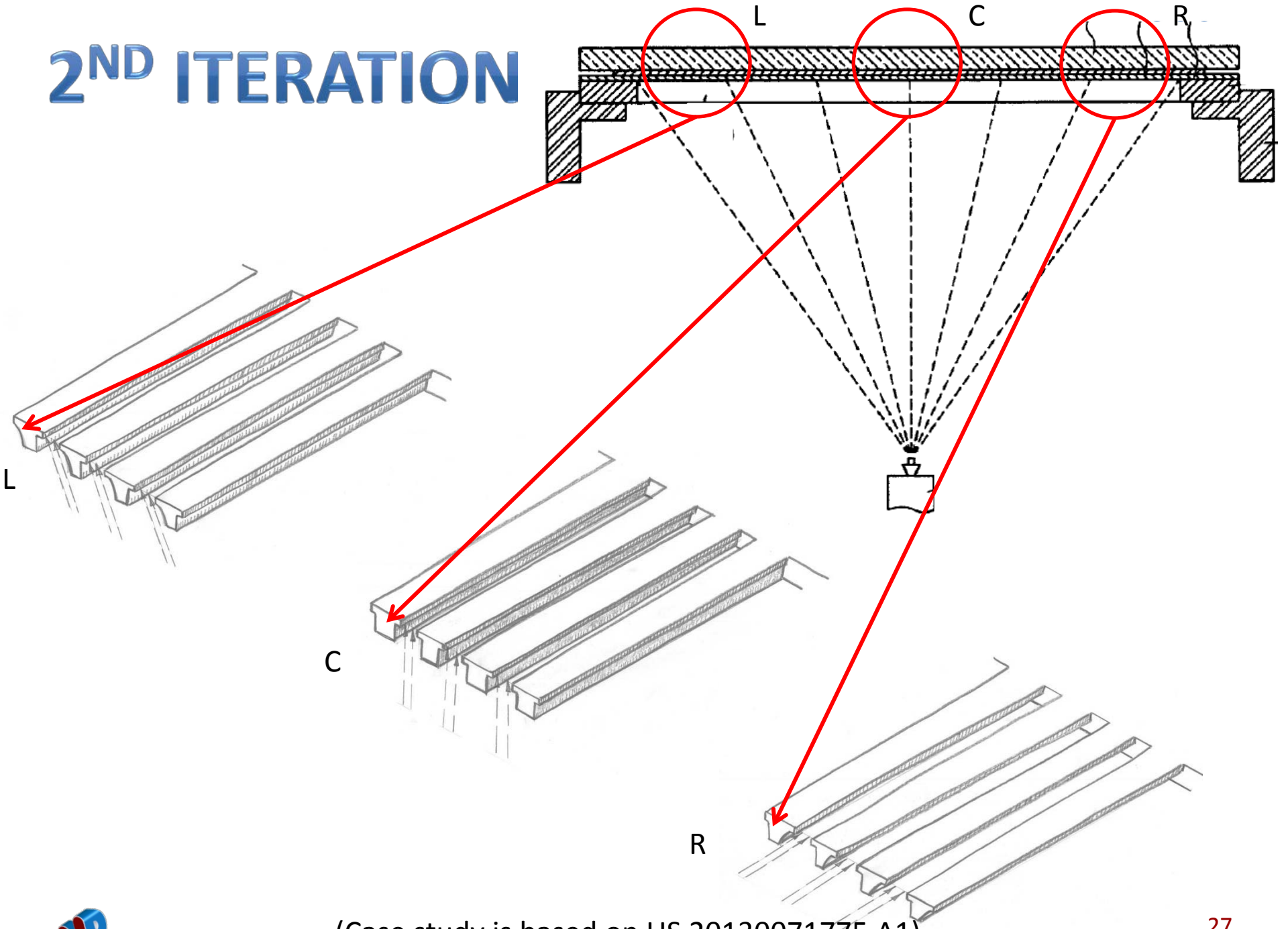
Step 2-12. Repeat hybridization process

Now we continue hybridization, and use concept of the second intermediate hybrid Mask#3 for further hybridization.

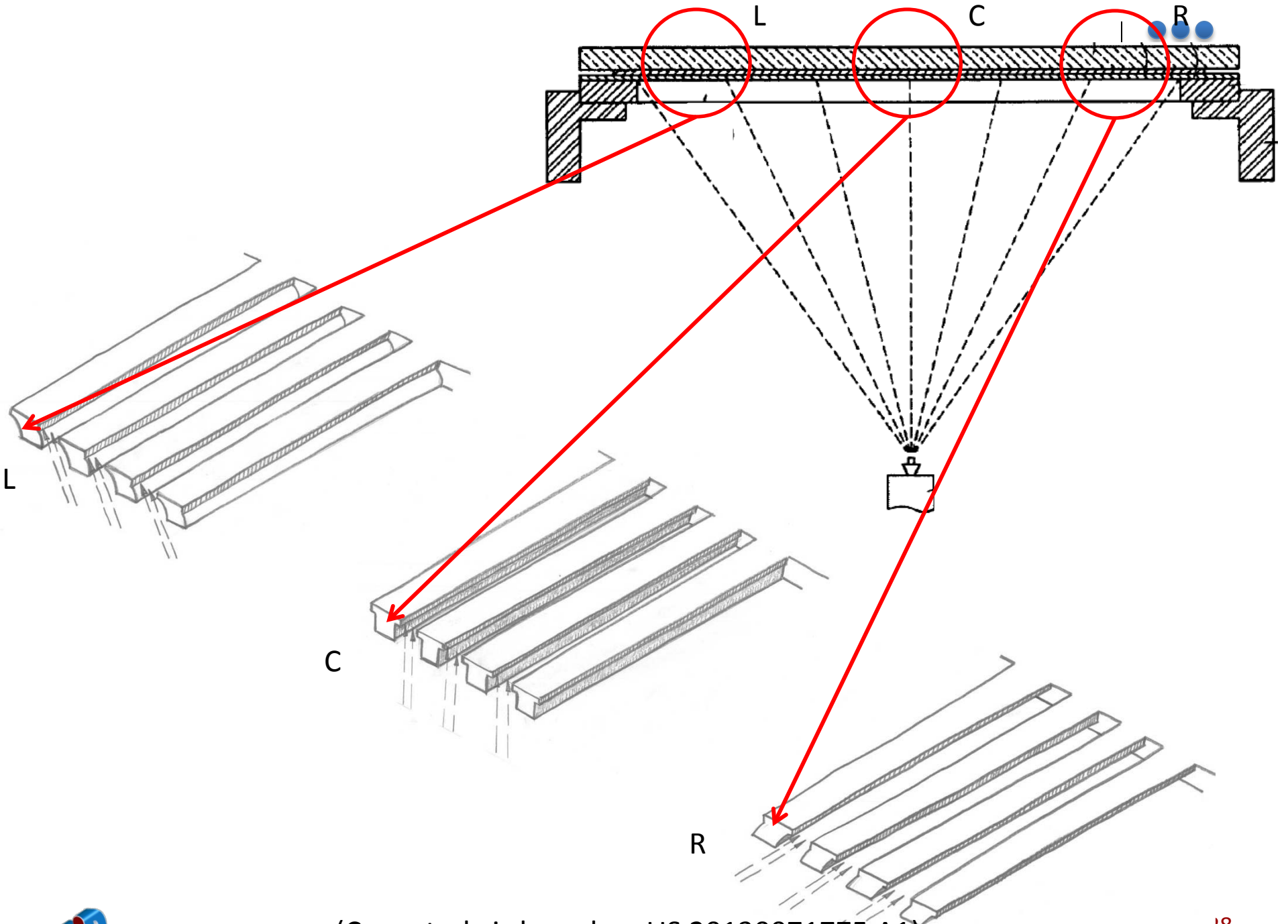


(Case study is based on US 20130071775 A1)

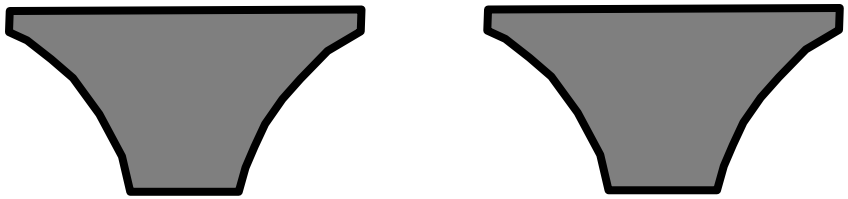
# 2ND ITERATION

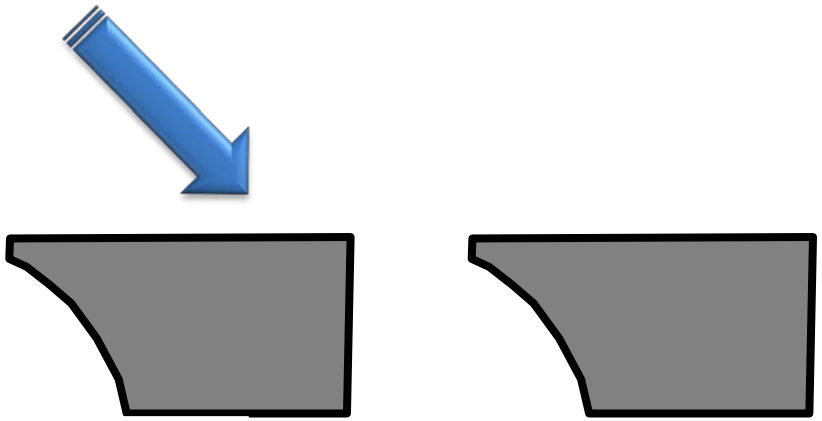


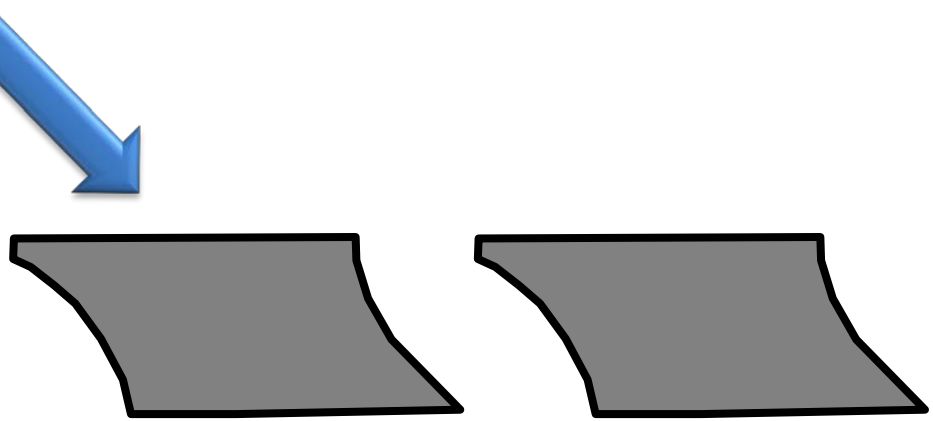

(Case study is based on US 20130071775 A1)




(Case study is based on US 20130071775 A1)









(Case study is based on US 20130071775 A1)

# 3RD ITERATION

Step 3-1. Identify initial engineering system (describe as a set of simple ideas with list of advantages and disadvantages)

Intermediate hybrid concept of Mask#3

- asymmetric ribs are stronger and prevent bending
- Individual sticks increase complexity of manufacturing

Step 3-2. Describe candidate for crossing (describe as a set of simple ideas with list of advantages and disadvantages)

Existing Mask, manufactured in 6 steps, as it was described above.

Advantage of this mainstream manufacturing process is reliability, but at if this approach will be applied for manufacturing the mask with fine high-resolution pattern, the bottom edge portion of the rib will be too small. For example, linear sidewalls 354b, 354d and 354'b ,354'd may disappear during etching, and final ribs may have a reduced rigidity, and may be deformed or distorted (fig. 7). This may result in a pattern failure of the mask.

Fig. 7. High resolution pattern problem.

Step 3-3. Describe hybridization contradiction

New hybrid Mask should have features of Mask#3 preventing bending, and should have features of manufacturing steps, described above.

Step 3-4. Select dominant engineering system

Intermediate hybrid Mask#3.

Step 3-5. Reveal resources for hybridization

- expanded base part in the left part and in right part of the mask
- expanded bottom part of the ribs in central part

Step 3-6. Describe portrait of hybrid

New Hybrid Mask during manufacturing process should have expanded base in left and right sides.

