Transformational Thinking: Innovating for the Future

12th CHINA COATINGS SUMMIT

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Shanghai: 8-9 May, 2014

The ChemQuest Group, Inc.

TM

TOPICS TO BE DISCUSSED

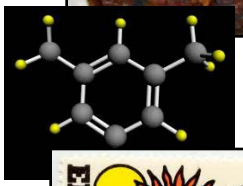
- "Wismer's Six Strategic Goals"
- Status of "Wismer's Six Strategic Goals" for the Coatings Industry
- Where is the Paint and Coatings Industry Today?
- Innovation, Creativity and Transformational Thinking
- Transformational Thinking in the Paint and Coatings Industry
- Transforming the "Interesting" into the "Essential"
- What's "Out There" Now?"
- What's Around the Corner?
- Into the Future via Transformational Thinking

Wismer's Strategic Goals

Wismer's "Six Strategic Goals" for the Coatings Industry—1984

- **Corrosion Protection**

- **Elimination of Solvents**



- **Conservation of Energy**

- **Reduction of Toxic Wastes**

- **Cost Reduction**

- **Improved Durability**

—Marco Wismer, PPG, 1984

Wismer's "Six Strategic Goals" for the Coatings Industry—1984

. . .Yet, in spite of improvements in all six areas, these are still the six most important goals of the global paint and coatings industry 28 years later. . . .

Even today, it is clear that the various global coatings marketplaces, both industrial and consumer, are seeking (in some cases, ***struggling***) to provide positive, proactive, and economically viable realizations for each of these goals.

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Corrosion Protection—**May or may not be *better* today, but performance of traditional hexavalent chromium anti-corrosive pigments is being approached, depending upon end-use requirements, with a variety of more environmentally friendly materials:
  - Phosphates
  - Pyrophosphates
  - Polyphosphates
  - Phospho- and Borosilicates
  - Metaborates
  - Mercaptobenzothiazoles
  - Various trivalent chromium compounds
  - Molybdenum compounds
  - Magnesium Metal
  - Ion exchange materials

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Corrosion Protection (cont'd)**
  - Nanoparticles that increase barrier properties—packing so tightly that water cannot permeate the film, leading to better barrier properties
  - Platy nanoparticles—don't pack, but orient in a laminar fashion and increase the path length that water must travel, leading to better barrier properties
  - Superhydrophobic coatings, containing polymer-modified nanosilica, creating superhydrophobic surfaces that cause water to run off (the so-called "lotus leaf" effect)
  - Silanes and organo-functional silanes—form SiO bonds with metallic substrates, increasing adhesion and decreasing corrosion

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Corrosion Protection (cont'd)**
  - Various organic compounds, including zinc salts of aminocarboxylates and cyanuric acid, benzothiazols, and others.
  - Inherently conductive polymers (ICPs—polyaniline, polypyrrole, polyphenolene, *et al.)*
  - Conductive, fullerene (carbon) nanotubes ("CNTs")
  - Addition of magnesium to the zinc pot for galvanized steel
  - Many, many, many others

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Elimination of Solvents—**Not universally eliminated yet, but certainly being used at lower levels in both consumer and in many industrial coatings.
  - In certain areas, such as heavy-duty Protective Coatings applications, solventborne coatings must still be used for optimum protection.
  - Coil Coatings—virtually all solvent is captured and burned to produce heat for the oven, as well as the factory and offices. Although not know for certain, solventborne coatings are likely to generate smaller carbon footprint than waterborne coil coatings.
  - Automotive OEM Clearcoats will remain predominately solventborne for the foreseeable and perhaps even many basecoats, as a result of the Ford Motor Company study indicating that waterborne coatings generate a larger carbon footprint than solventborne systems.

