COST MODELING AS A MARKETING TOOL - DEVELOPMENT OF A VALUE PROPOSITION FOR UV-CURING IN THE AUTOMOTIVE COATINGS MARKET

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RadTech Report

March/April 2002

INTRODUCTION

The Automotive Focus Group of RadTech International contracted the ChemQuest Group, Inc., to develop a cost model comparing the costs of UV-curing to thermal curing for a basecoat/clearcoat system on an SMC (sheet molding compound) hood. The purpose of the cost model is to give the Automotive Focus Group and RadTech member companies an unbiased insight into the key variables that drive each process so that UV-curing can be marketed to the automotive companies and their suppliers on a value vs. cost basis as a viable alternative to incumbent thermal-cure facilities.

The conclusion of the study is that a hybrid process (i.e. combination of UV-curing for the primer-surfacer and clearcoat and thermal-curing for the colored basecoat) has operating costs 3% less than a conventional thermal-curing process. However, the unexpected results were that the variables that drive the hybrid UV system to be more competitive were not the traditional energy savings. The cost savings for the hybrid UV process result from a significantly improved first pass quality and lower reject rate. These improvements are due to the elimination of defects that result from outgassing from the SMC substrate during the thermal cure of the primer-surfacer coating. These results suggest that UV-cured systems can bring value to customers in unexpected ways and that cost modeling can be the technique for uncovering and quantifying these opportunities.

THE VALUE OF COST MODELING

Cost modeling need not be used only by accountants – properly developed and analyzed, cost models can be an especially effective marketing tool. Marketers and product managers can use cost modeling to:

- identify and quantify opportunities for value extraction (or value creation) in existing value chains
- quantitatively validate value propositions for new products and services
- refine existing products and services
- develop sales proposals and bids

The Automotive Focus Group's goal for cost modeling was to quantify the value proposition for UV-curing in the automotive OEM markets. In essence, to answer the question, "What are the costs associated with thermal-curing and what opportunities exist for the UV-curing industry to extract value from the existing thermal-curing value chain structure and displace thermal-curing as the industry-standard process"?

ChemQuest Group specializes in the analysis of value chains in the coatings industry. This specialization consists of in-depth knowledge of the entire value chain starting with the basic raw materials used to manufacture the coatings and ending with the application processes used to manufacture the finished coated good. Value chain analysis consists of two parts:

- Mapping of the discrete steps of the flow of goods and services through the chain
- Determining of the costs and investment associated with these discrete steps

Value chain analysis leads directly to cost modeling. Using Microsoft® Excel®, spreadsheets can be developed to calculate the costs of each discrete step of the value chain.

COST MODELING OF COATING AN SMC HOOD

The cost model consists of two separate models:

- A model of the incumbent thermal-cure process
- A model of the challenger UV-cure process

Once the models are developed, relative comparisons can be readily made between the two models to glean insight into the costs for both processes and to find opportunities for UV-curing to replace thermal-curing. Because of prior success in other markets with UV-cured coatings over plastic substrates, the Focus Group chose to model the coating of a hypothetical SMC hood for a sport sedan. The portion of the value chain covered by the cost modeling for both processes starts with the application of a primer-surfacer and ends with the application of a clearcoat. All costs prior to priming (e.g. molding, trimming, surface preparation) and after clearcoating (e.g.

packing/dunnage, shipping, final assembly) were assumed to be the same for both processes.

ChemQuest Group developed a representative process and cost model for thermal-curing. This model is a composite and is typical of processes used by OEMs and their Tier 1 suppliers in North America. A simple schematic of the thermal-cure process is shown in Figure 1.