Step 3-7. Formulate ideal vision of hybridization problem

New hybrid mask should use existing manufacturing process with minimal changes.

Step 3-8. Reveal resources of dominant engineering system

Wide base of the rib, expanded bottom portion of the rib.

Step 3-9. Describe intermediate hybrid

In order to use advantages of the current manufacturing technology, it was proposed to produce mask with "oversized" ribs wide base and top part, and then apply additional patterning to remove excessive material and make ribs smaller. Final concept of proposed technology will have following steps (fig. 7):

1. Patterning mask substrate (usually metal sheet) by forming first photoresist pattern on a top surface of the mask substrate, where first photoresist pattern having a top width greater that those of the final ribs
2. Forming a second photoresist pattern on a bottom surface of the mask
3. Etching mask to form first recess
4. Forming a third photoresist pattern to cover the first photoresist pattern and the first recess
5. Etching the mask substrate using the second photoresist pattern to form sidewalls of the ribs
6. Forming photoresist pattern having width substantially equivalent to the top widths of the final ribs and facing the bottom photoresist pattern
7. Etching the upper edge portions of the initial ribs using the upper and bottom photoresist patterns as etching masks
8. Stripping of photoresist and obtaining mask.

Fig. 7. Final concept.

Step 3-10. Reveal drawbacks, not addressed by intermediate hybrid

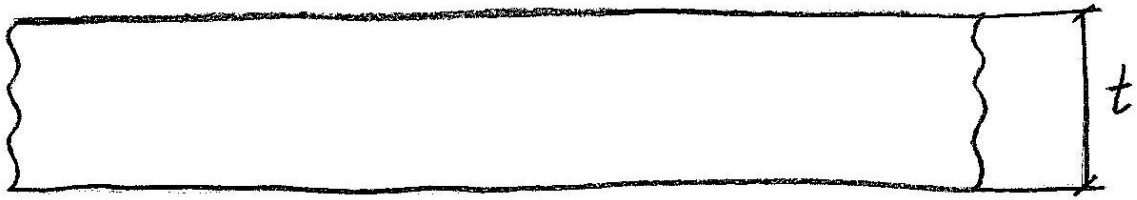
Although the number of manufacturing steps was increased, manufacturing of high resolution mask is possible in framework of current manufacturing paradigm. Several manufacturing alternatives were proposed based on the same concept.



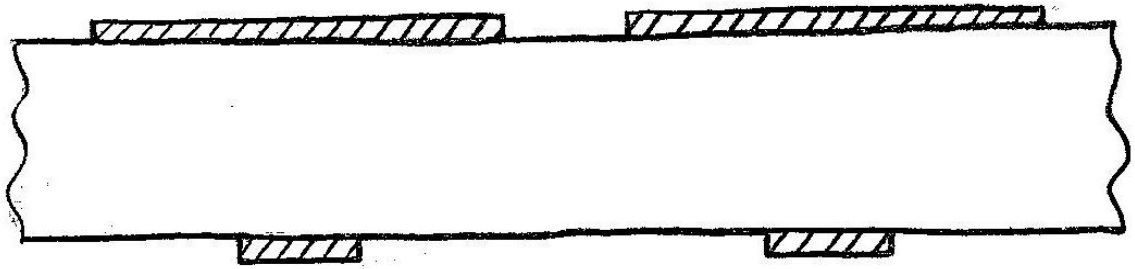
(Case study is based on US 20130071775 A1)

# SEARCH OF RESOURCES FOR NEXT CYCLE OF HYBRIDIZATION

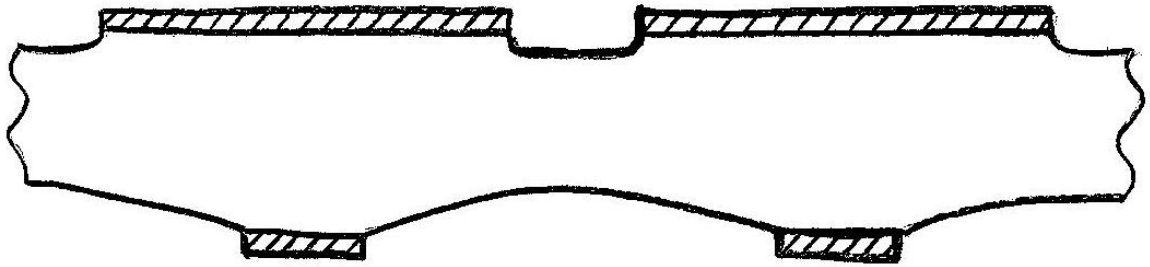
Step 1




Step 2

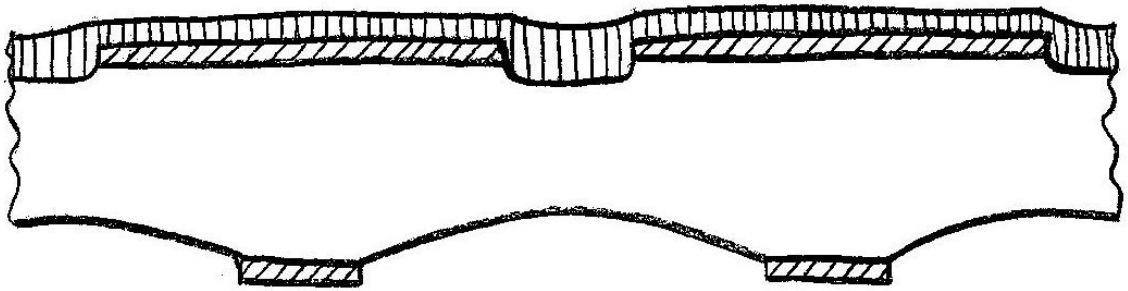


Step 3

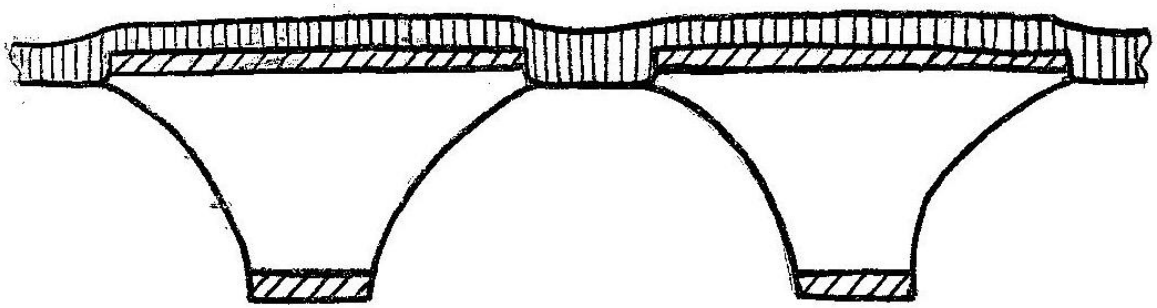


(Case study is based on US 20130071775 A1)

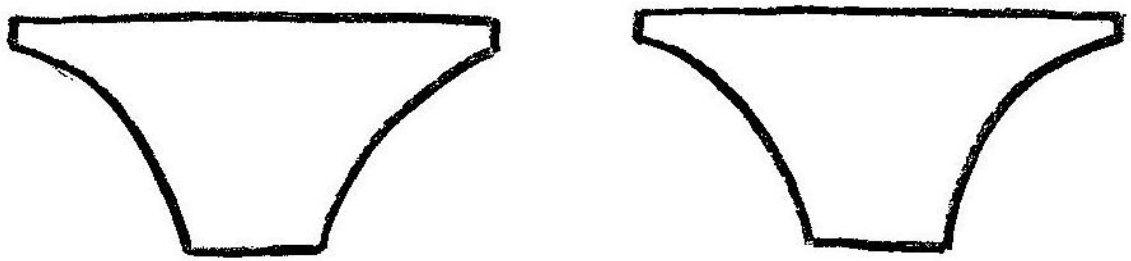
Step 4



Step 5



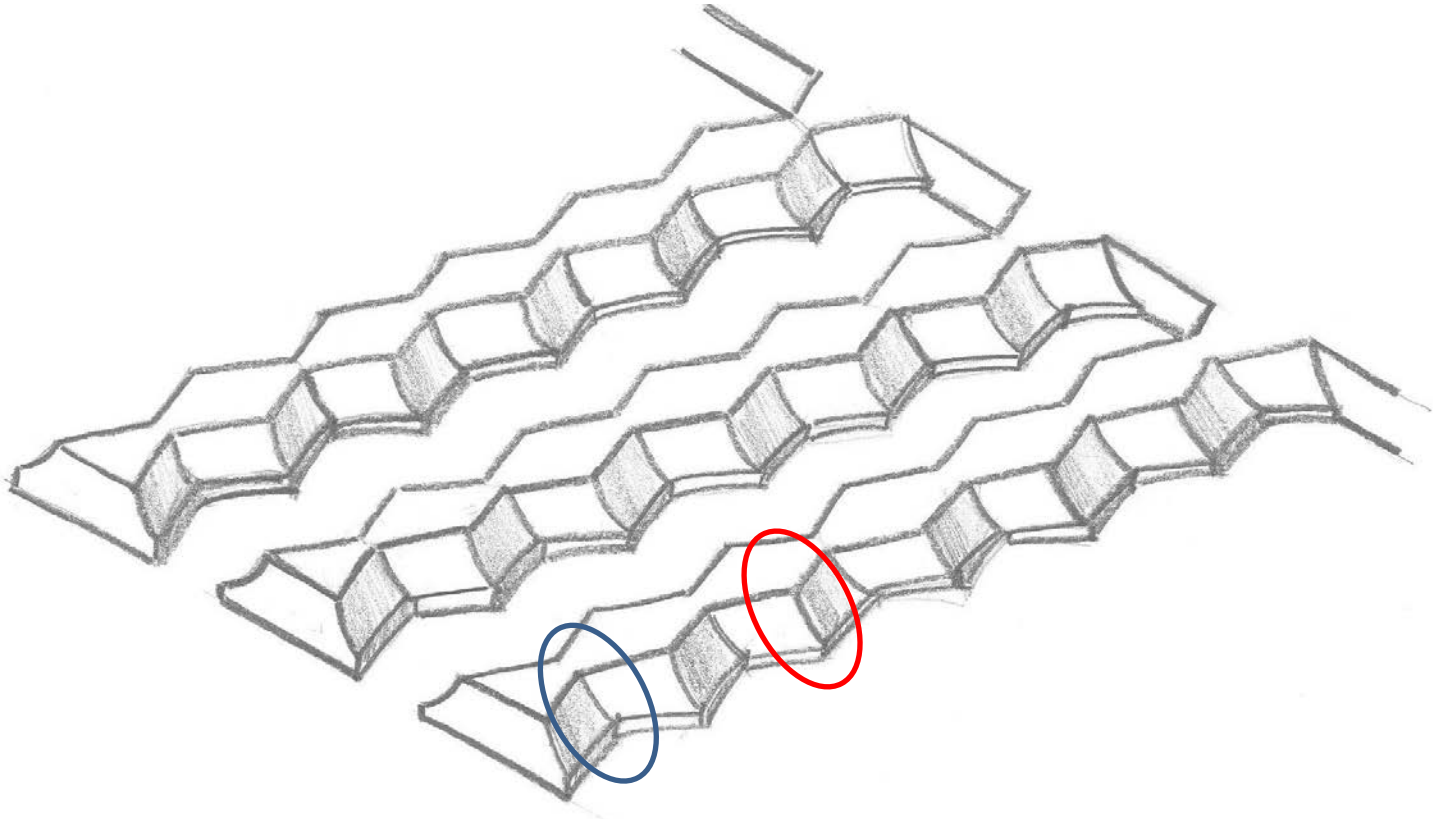
Step 6





(Case study is based on US 20130071775 A1)