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Conservation of Energy—**Poorly defined and difficult to quantify. Must be able to measure Energy use of:
  - Paint application process
  - Paint making process
  - Synthesis of polymers, pigments, additives and solvents
  - Regulatory bodies are making it difficult to engineer and register new monomers, some of which might conserve energy and reduce carbon footprint.
  - As much as 90% of the carbon dioxide equivalents ("CO_{2e}", which consist of CO_2, nitrous oxide and methane) used to make paint is used to make the monomers from which the polymers are made
  - "Cool Roof coatings have been developed which decrease energy usage in southern climates by both reflecting infrared energy and emitting infrared energy to the atmosphere.
  - Much, much more needs to be done in this area, however.

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Reduction of Toxic Wastes**
  - On-going reduction of lead-containing pigments, even in OEM industrial coatings
  - Global reduction in the use of hexavalent chromium for corrosion resistance
  - Significant decrease in the use of cadmium pigments
  - Elimination of perfluoronated surfactants
  - On-going elimination of alkyl phenol ethoxylate surfactants in latex synthesis
  - Re-use, rather than disposal—*e.g.*,
    - Recycled supersacks
    - Wash solvent reclamation and re-use
    - Scrap material used as fuel
    - Using heat from incineration to heat ovens and buildings
  - Recycling of reclaimed consumer paint into new products
  - Many other approaches

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Cost Reduction—**
  - "Cost down" programs have affected not just the automotive industry over the past decade—they have affected virtually all industrial OEM segments, and have even cut into the profits of the architectural (consumer) coatings segment, although not with the same intensity.
  - Fortunately, soaring raw material prices over the years 2009-2011, and—to some extent—in 2012 as well, have enabled most coatings companies to "pass along" all or part of the increased raw material costs and, in many cases, pass them along with an additional increase in the cost of the coatings to help improve the bottom line of the coatings manufacturers.

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Improved Durability—**Significant improvements are available in consumer and industrial products:
  - UV-absorbers and HALS (hindered amine light stabilizers)-containing automotive basecoats/clearcoats have dramatically improved the long-term appearance of automobiles.
  - Significantly improved polyester technology has enabled extended life expectancies and enhanced appearance for metal building coatings.
  - Polyurethane Dispersions ("PUDs") and Acrylic/Polyurethane "Hybrids" have produced superior performance in waterborne technology for a variety of substrates, from wood flooring to leather goods.
  - Improvements have been made in radiation-curing technology, although there is still considerable room for more advances, including improved UV-cured powder coating technology.

Current Status of Wismer's "Six Strategic Goals" for the Coatings Industry

- **Improved Durability (cont'd)—**
  - Increased use of Colored Complex Inorganic Pigments ("CCIPs," "calcined colored pigments," "ceramic pigments," and other common names) have dramatically improved the lightfastness of highly-warranted building panel systems and plastics and other applications where color stability and overall durability are expected for 20+ years.
  - The use of inherently conductive polymers and fullerene carbon nanotubes have improved the durability of heavy-duty protective coatings, as well as reduced the amount of toxic waste associated with those coatings.
- Many others

Where is the Paint and Coatings Industry Today?

Where is the Paint and Coatings Industry Today?

“The entire coatings community is suffering from a lack of innovation.”

—Prof. R.A.T.M. van Bentham,
Eindhoven Technical University, 2004

Where is the Paint and Coatings Industry Today?

- Whether a coatings business is in a country that is in recovery mode from the 2007-2009 recession or is entering into a new recession, there are certain questions that need to be asked:
  - Is your company hanging on by its fingernails, hoping to get back to "business as usual," once the overall economic situation finally improves?
  - Is your company pawing the ground so that you can get "back to business" faster than your competitors because—during the recession—you made some incremental improvements to your products, which you now feel are "better" than your competitors?
  - Or is your company. . . .

Where is the Paint and Coatings Industry Today?

- . . .Calmly working with your Technical and Marketing colleagues and your customers, polishing and releasing your new literature telling the world about the new products that you developed during the past 5 years, and successfully trialed on your customers' lines while their business was slow, and they had the time to work with you to optimize your new products on their equipment?