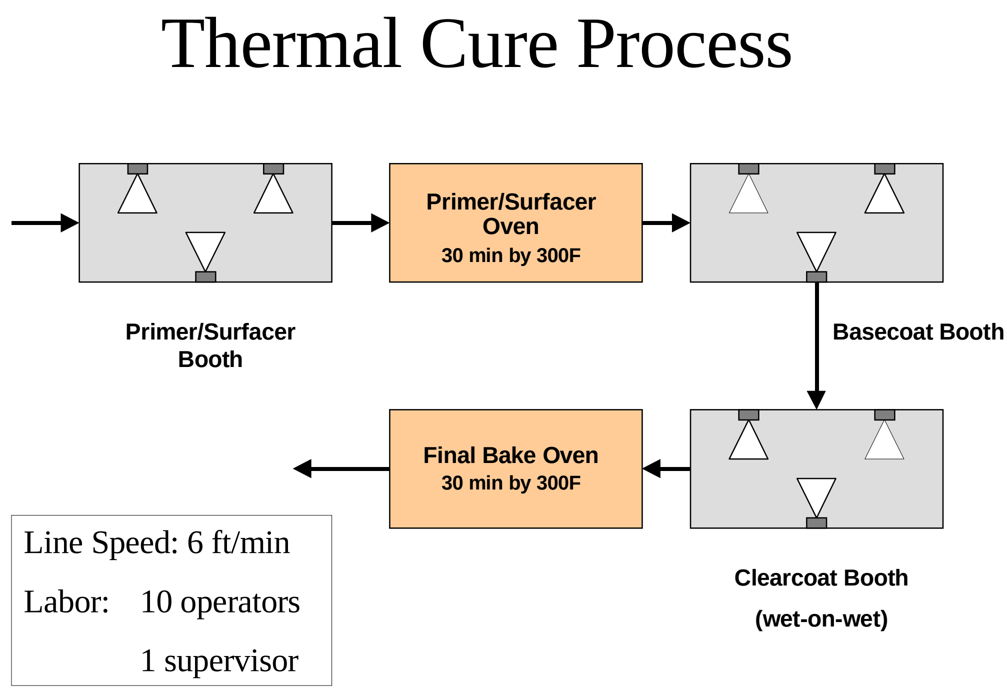


Figure 1 Thermal Cure Process Schematic

Since UV-curing is not yet widely used for large automotive parts, the Focus Group had to design a hypothetical, yet realistic, process for UV-curing. The process design was based upon existing development work in the automotive industry, but was developed so as not to divulge confidential developmental technology. While the process was hypothetical, the design was based upon actual processes in use or development that could be readily installed in the automotive industry. Process conditions and the assumptions for key process variables were developed from expert opinions and/or experience. UV-curing of the highly pigmented basecoats used by automotive OEMs and their Tier 1 suppliers was considered to be a significant technical challenge. Therefore, a decision was made to develop a hybrid process that consisted of UV-curing for the primer-surfacer and clearcoat and thermal-curing of the basecoat. Furthermore, the process was designed so that it could be installed in existing facilities as a retrofit. Since the ovens associated with thermal curing are already in place, this hybrid process only requires a modest new capital investment for the UV-lamps. This so-called "hybrid UV" process is shown in Figure 2.