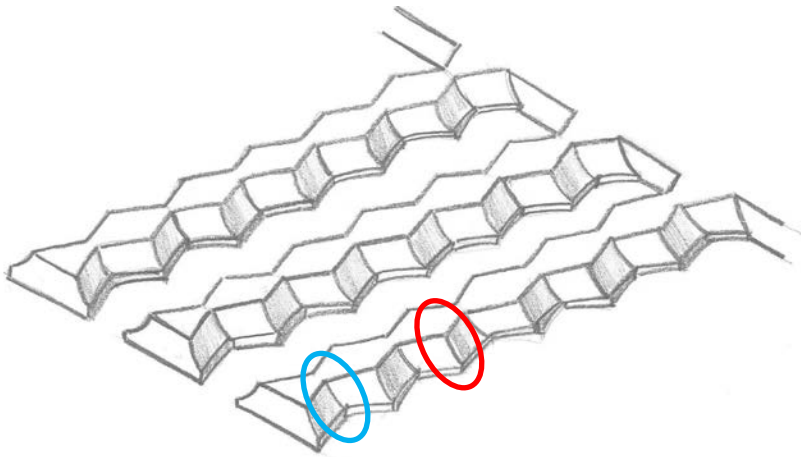
# NEXT CYCLE OF HYBRIDIZATION

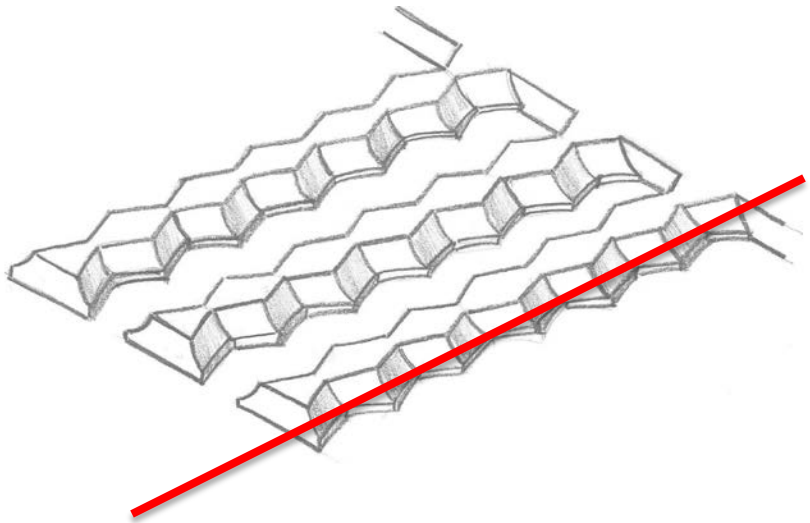


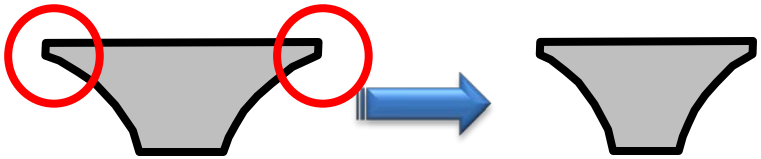


(Case study is based on US 20130071775 A1)

# NEXT CYCLE OF HYBRIDIZATION



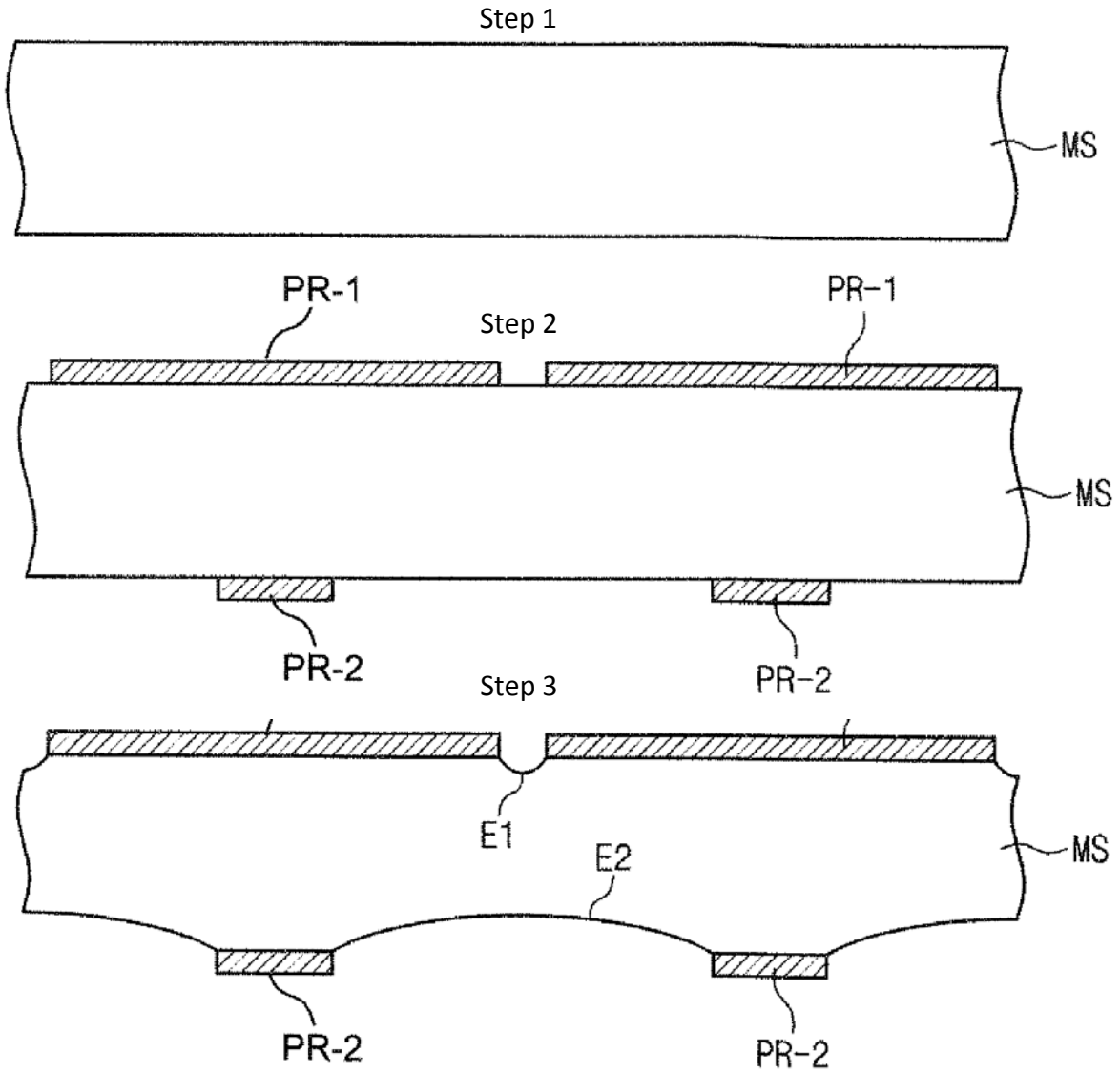


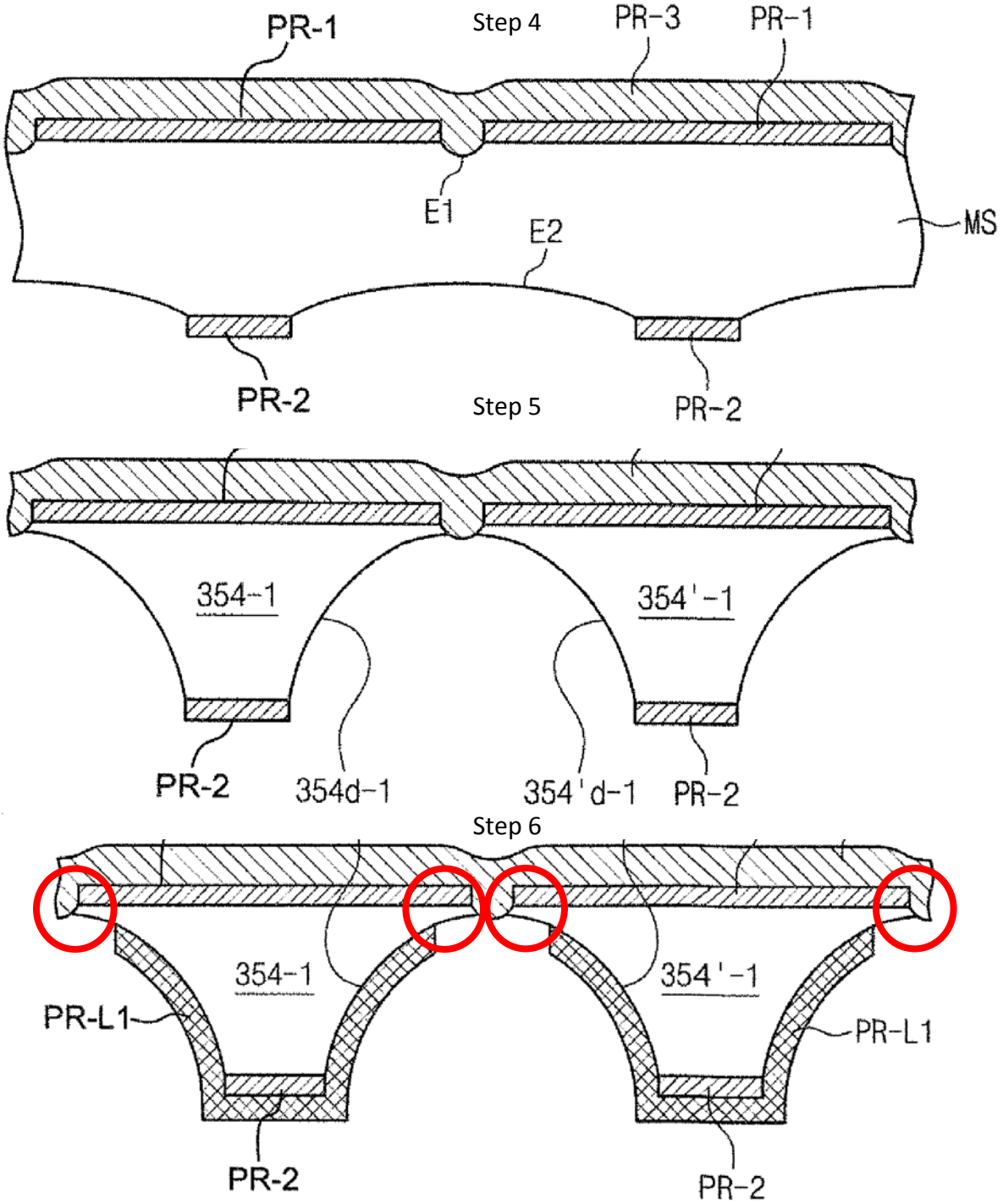




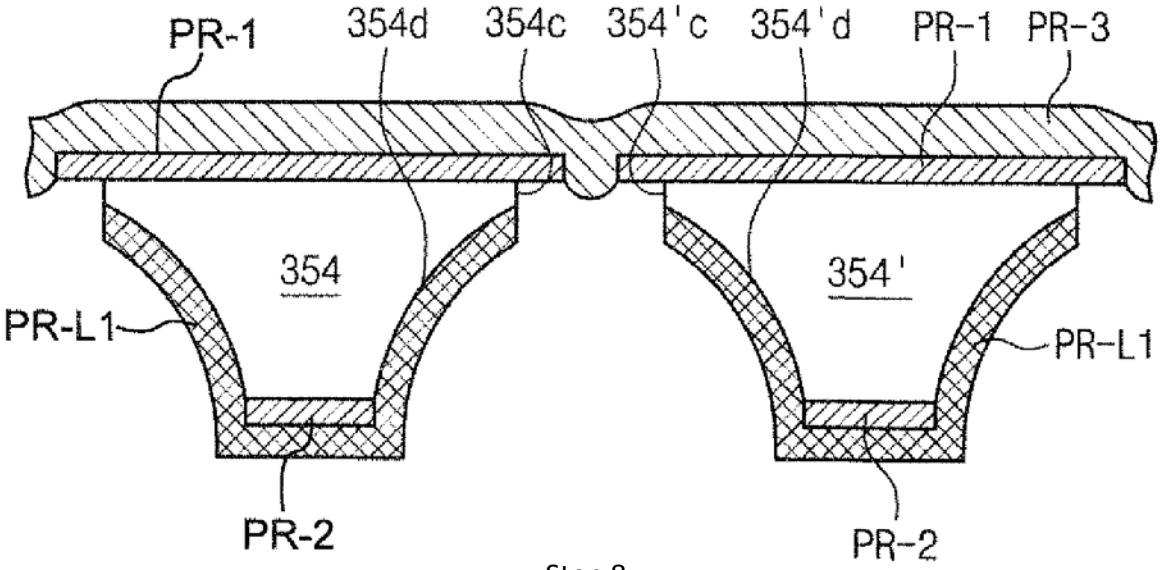
(Case study is based on US 20130071775 A1)