- The truth is that—given the choice between incremental improvement focused on value-maintenance and strategic creation of value-added platform technologies and truly new products—there truly is no choice, although both are preferable to doing nothing, and waiting for the "good times" to return. . . .
- We are living through a transformational period of history—a period that is altering not just individual behavior, but which is affecting society at large, and industry as a whole.

We Are Living in a Transformational Period

- With a few notable exceptions, we are *slowly* emerging from global recession, and much looks the same as prior to the recession—but don't be fooled.
- Governments around the globe have been in the process of spending untold amounts of money on infrastructure improvements, alternative energy generation, programs that will reward the development of advanced manufacturing strategies, *et al.*
- The past two decades have largely been years of creative stagnation for chemical-based manufacturing industries, and certainly for the coatings industry. Yes, we've seen our share of new products and processes, but—take a second look—and it becomes clear that what we've mostly been practicing is "incremental improvement," not transformational product design.
- So what is "transformational product design"?

Invention, Creativity, and Transformational Thinking

Wismer's Wisest Words

A product has to be developed before its needed, because by the time it's needed, it's too late."

—Marco Wismer

. . .And There is Only One Way to Get There

“. . .innovation is key in driving profitability for customers. . .”

—Mark Brockaert, 2004

Transformational Thinking

- Here's what it's not: making a new and slightly improved mousetrap to replace the last mousetrap that did not live up to its advertised performance.
- Transformational thinking is harnessing our creative energies to look at both processes and products in a different way, to see potential opportunities that we have missed in the past—so that we can see past "what is" to "what might be," and how "what might be" can add value to our products and processes, and to our customers products and processes, as well.
- Transformational thinking can be as much about products as processes.

Transformational Product Design

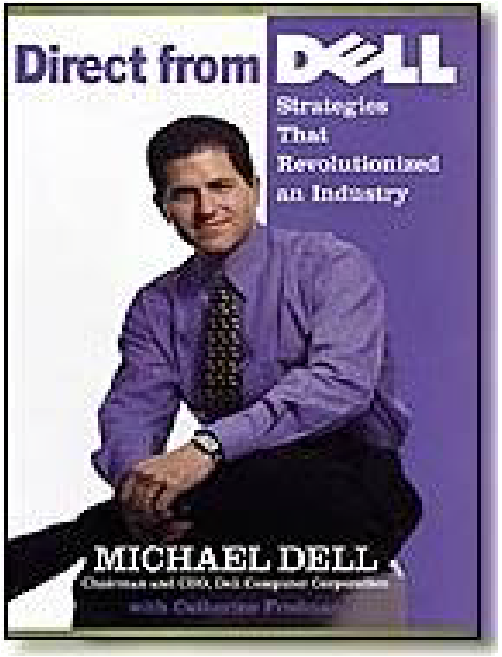
- As an example of a **product**, Frito-Lay (a PepsiCo subsidiary) which had been making corn chips for decades, created a new ***scoop-shaped*** corn chip.
  - ***Practical effect*:** More salsa in the consumer's mouth, and less on his rug
  - ***Bottom line:*** Frito-Lay saw significant improvement in its sales and profits. . . .and both the function and the efficacy of the lowly corn chip was forever transformed. . . .

Transformational Product Design

More in your mouth. . . .less on the Oriental Rug!

Transformational Product Processes

- No better examples of transformational **processes** can be offered than the ways in which Dell, Toyota and Wal-Mart all rose to the top of their respective industries by creating stunningly efficient ways of getting products into consumers' hands more cheaply than their rivals.



Transformational Thinking in the Paint & Coatings Industry

Transformational Product Design

- Somewhat closer to home, with respect to the world of paints and coatings. . . .
- ***Classic Example of Transformational Thinking***—Automotive Basecoat/Clearcoat Concept
  - Clearcoat provides aesthetic properties and is intrinsically resistant to environmental degradation—resin composition + UV absorbers + HALS
  - AND—it shields the colored basecoat, primer and E/D coating from being damaged by UV radiation and subsequent hydrolysis.
  - THUS—the colored basecoat, at the very least, can be formulated with much less expensive materials.
- How about a few more current examples of transformational thinking?. . .

