

GE Plastics Color Matching

Bill Cheetham

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Outline

- Introduction to Color Matching
- FormTool - lab color matching tool
- ColorXpress - web customer tool
- Customer Innovation Center
- ProductXpress - product selection and research
- Conclusion

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Introduction to Color Matching

GE is one of the worlds largest producers of plastics

Customers specify the color they want the plastic

GE needs to create a formula that matches the customers color

- 10,000 color matches per year globally (\$500 per match)
- colorants are the most expensive component of plastic

Customers Color	Formula	Chip
	Green_332 1.23 Yellow_102 0.13 White_107 .63 Black_203 .025	


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Introduction to Color Matching

There are 40 possible pigments that can be used. Choose 4 to 7.

The color of pigments can change with concentration

Concentration 1% 2% 3% 4% 5%

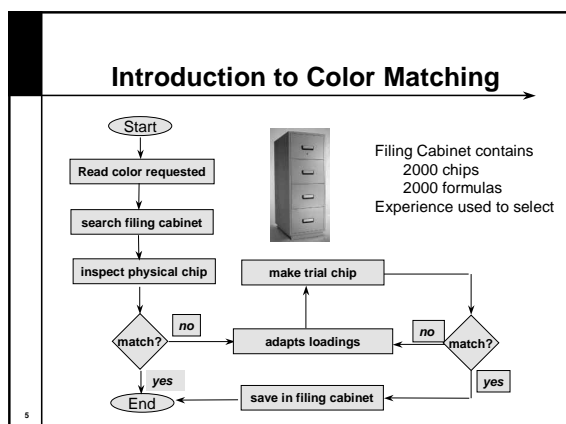


Color yellow tan orange red

The effect of small changes in colorant loadings can be predicted, but large changes are more difficult.

Easier to select a close match and adapt than create new.

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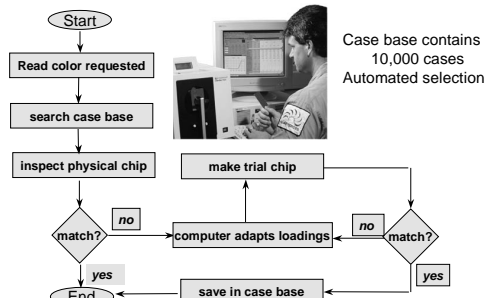
Formtool - started 1993

Digitize Knowledge

- create case for each chip in filing cabinet
 - problem: numerical representation of color
 - solution: formula of color
- algorithm for selecting best case
- algorithm for adapting case selected
- process for learning new cases

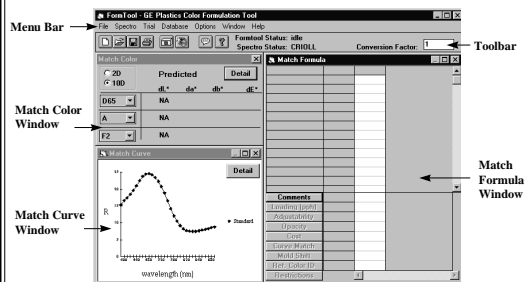
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FormTool Process



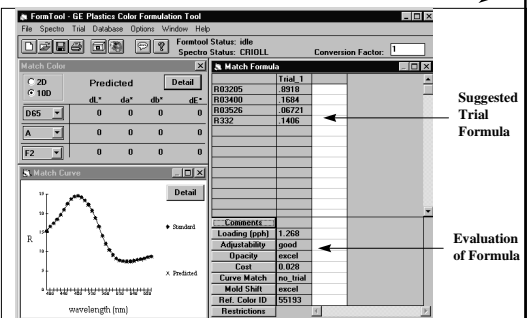
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FormTool User Interface



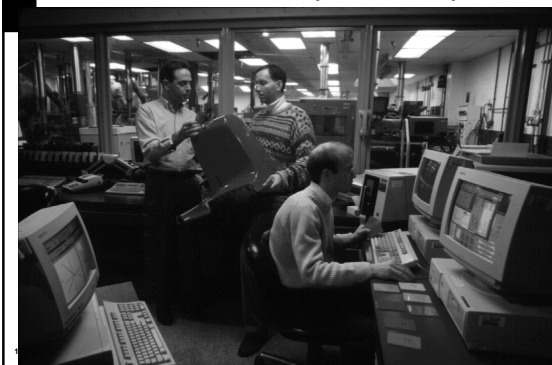
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FormTool User Interface



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The Color Lab (Selkirk NY)