# NEXT CYCLE OF HYBRIDIZATION

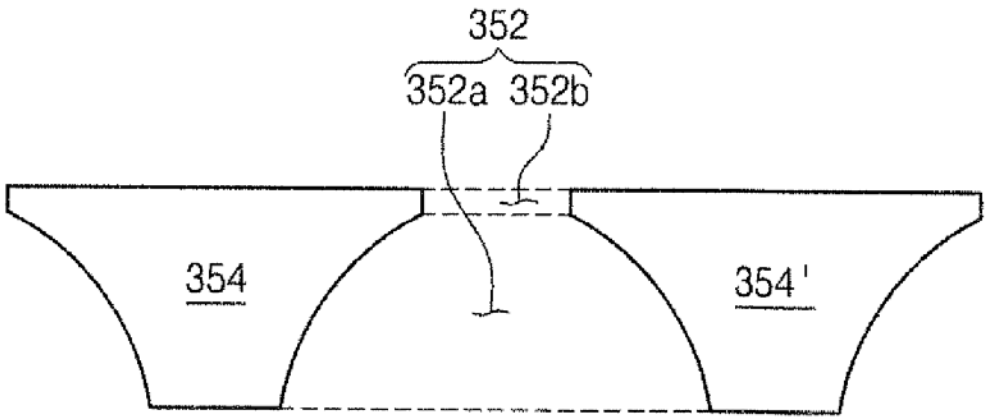



PR-1
Step 4
PR-3
PR-1
E1
E2
MS
PR-2
Step 5
PR-2
354-1
354'-1
PR-2
354d-1
354'd-1
PR-2
Step 6
354-1
354'-1
PR-L1
PR-L1
PR-2
PR-2

Step 7



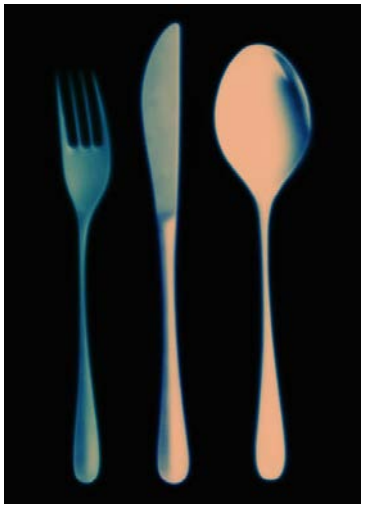

Step 8





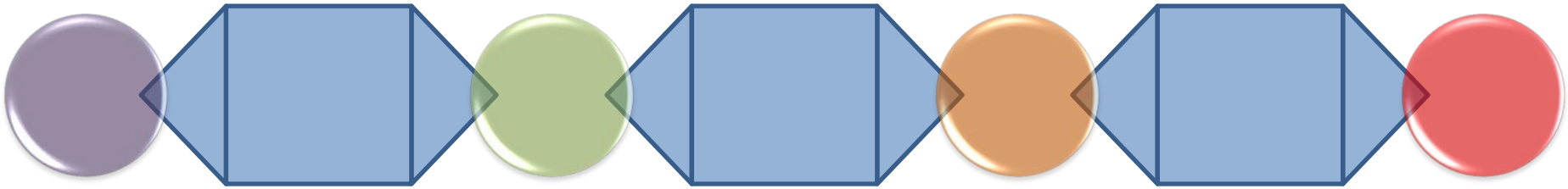

(Case study is based on US 20130071775 A1)

# HYBRIDIZATION OF MULTIPLE SYSTEMS

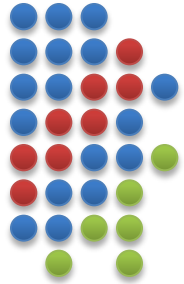


$$\left.\begin{array}{l} P_1 \rightarrow T_1 \\ P_2 \rightarrow T_2 \end{array}\right\} \Rightarrow \left.\begin{array}{l} P' \rightarrow T' \\ P_3 \rightarrow T_3 \end{array}\right\} \Rightarrow \ldots \Rightarrow \left.\begin{array}{l} P'' \rightarrow T'' \\ P_n \rightarrow T_n \end{array}\right\} \Rightarrow P \rightarrow T$$

- 12 steps algorithm for crossing multiple systems together one after another.



# ALGORITHM OF CONSECUTIVE HYBRIDIZATION OF MULTIPLE SYSTEMS

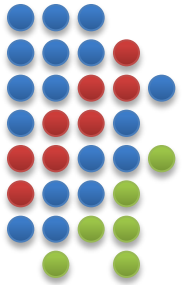


1. Identify initial engineering system (describe as a set of simple ideas with list of advantages and disadvantages)
2. Describe candidate for crossing (describe as a set of simple ideas with list of advantages and disadvantages)
3. Describe hybridization contradiction
4. Select dominant engineering system
5. Reveal resources for hybridization
6. Describe portrait of hybrid
7. Formulate ideal vision of hybridization problem
8. Reveal resources of dominant engineering system
9. Describe intermediate hybrid
10. Reveal drawbacks, not addressed by intermediate hybrid
11. Select next engineering system for hybridization
12. Repeat hybridization process




39

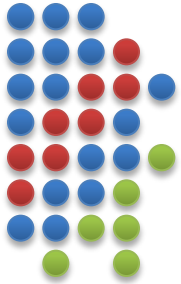
# CONCLUSIONS AND FUTURE TRENDS



- Consecutive hybridization plays key role in modern innovation processes.
- Lifetime of the electronic consumer products is continuously reduced, so that number of the candidates available for hybridization is dramatically increased.
- Applying Algorithm of Multistep Hybridization provides concepts for new disruptive technologies and products.
- Hybridization as thinking approach can drive companies for better and more systematic innovations, defining advantages that important for consumers.




40



# BASIC SCHEMES OF HYBRIDIZATION

# SIMPLEST HYBRIDIZATION SCHEMES IN BIOLOGY

- Hybridization describes any manipulations with product genetic material
- Simplest mutations in nature:
  - Addition
  - Falling out (Subtraction)
  - Deletion
  - Inversion, and
  - Exchange of genetic material

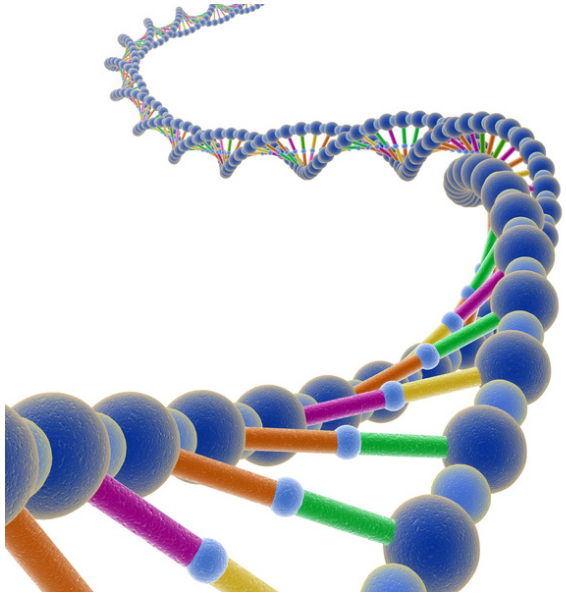
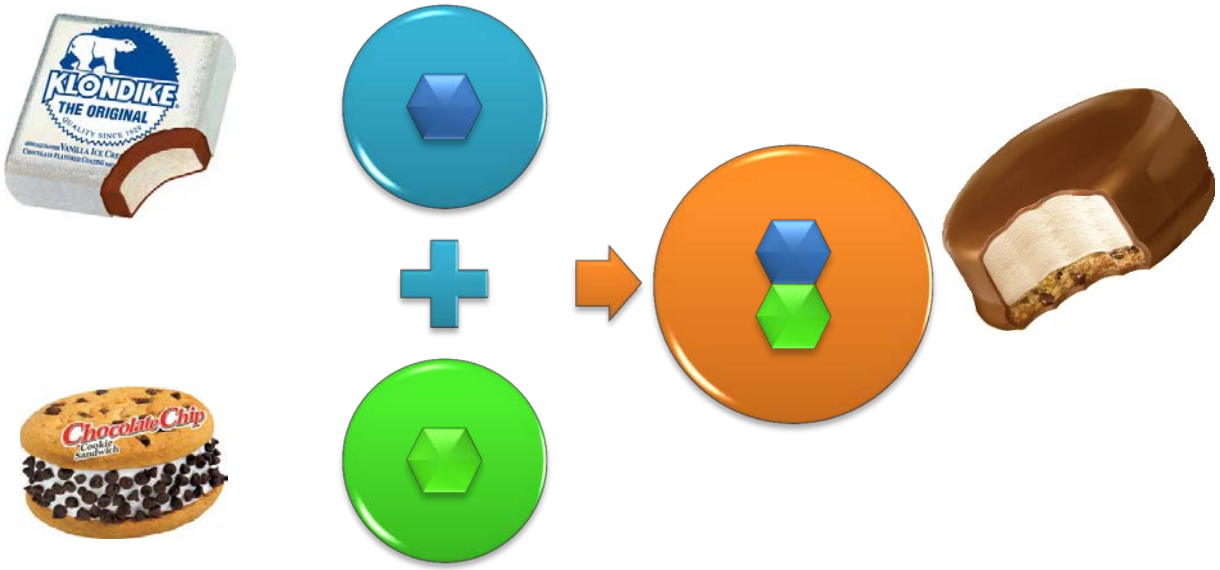


Image: http://life-inspired.blogspot.com/2010/10/links-for-lecture-12.html 3/20/2012

# ADDITION




P1 → T1

=> T(T1+T2) → P

P2 → T2

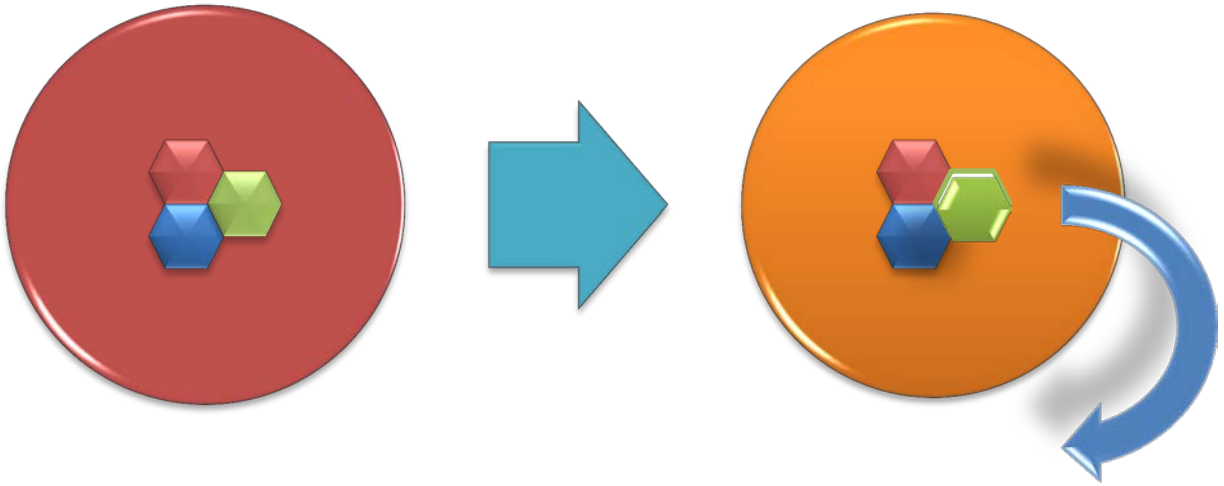
# ADDITION


- Source: http://gadgetian.com/43906/samsung-galaxy-camera-available-in-u-k-this-wedneday/

- Definition: Addition is analytical tool for improvement the Engineering System by adding relevant features from another Engineering System.
- Which features were added to camera?