Transformational Product Design

- Ten years ago, less than 5% of residential homes in North America had a metal roof, even though they typically last for 30-40 years compared to an asphalt shingle roof which typically lasts 12-15 years, and constitutes hazardous waste when it is removed.
- Why was this? Because metal roofing was expensive, it had an “industrial” look, and it brought nothing exciting to the game—
  - It looked “OK”
  - It basically kept the rain out
  - It tended to have an “industrial” look

Transformational Product Design

- Today, the number of residential homes with metal roofing has nearly doubled. Why? Because the industry has transformed the way in which the homeowner views these roofs:
  - Design changes have turned their look from “industrial” to “designer”
  - New “cool roofing coatings” have made them more energy efficient
  - The wildfires in the Western U.S. over the past 8-10 years have demonstrated that a metal roof can make the difference between a house unharmed and a house destroyed
  - Metal roofing is perceived to last “forever”
  - Steel is infinitely recyclable

Metal Roofing—Before and After Transformational Product Design

Transformational Thinking–"Cool" Metal Roofing

FORMER PERCEPTION:

THEY LOOK OK…
THEY KEEP RAIN OUT…

TRANSFORMATIONAL THINKING 

Transformational Thinking–"Cool" Metal Roofing

TRANSFORMED REALITY:

THEY LOOK GREAT…
THEY REDUCE ENERGY COSTS…
THEY ARE FIRE-RETARDANT…
THEY LAST "FOREVER"

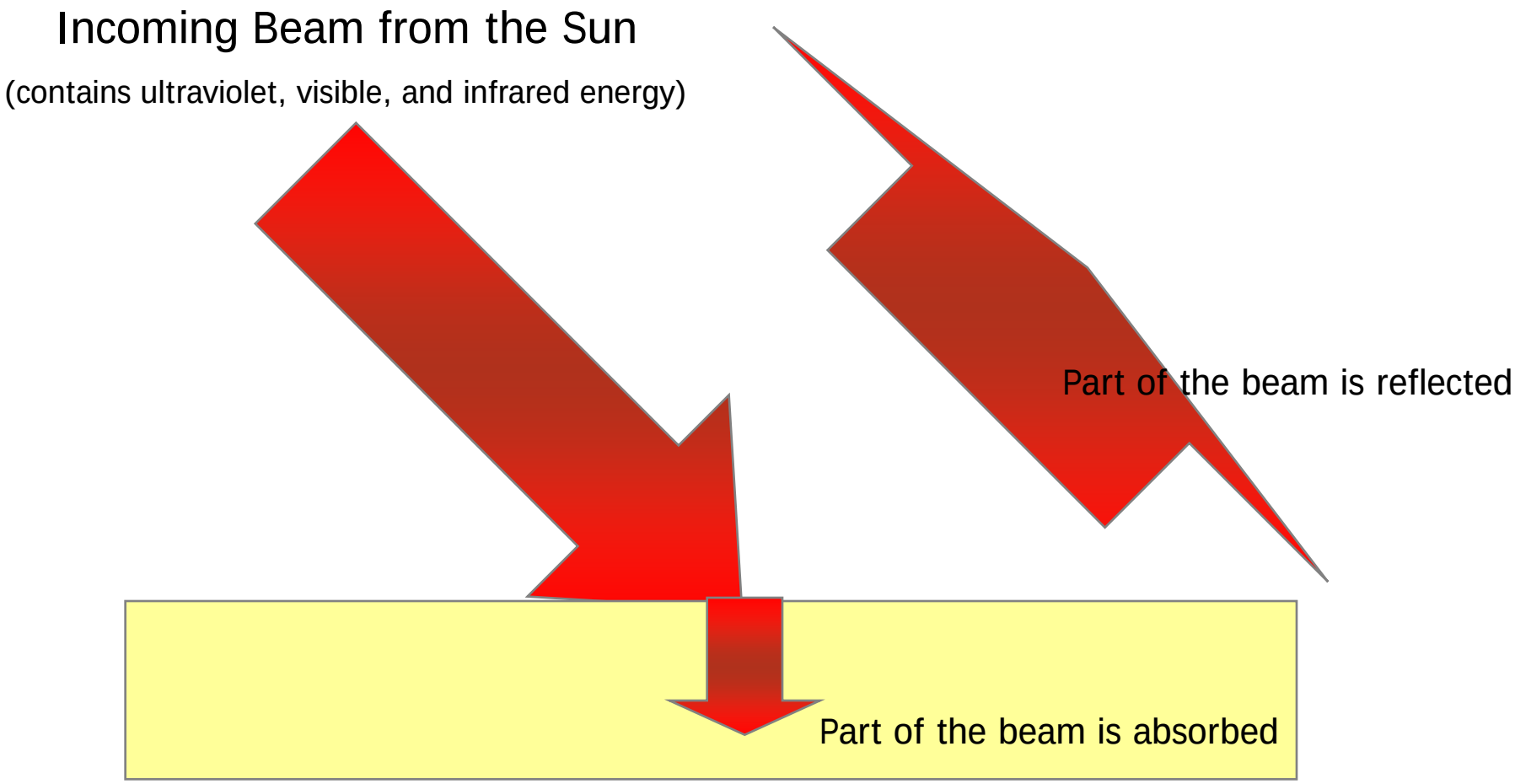
Transformational Thinking–"Cool" Metal Roofing