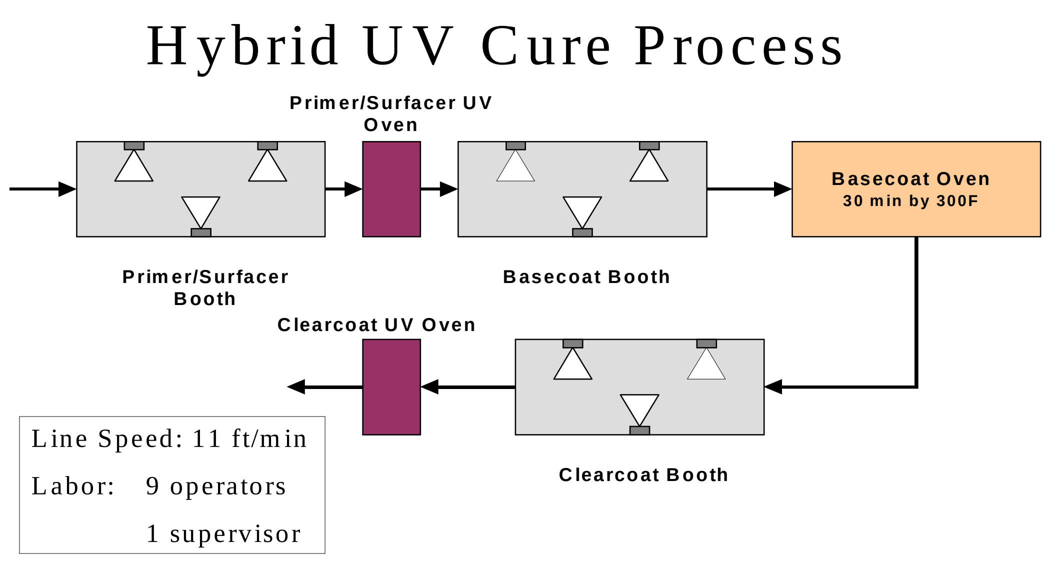


Figure 2 Hybrid UV Cure Process Schematic

ASSUMPTIONS

Once the mathematical equations are developed to model the coating application and curing processes, the next most important factor in cost modeling is the development of the key assumptions for the cost of materials, energy, labor, capital investment, reject/rework rates and miscellaneous maintenance and sundries. ChemQuest tracks these costs for the coatings value chains and drew heavily from their database to populate the model with these costs. Unique and/or specific knowledge about the hybrid UV system costs were used in lieu of ChemQuest data in a few instances. In these cases, the costs are kept confidential out of respect for the member company that provided the information.

Figure 3 shows the baseline assumptions that were used for key variables in the model.