# SUBTRACTION

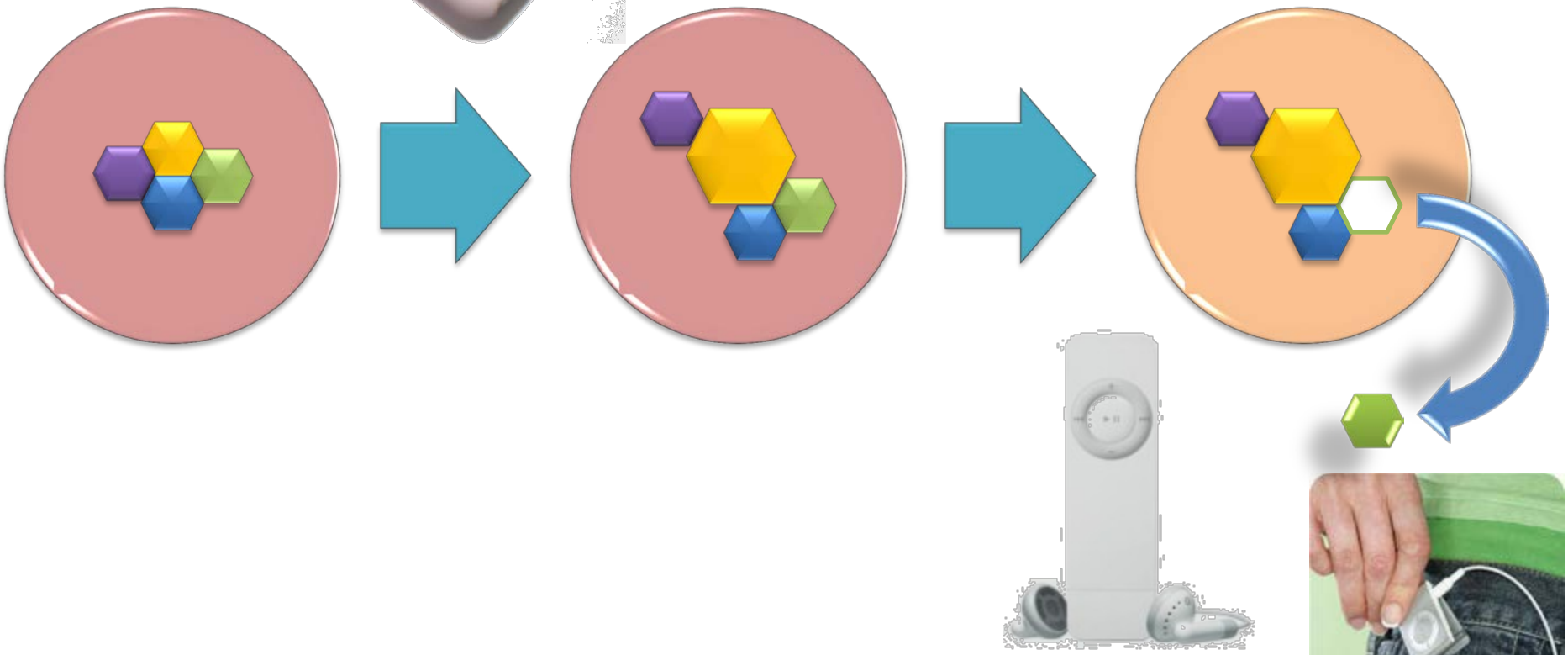
- Definition:Subtraction is analytical tool for improvement the Engineering System by subtracting of selected features from the Engineering System.



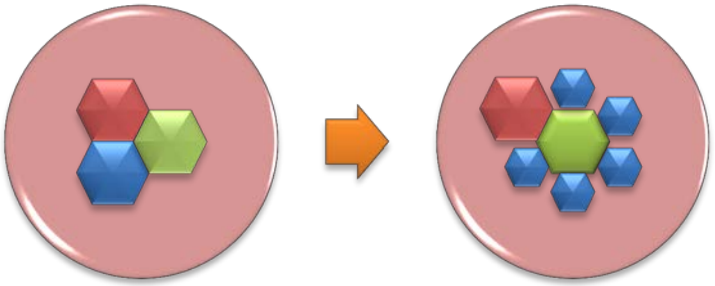
T(T1+T2+T3) → P => T(T1+T2) → P1

↘

T3



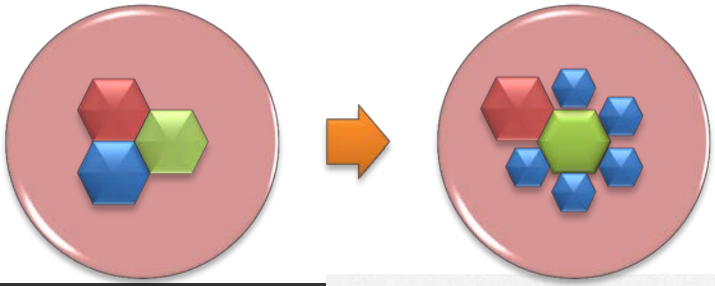
# MULTIPLICATION

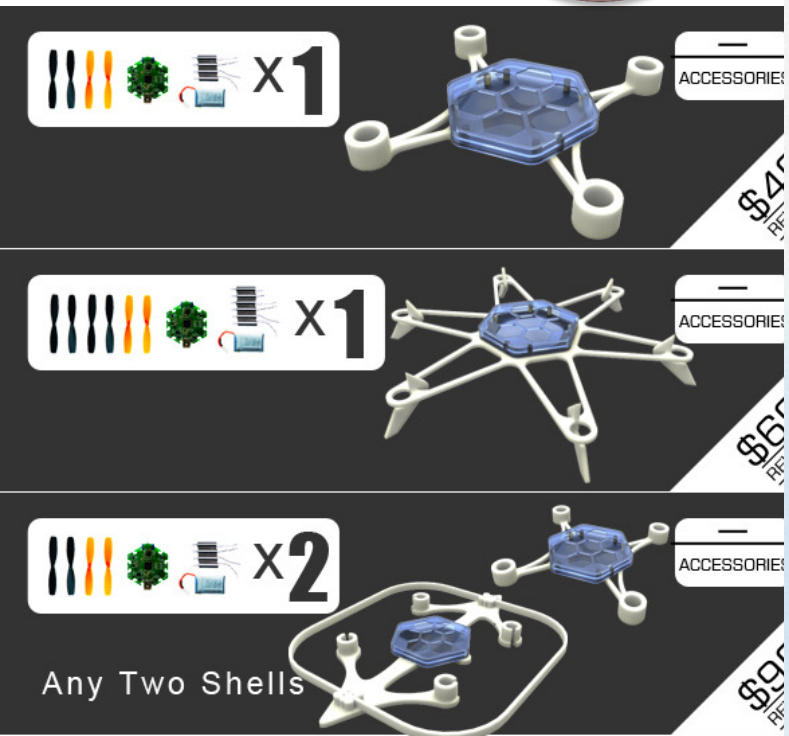


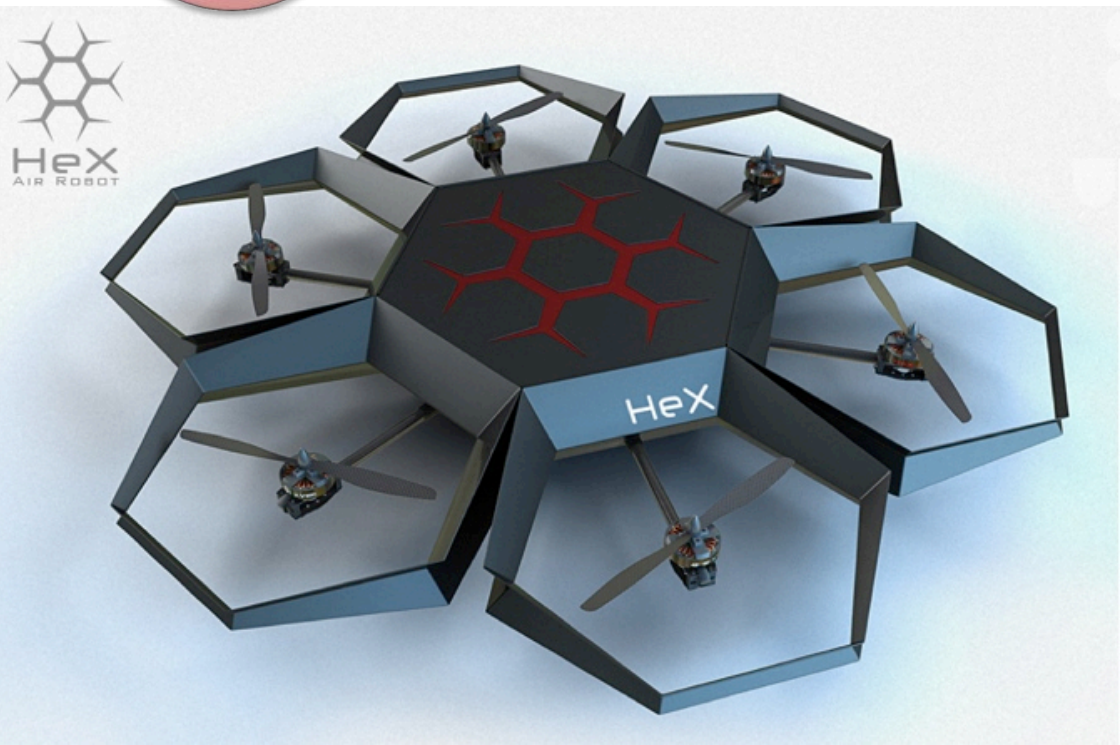
- Multiplication is analytical tool for improvement the Engineering System by multiplying selected features of the Engineering System.

# MULTIPLICATION

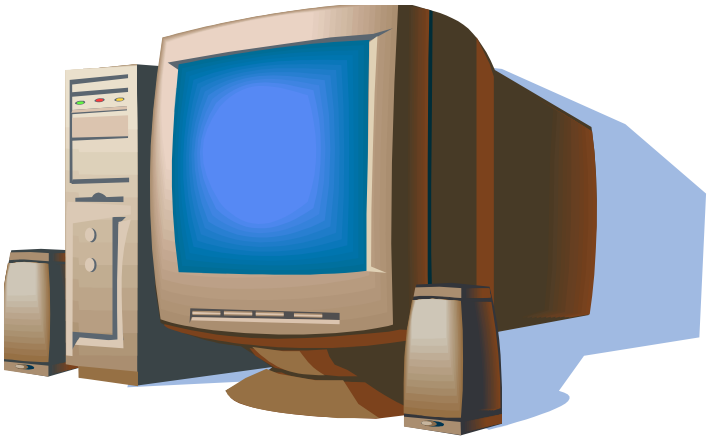
$$P_1 \rightarrow (T_1 + T_2 + T_3) \Rightarrow P \rightarrow T = (T_1 + T_2 + N \times T_3)$$