Two Terms to Learn

- **Total Solar Reflectance**
  - Also known as "TSR"
  - The percentage of all solar radiation that is reflected from a surface
  - Usually expressed as a decimal (*e.g.*, 0.65), but may also be expressed as a percentage (*e.g.*, 65%)
  - Intuitive
- **Thermal Emittance**
  - Also known as "TE"
  - Sometimes called "emissivity"
  - ***Always*** expressed as a decimal (*e.g.*, 0.8)
  - Compares the IR emissive property of the material vs. a perfect emitter
  - Not very intuitive

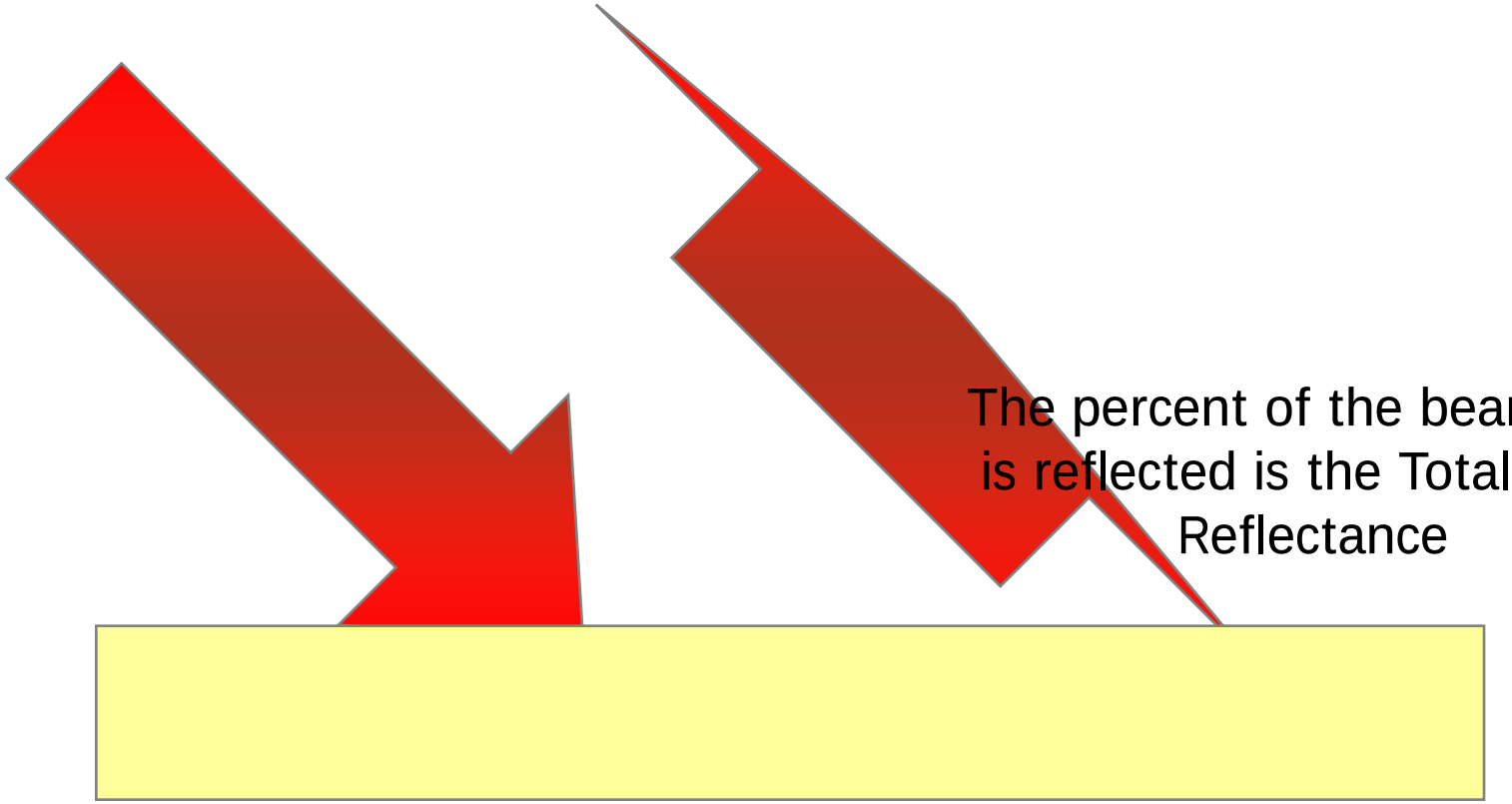
Transformational Thinking–"Cool" Metal Roofing

Total Solar Reflectance (TSR)



Transformational Thinking–"Cool" Metal Roofing

Total Solar Reflectance (TSR)