Case Selection

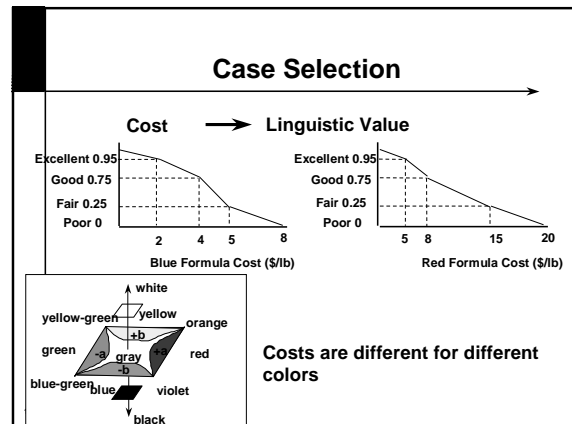
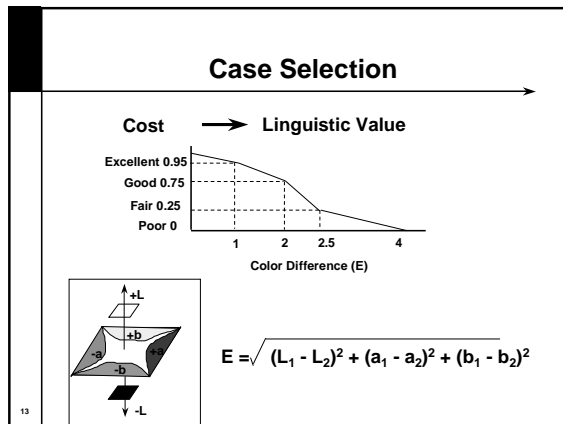
Selection is NOT just finding the most similar case

- Best previous case meets all of the following attributes
- Color must match under multiple lighting conditions
 - Pigments must hide the color of the plastic
 - The cost must be as low as possible
 - A limited amount of light can go through plastic
 - Color should not change when plastic is molded

The selection needs to provide a consistent meaning throughout all attributes

The consistency is achieved by using linguistic terms, such as Excellent, Good, Fair, and Poor, which are associated with measured differences in each attribute

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Case Selection

Aggregation of Linguistic Terms

	Term	Value	Weight	Product
color match	Excel	.95	.2	.18
hide plastic	Good	.8	.2	.16
cost	Good	.8	.2	.16
light transmitted	Excel	1	.2	.20
color change	Fair	.65	.2	.13
Total	Good			.83

Adaptation Needs

- 1) A method to search for a better solution
 - Greedy search which modifies colorant loadings
 - Modify each loading individually and test
 - Select best modification
- 2) A good method to evaluate if you are closer to the solution

The case selection calculation

Green_332	1.23	→	Green_332	1.65
Yellow_102	0.13		Yellow_102	0.13
White_107	.63		White_107	.78
Black_203	.025		Black_203	.025

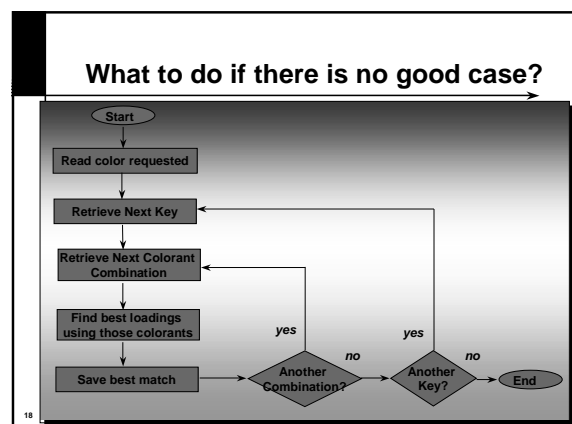
What to do if there is no good case?

Find patterns from case base that can guide heuristic search

For each color, what are most likely combinations

Colorant type	Colorant of that type
White	Ivory, Pure, Bright
Black	Coal, Midnight
Red	Crimson, Garnet, Wine, Fire
Orange	Orange, Pumpkin
Yellow	Canary, Lemon, Sunflower

Formula Key	Colorants in each Key
Key1	White, Black, Red
Key2	White, Black, Red, Yellow
Key3	White, Black, Red, Yellow, Orange
Key4	White, Black, Red, Orange
...	...



FormTool - Benefits

Productivity

- average number of test chips created decreased from 4.2 to 2.7
- average reduction of 4.5 hours per color match
- savings of \$2.25 million per year

Colorant Cost

- reduced amount of colorants
- cost part of selection algorithm
- average of \$2.4 million per year

Global Consistency

Speed

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ColorXpress Select

Internet Color Matching and Ordering

Customers use our pallet to select colors


Existing color samples delivered in 48 hours

ColorXpress Web-site




Step 1

Color Matching Process



Step 2

Order Entry Process



Step 3

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ColorXpress Select - Benefits

ColorXpress Select has been in use since 1999.

It is one of the first customer service tools that GE Plastics has made available over the web.

Simplified the process for customers to submit orders over the web.

GE now leads the plastic industry in on-line sales.

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Innovation Center

Brings together all information needed to select colors


- Chip room
- FormTool
- Small lot manufacturing
- Experienced color matchers

Create custom color and effects in one day

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Innovation Center Video



Click to Play


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GE ProductXpress - In development



Application

Specify all needs:


- color
- thermal
- molding
- strength
- etc.



ProductXpress Wizard

Search global knowledge base of products

OR



Research

Search global knowledge base of experiments

Existing Solution

OR

New Solution

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Conclusion

One Possible CBR Project Life Cycle

- start as internal productivity tool
- expand to customer web tool
- allow greater customer interaction
- expand to a wider range of uses

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The end

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