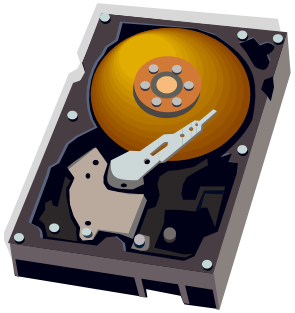


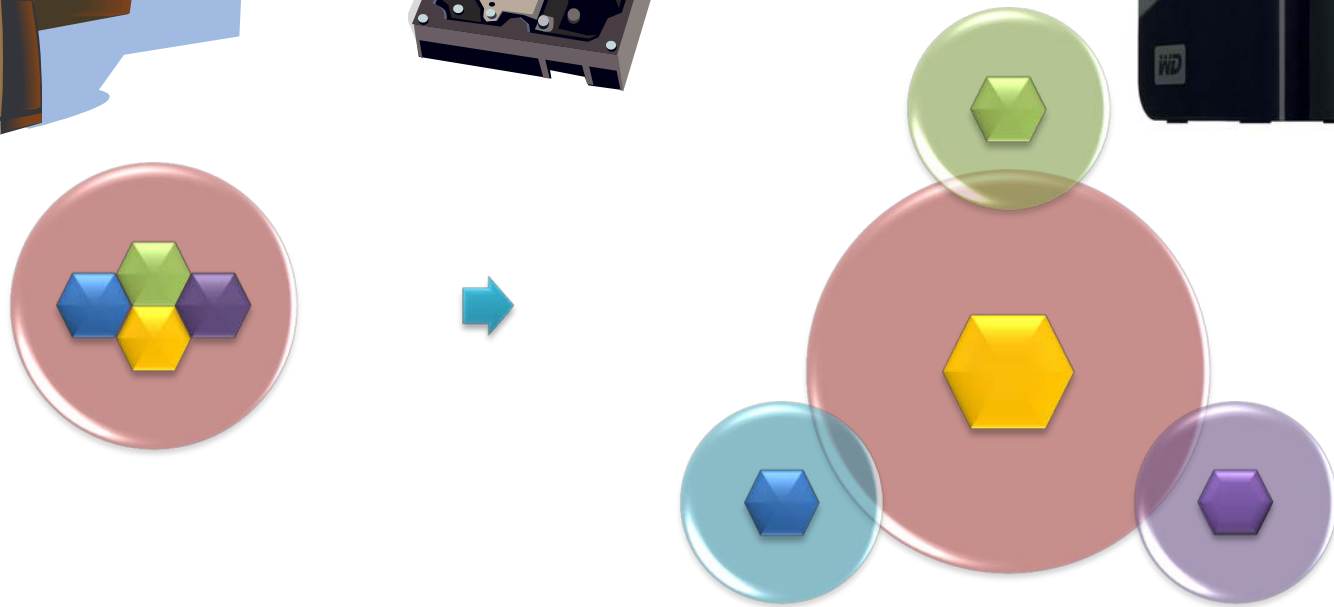


# DIVISION





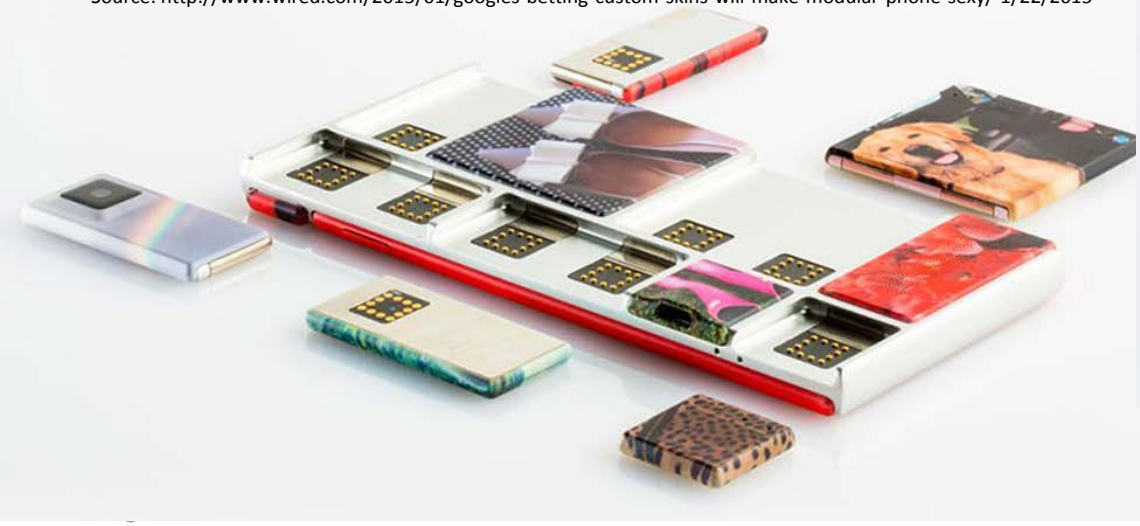


- Definition: Division is analytical tool for improvement the Engineering System by dividing it into several separate Engineering Systems.

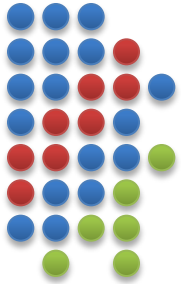
# MODULAR CELL PHONE

# MODULAR CELL PHONE

- Project Ara is Google's modular phone project. Spiral 2 would consist of a skeletal frame and 11 modular tiles that snap on via electro-permanent magnets.
- Source: http://www.wired.com/2015/01/googles-betting-custom-skins-will-make-modular-phone-sexy/ 1/22/2015



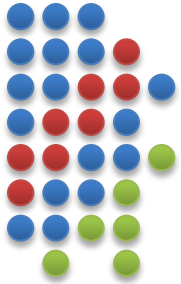
# HYBRIDIZATION



*Key Terms*

- *Hybridization* is an analytical tool for improvement of system (product) by changing its traits.
- *Addition, Subtraction, Multiplication and Division* are tools for obtaining new systems.
  - Thinking process of addition is facilitated by “Copy and paste”, “Cut through”, “Subtract”, “Divide”, “Multiply” algorithms.
  - Systems (products) can be combined together permanently or temporary.
  - If 3 or more systems are hybridized use sequential process of hybridization.

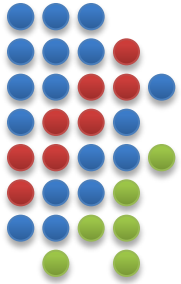
# THE END



Next Steps

- Apply  Multistep Hybridization and Basic Hybridization Schemes to your innovative situation.
- Integrate Hybridization with all your creativity and improvement tools.
- Start it now.

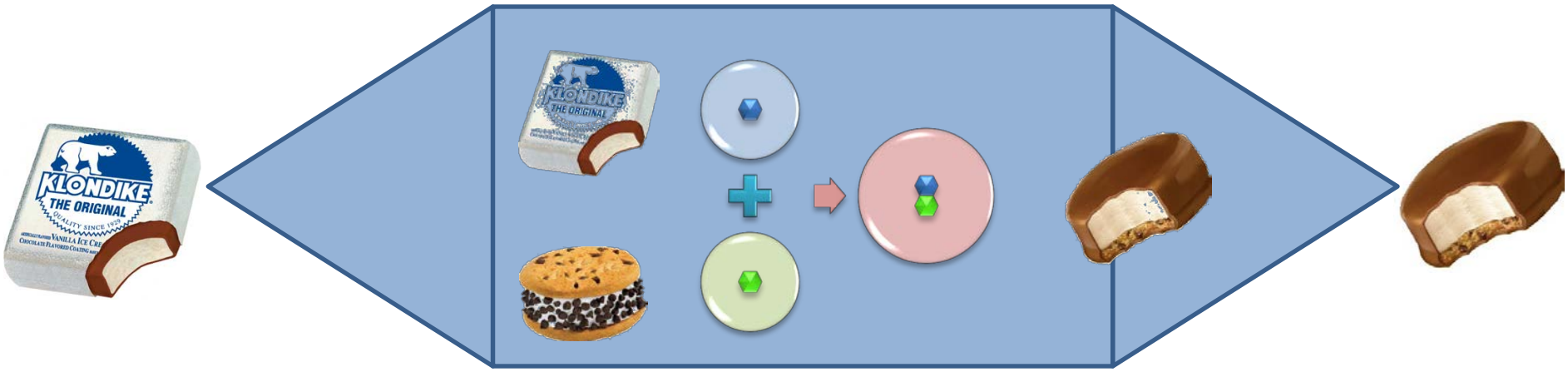
- Thank You!
- vprushinskiy@idealmatrix.com