The percent of the beam that is reflected is the Total Solar Reflectance

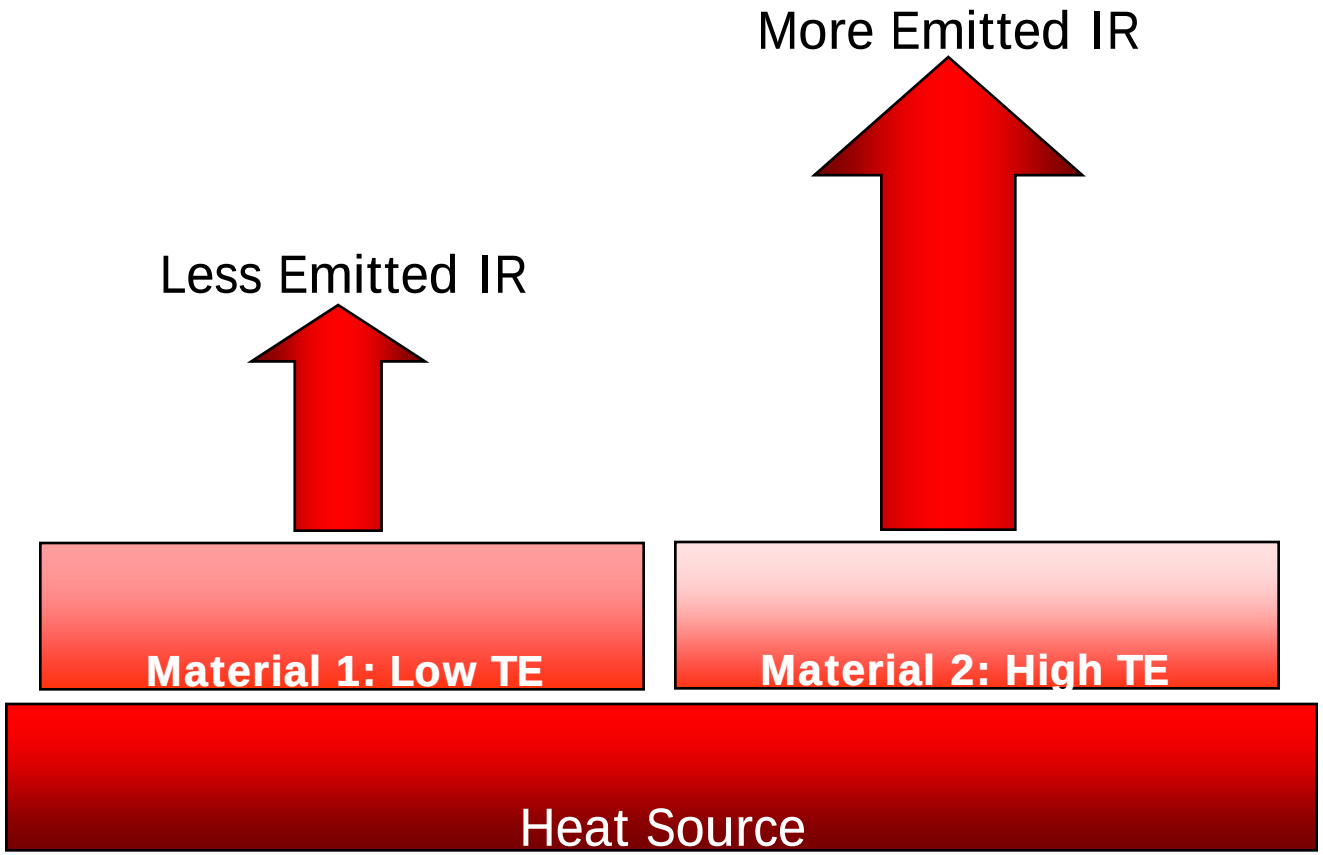
Transformational Thinking–"Cool" Metal Roofing

Thermal Emittance (TE)

- Basic material property (*e.g.*, density)
- Describes a material's ability to emit heat
- A perfect emitter has a TE = 1.0
- Painted metal typically has a TE = 0.8-0.9
- Shiny, unpainted metal has a TE < 0.1
- Materials with high TE cool down faster than those with low TE, because the high TE material "gives up" its heat more readily