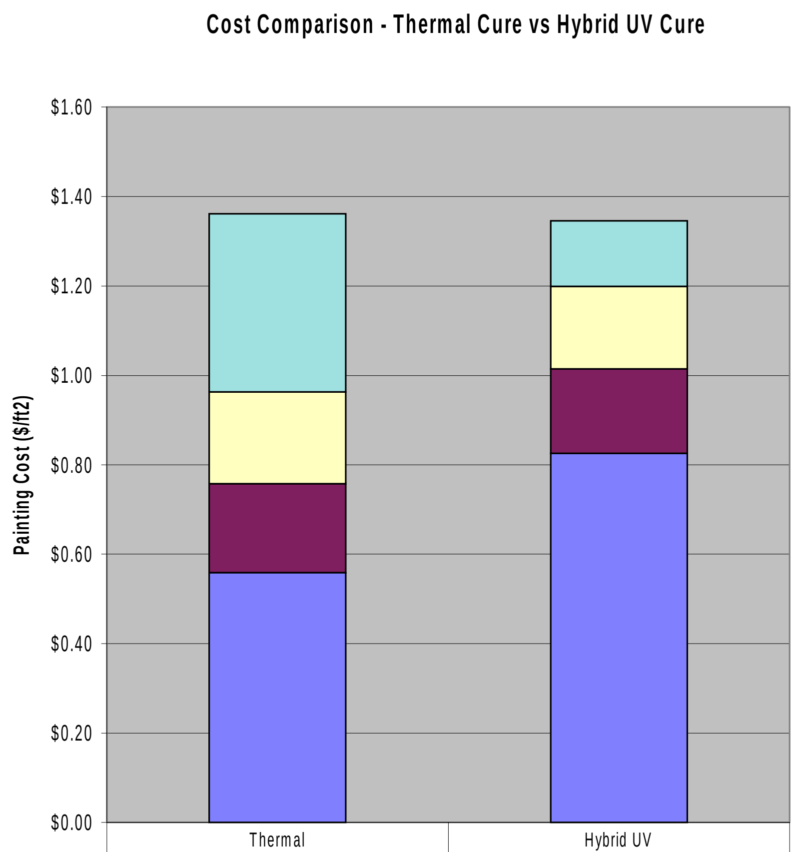
Key Variables

		Thermal	Hybrid UV	
Par				
	Name	Hood	Hood	
	Surface Area	30.0	30.0	square feet
	Weight	25.0	25.0	lbs
	Annual Production	90000	90000	parts/yr
	Racking Rate	14.0	14.0	feet/part
	Hanger Weight	5.0	5.0	lbs/ft
	Conveyor Weight	20.0	20.0	lbs/ft
Labo				
	Shift length	8.0	8.0	hrs/shift
	Shifts/day	2	2	shifts/day
	Operating weeks	50	50	weeks/yr
	Operating days	5	5	days/week
	Operating hours	4000	4000	hrs/yr
	Line Supervisors	1	1	Number/shift
	Supervisor Compensation	$15.00	$15.00	$ per Hr.
	Line Operators	10	9	Number/shift
	Operator Compensation	$11.25	$11.25	$ per Hr.
	Clean Up Man-hours per Shift	3	1	Hrs.
	Clean Up Labor Compensation	$11.25	$11.25	$ per Hr.
Line				
		6.0	11.0	ft/min
Coating				
	Primer/surfacer Cost ($/gal)	Confidential	Confidential	
	Basecoat Cost ($/gal)	Confidential	Confidential	
	Clearcoat Cost ($/gal)	Confidential	Confidential	
	Primer/surfacer % Solids by Volume	65.0%	80.0%	
	Basecoat % Solids by Volume	55.0%	55.0%	
	Clearcoat % Solids by Volume	55.0%	60.0%	
	Average % Solids by Volume	58.3%	65.0%	
	Primer/Surfacer Film Thickness	2.00	2.00	mils (10^{-3} inches)
	Basecoat Film Thickness	1.50	1.50	mils (10^{-3} inches)
	Clearcoat Film Thickness	2.00	2.00	mils (10^{-3} inches)
Yield				
	Reject Rate	12.0%	4.0%	
	Rework Rate	40.0%	10.0%	
Capital		$0	$605,000	
Fuel		**Efficiency**	**Cost**	
	Electricity	75%	$0.06	$ per KWH
	Gas- Indirect Fire	80%	$0.55	$ per Therm
	Gas- Direct Fire	90%	$0.55	$ per Therm

Figure 3 Baseline Values of Key Variables for Cost Models

RESULTS AND ANALYSIS

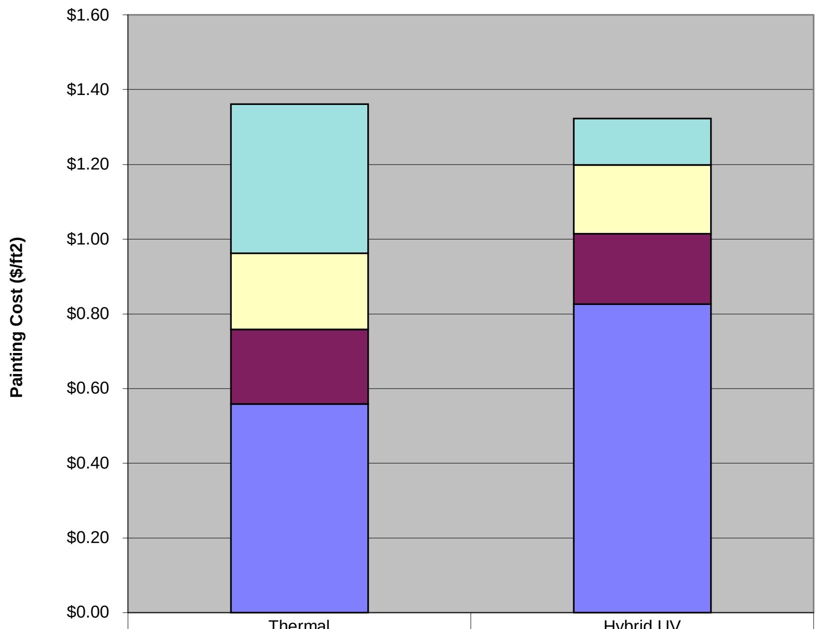
A comparison of the full cost (including depreciation) of the two processes is shown in Figure 5. The hybrid system is approximately 1% less in cost than the thermal system - $\$1.35/ft^2$ vs. $\$1.36/ft^2$. The total cost for painting a hood is $40.35 for hybrid UV and $40.85 for thermal – savings of $0.50/hood.