# APPENDIX 1: BASIC SCHEMES OF HYBRIDIZATION

# SCHEMES OF HYBRIDIZATION: ADDITION OF 2 SYSTEMS

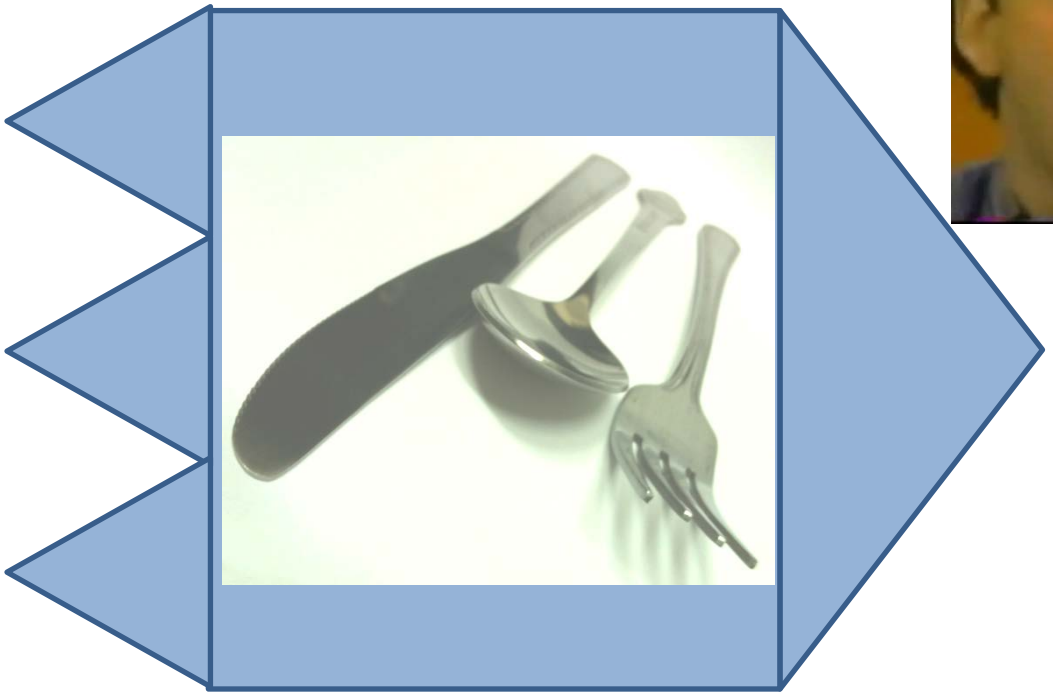
Opening Exploration Closing



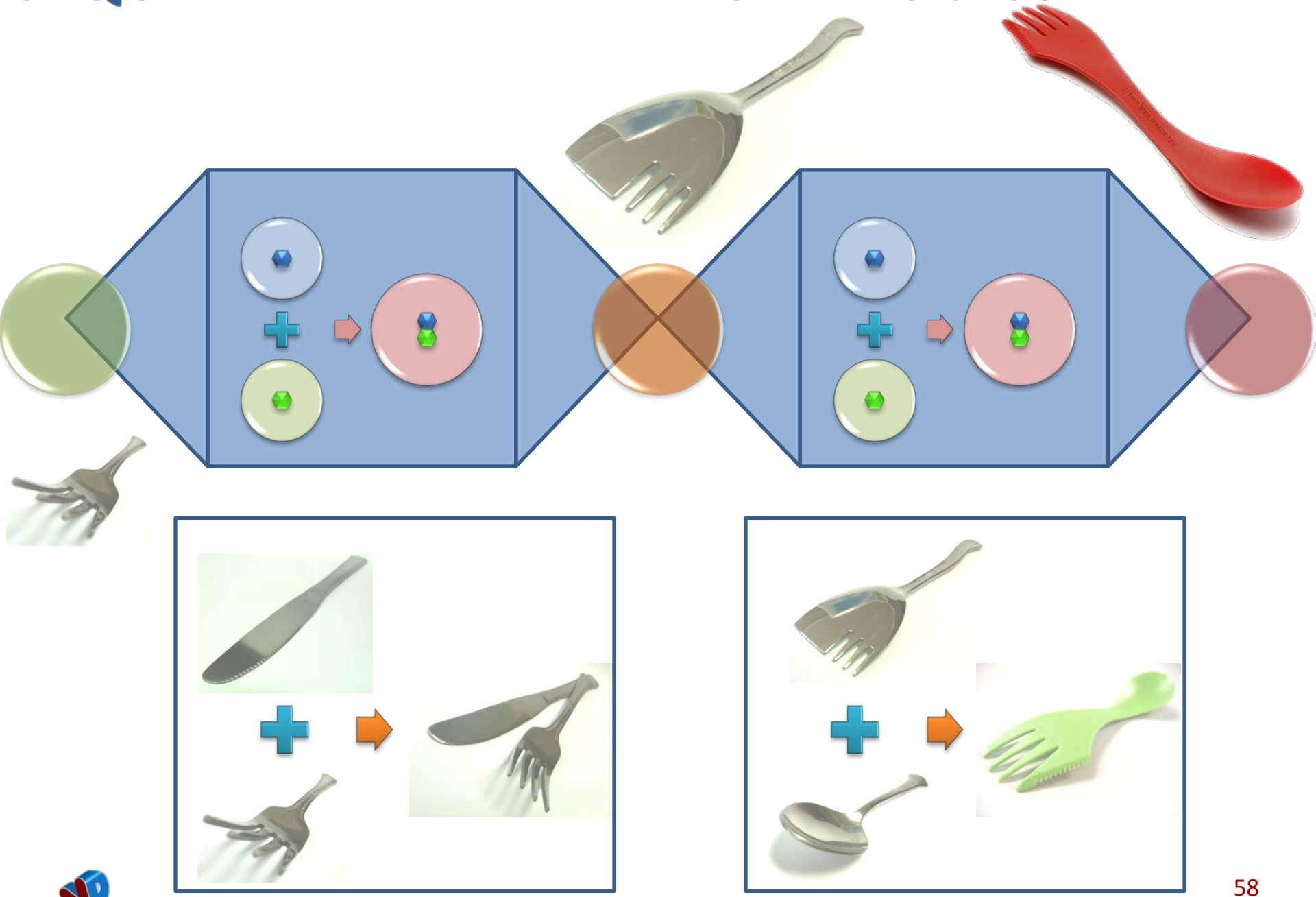
# HYBRIDIZATION OF MULTIPLE SYSTEMS

Source: Madtv Spishak – Snoorpk accessed 10/21/2010

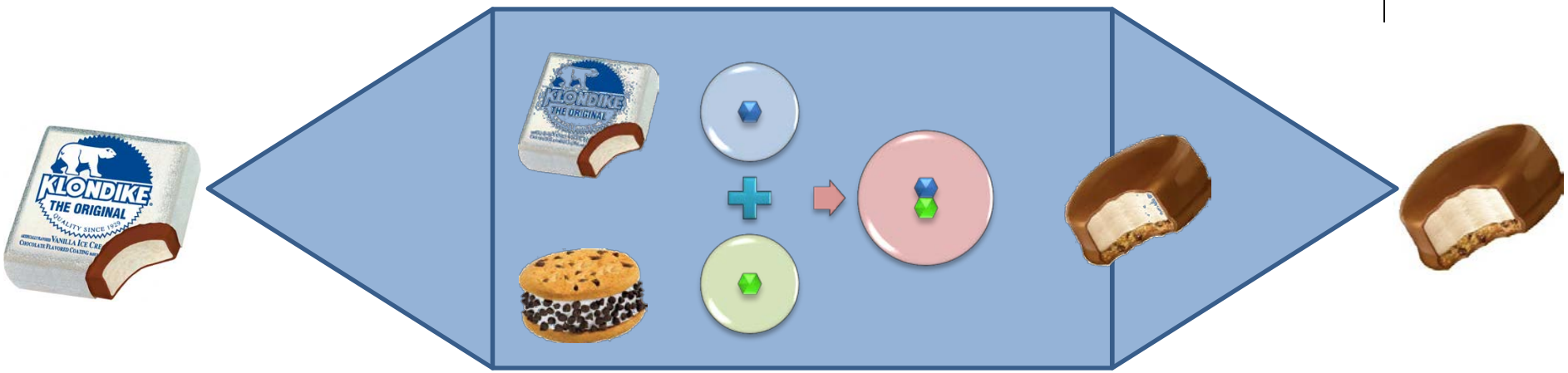
# HYBRIDIZATION OF MULTIPLE SYSTEMS



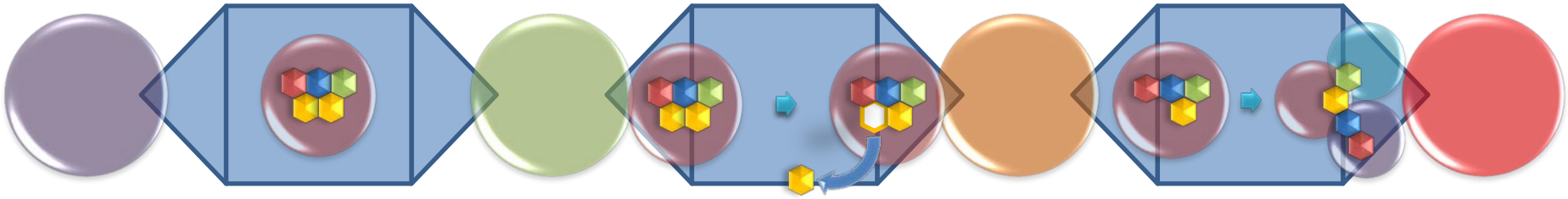
# SEQUENTIAL HYBRIDIZATION PROCESS



# WHAT WE LEARNED TODAY:
# ADDITION - COMBINING OF TWO OR MORE SYSTEMS



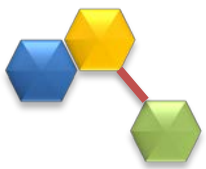

## You can apply various hybridization schemes:
## Adding, Subtraction, Multiplication and Division



# TYPICAL SCHEMES OF HYBRIDIZATION

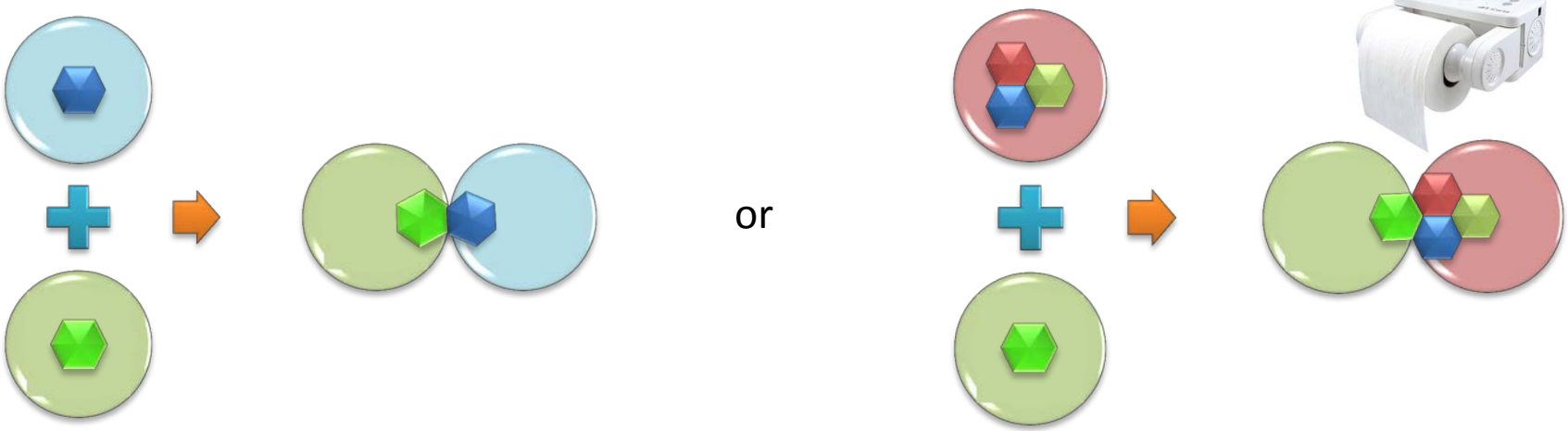
Legend:

- Product
- Traits/Features of Product
- Primary Trait of Product
- Harmful Trait
- Trait of “Zooming-in”
- Trait of “Zooming-out”
- Modifying/adjusting trait
- Resolution of contradiction in time

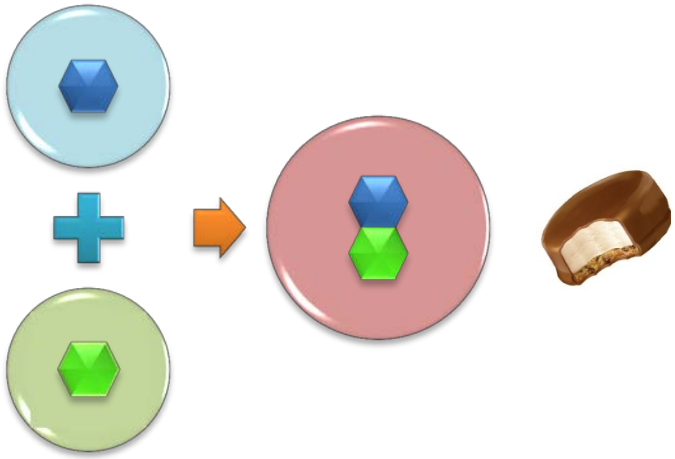


# 1. Adding

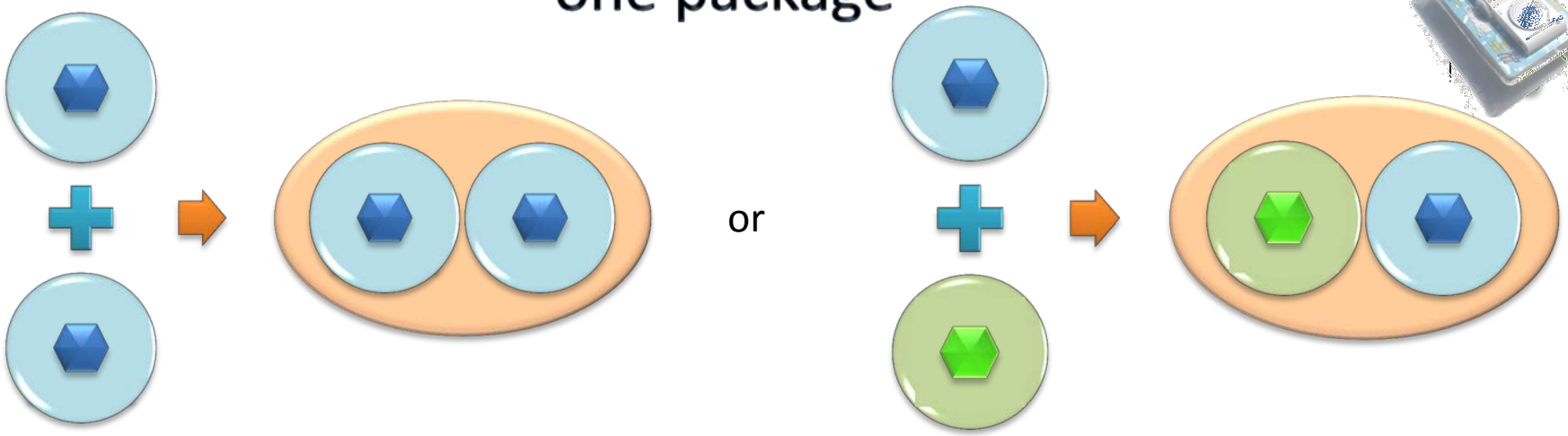
## 1.1. Without formation of “combined” product



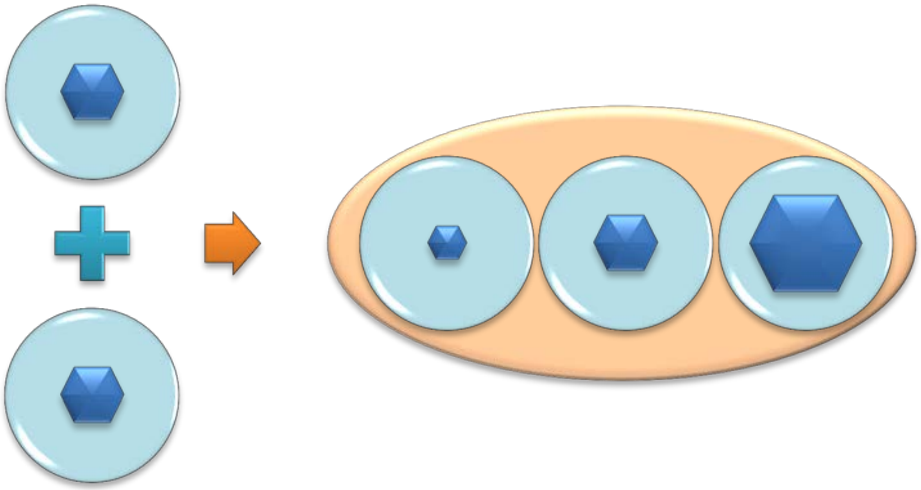

## 1.2. With formation of “combined” product



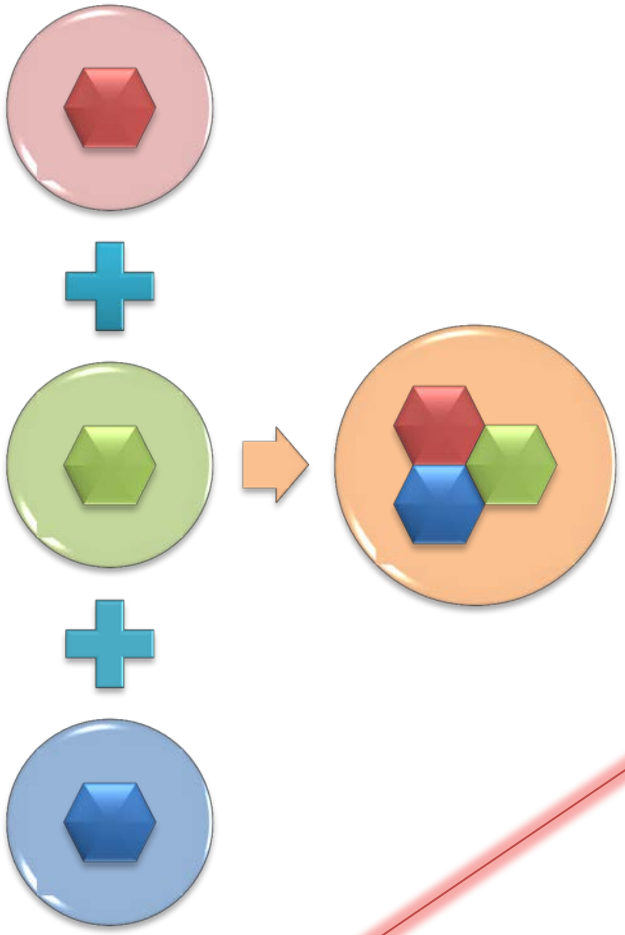
# 1.3. Temporary adding of similar / different products in one package