	Thermal	Hybrid UV
Miscellaneous/Rework	$0.40	$0.15
Labor/Maintenance	$0.20	$0.18
Energy	$0.20	$0.19
Material	$0.56	$0.83

Figure 4 Full Cost Comparison of Thermal Cure vs. Hybrid UV Cure

It is wise and common to compare the operating costs of both processes (i.e. full cost excluding depreciation). While an accounting purist wishes to make the comparison on a full-book basis, ChemQuest has found many instances where operating costs comparisons are used to make the final decision for process changes. The capital investment is considered in decision making, but only in the ability of the process change to yield savings that give an adequate return on the investment. Figure 5 shows a comparison of the two processes excluding depreciation. The hybrid UV process advantage is greater at $1.32/ft^2 vs. $1.36/ft^2 for thermal – savings of 3% or $1.15/hood!



	Thermal	Hybrid UV
Misc/Rework less depr	$0.40	$0.12
Labor/Maintenance	$0.20	$0.18
Energy	$0.20	$0.19
Material	$0.56	$0.83

Figure 5 Operating Cost (full less depreciation) Comparison of Hybrid UV Cure vs. Thermal Cure

Note that the line speed for hybrid UV is nearly twice as fast as the thermal system (11 ft/min vs. 6 ft/min) due to the faster reaction kinetics associated with the UV-curing mechanism. This nearly doubles the painting capacity for hybrid UV for an investment of only $605,000.

The bottom line – at baseline conditions, the hybrid UV process has twice the capacity and a savings of $1.15/hood for an investment of $605,000. At full utilization at the new capacity this gives a payback in 2.8 years.

SENSITIVITY ANALYSIS – A DEEPER LOOK

To properly use (and prevent the abuse of!) cost models, a deeper analysis must be made. The danger of cost modeling is that decisions can often be made using one set of baseline assumptions. It is often said that spreadsheets can be "tortured" to give you the "right" answer! In other words, human nature will seek assumptions that cause the model to give the answer we are looking for. To prevent this "torturing", a range of assumptions should be used to assess the results. A simple technique for looking at a range of results is a sensitivity analysis. Sensitivity analysis requires that changes be made to one variable at a time, keeping all other variables at the baseline value. The changes can be any range, but a reasonable range is +/- 20% of the base line value. By varying the baseline assumptions, the model can be analyzed for uncertainties and variabilities that can arise from incomplete knowledge of today, inability to forecast the future, and variability across customers, markets and regions.

A cost model is considered to be "insensitive" to variables that have little impact on the final cost when varied. In most cases, insensitivity is considered good because it suggests that variable has little outcome on the operating cost of the process and can often be ignored. Of most interest to the value chain analyst are the "sensitive" variables. Highly sensitive variables are where the action is – from the perspective of a challenger (i.e. hybrid UV), highly sensitive variables represent opportunities when they are in the incumbent's cost model. Conversely, sensitive variables can be vulnerabilities when they are in the challenger's model.