# 1.4. Temporary adding of products with scaling differences in one package

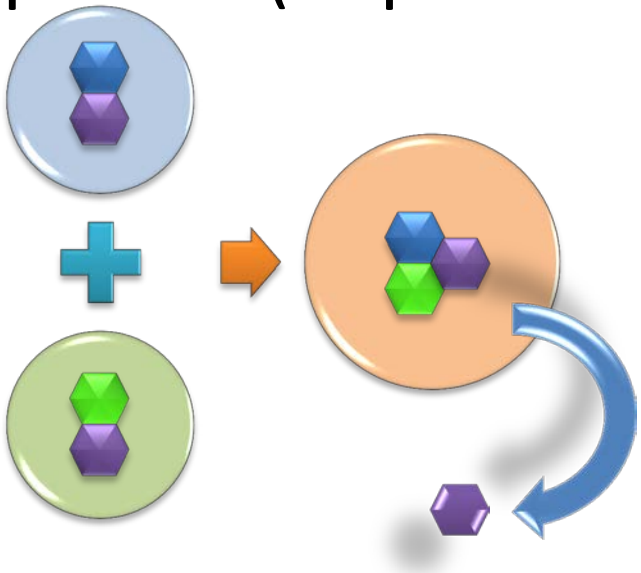


# 1.5. Adding of three and more products

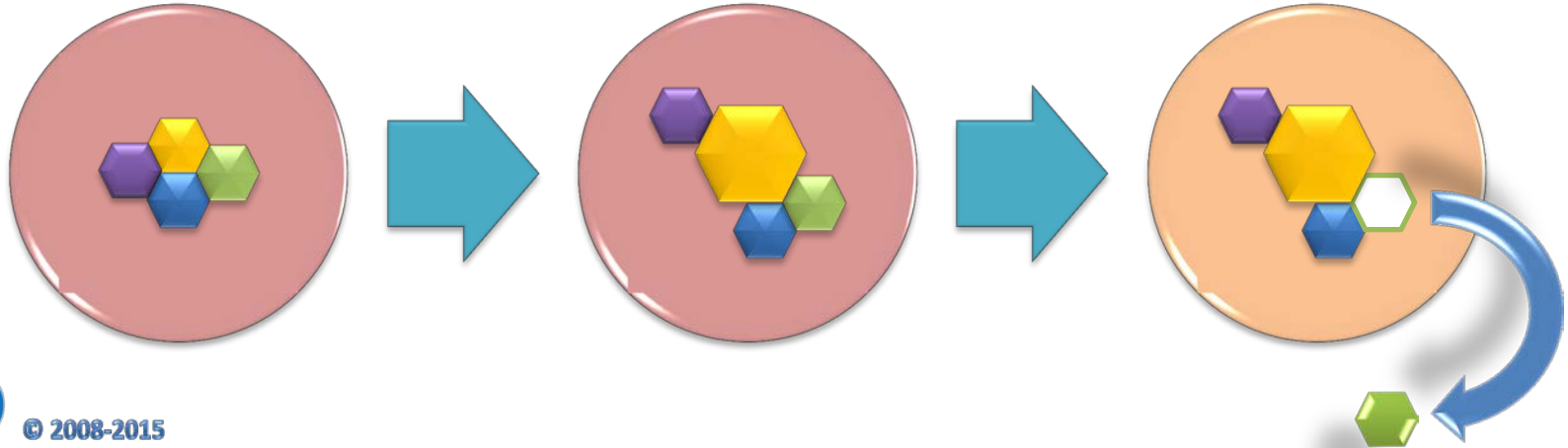


# 2. Subtraction

## 2.1. Repeated (duplicated) trait

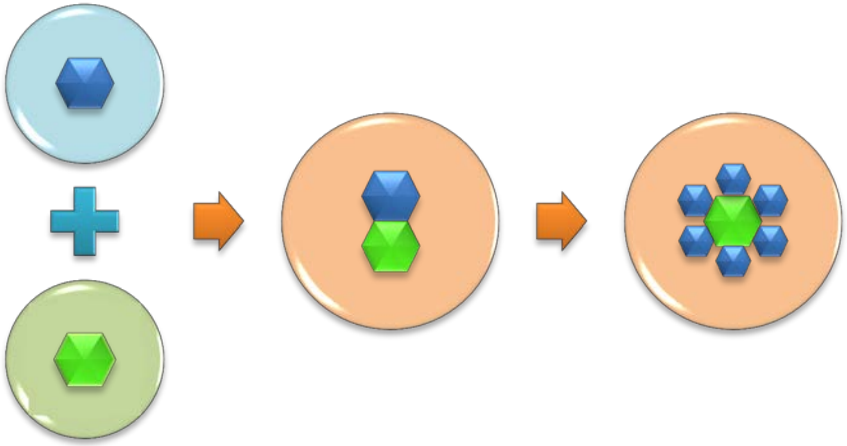


## 2.2 “Secondary” trait

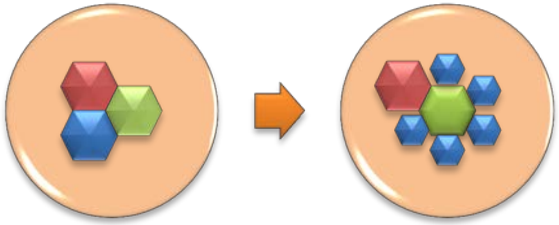


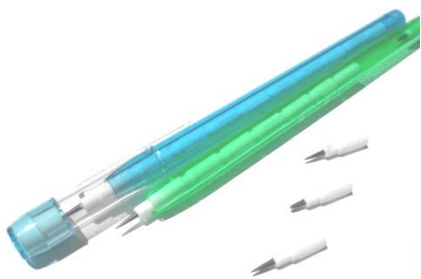
# 3. Multiplication

## 3.1. Adding with follow-up multiplication of trait



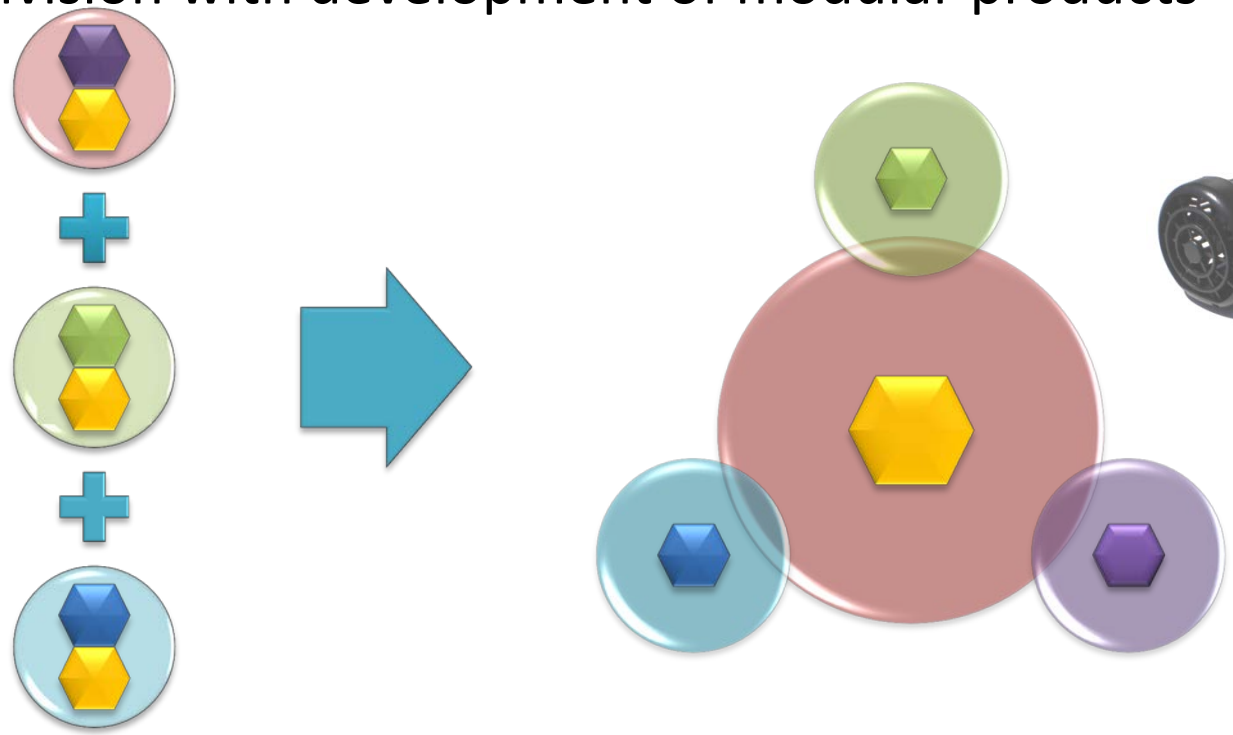
## 3.2. Multiplication of trait of complex product



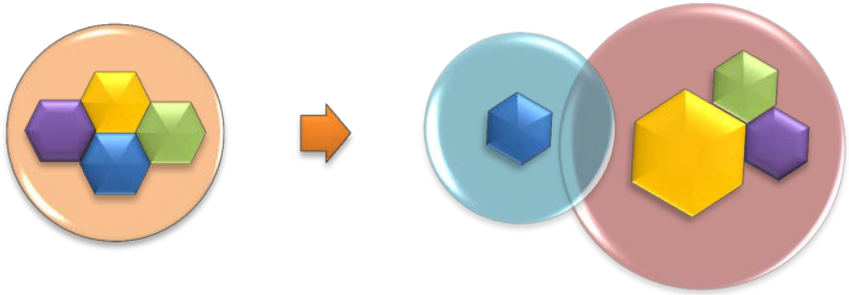


# 4. Division

## 4.1. Division with development of modular products

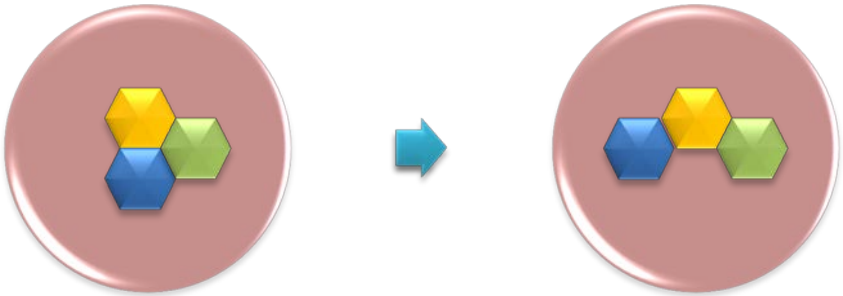


## 4.2. Development of product with “separable” primary trait



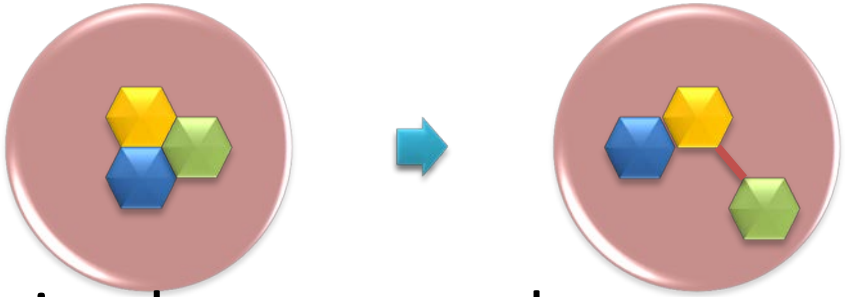
# 10. Resolution of contradictions

## 10.1. In space



http://en.paperblog.com/samsung-galaxy-s4-multi-window-multi-tasking-functionalities-and-tricks-603142/

## 10.2. In time



http://blog.macblurayplayer.com/iphones-evolution-and-expectations/

## 10.3. With simultaneous replacement of primary trait