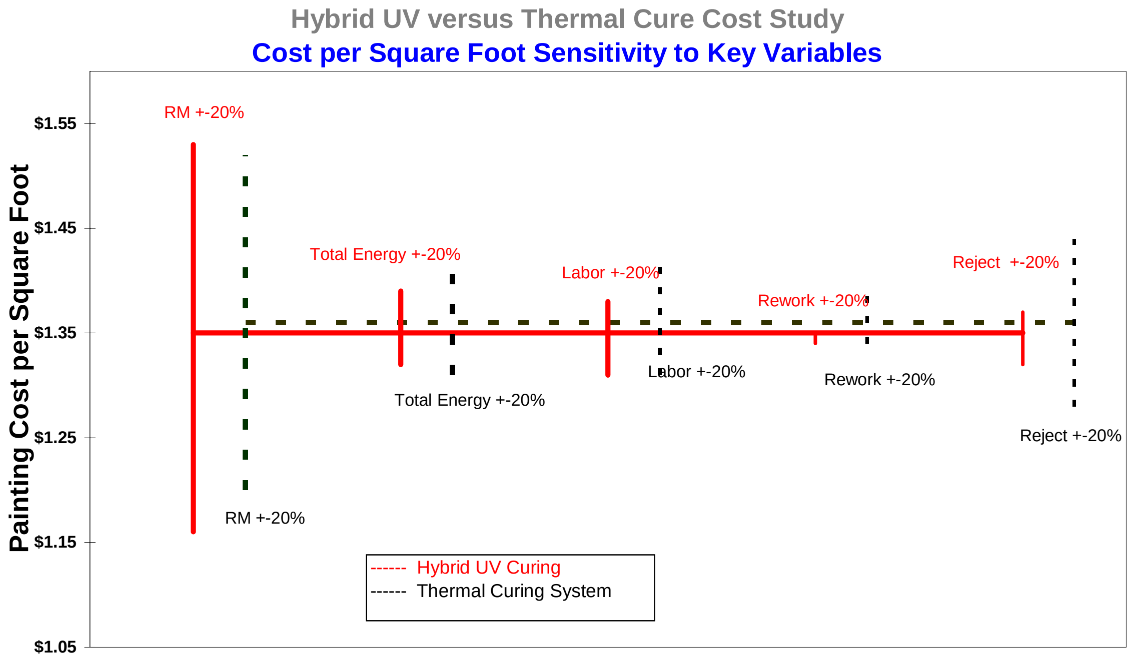


Figure 6 Sensitivity Analysis of Key Variables

A graphical view of the sensitivity analysis of the hybrid UV and thermal processes can be seen in Figure 6. The horizontal line represents the full-book cost for each process under the baseline assumptions (solid represents hybrid UV at $\$1.34/ft^2$ and dashed represents thermal at $\$1.35/ft^2$). The vertical lines show the effect on costs of varying the value of that key variable (one at a time leaving the other variables at the baseline value). The longer the vertical line, the more sensitive the model is to that variable. Since all models will have at least one sensitive variable, it is especially insightful to make a comparison of the length of the vertical lines of the two processes. The challenger would want to find variables where the incumbent is especially sensitive in order to exploit that variable in their value proposition.

In this study, several observations can be made about sensitivity:

- Both processes are sensitive to the price of materials, with hybrid UV being slightly more sensitive – a potential vulnerability.

- Both processes are moderately sensitive to energy and labor prices, but hybrid UV has a slight advantage due to more efficient use of energy.
- The thermal process is highly sensitive to, and especially vulnerable to, first pass quality and overall reject rates. So much so that a strong value proposition can be developed and practiced for hybrid UV.

CONCLUSION

A number of conclusions can be made from this cost modeling:

1. Under the baseline conditions, the hybrid UV-cure system has operating costs that are 3% less than the incumbent thermal-cure system. The savings are a combined result of drastically improved first-pass quality and less energy use.
2. The hybrid UV-cure system is much more robust from a cost standpoint than the thermal-cure system. Cost robustness can be thought of as insensitivity to changes in the key variables of the model. The robustness advantage for hybrid UV-cure is a result of two factors:
   - Substantially higher first-pass quality and lower reject rates.
   - More efficient use of curing energy.
3. A compelling value proposition can be made (and supported with data!!) for the hybrid UV-cure system with the following elements:
   - Lower overall full-book cost and operating cost
   - Higher first-pass and overall quality due to less outgassing during the cure of the primer-surfacer
   - Doubling of painting capacity due to faster line speed
   - While not readily apparent in the model, the hybrid UV process has less environmental emissions of volatile organic compounds (VOCs) as a result of higher solids (less volatile solvents) formulations for the primer-surfacer and clearcoat.

These conclusions can assist the marketer of UV systems in the development and refining of materials, equipment and services to displace thermal curing in the automotive industry.

ACKNOWLEDGEMENTS

ChemQuest Group wishes to acknowledge the support and cooperation of the Automotive Focus Group, in particular Chuck Cameron of Ciba Specialty, Kevin Joesel of Fusion UV and Gary Cohen of RadTech International. Without their help and encouragement, this study would have been impossible.

NOTE: This article originally appeared in the March/April 2002 issue of the *Rad Tech Report.*

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