Transformational Thinking–"Cool" Metal Roofing

Thermal Emittance

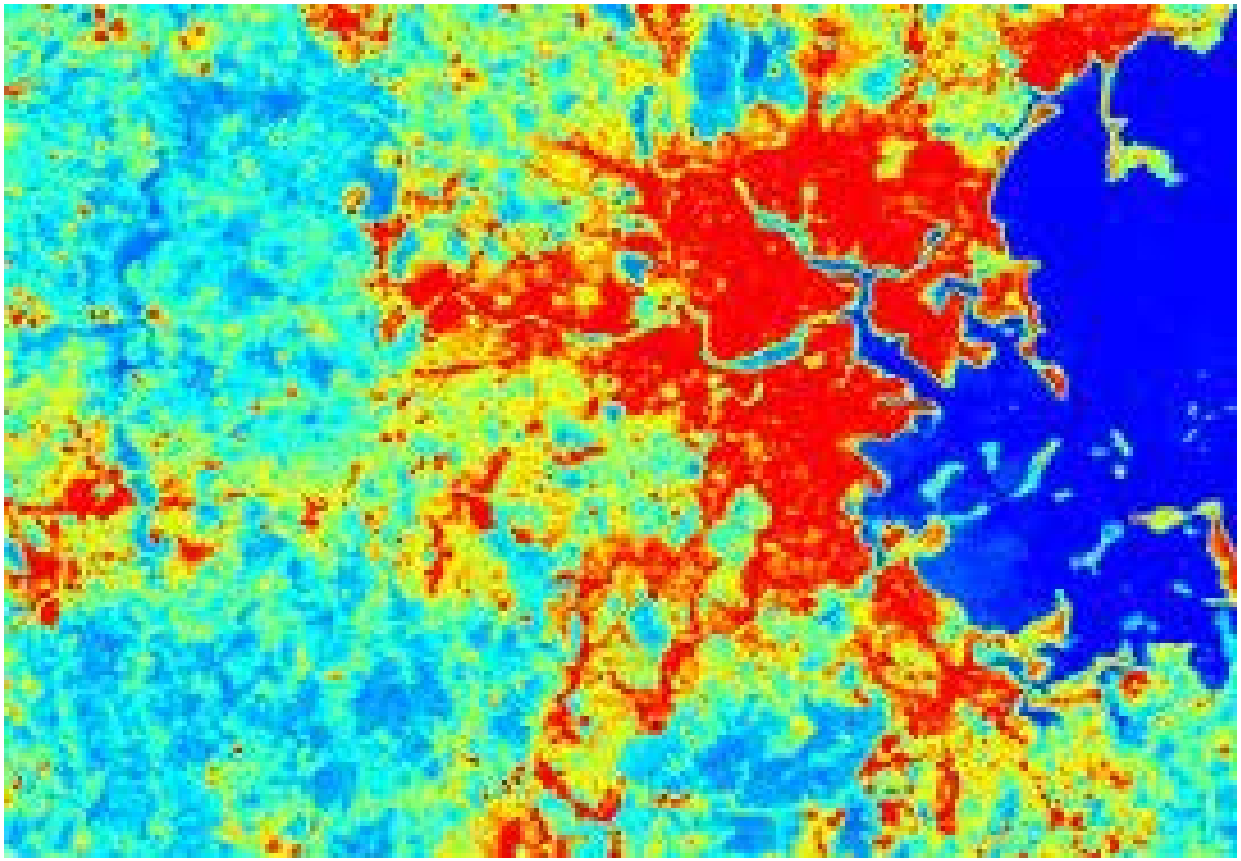


Transformational Thinking–"Cool" Metal Roofing

Urban Heat Island Effect

- Urban areas hotter than Rural areas, sometimes by as much as 7-8℃
- Less green space = heat island
- Heat Islands exacerbate smog problems
- Decreasing heat by 0.3℃ reduces smog by 5%
- Cooling Los Angeles, California (USA) by 2℃ would have the same effect as converting all gasoline-powered cars to electric-powered vehicles
- Smog creates health problems

Boston, Massachusetts, U.S.A—Red Land Areas ~7-8℃ Hotter than the Blue Land Areas



Transformational Thinking–"Cool" Metal Roofing

- Metal Roofing will continue to grow and flourish, in spite of its initial cost, because it has been ***transformed*** from a product that had nominal aesthetic and functional appeal to being both a ***product*** and a ***concept*** that has highly aesthetic and very clear—and very "Green" and "Sustainable"—functional appeal.
- Transformational thinking. . . fueling transformational product design. . . .fueling innovative thinking. . . .fueling innovative products and processes.

Transformational Thinking

TRANFORMING THE

"INTERESTING" INTO THE

"ESSENTIAL"

OPENS UP A WORLD OF

POSSIBILITIES AND OPTIONS…

Transforming the "Interesting" into the "Essential"

- Only about 40% of companies in the manufacturing sector are making sure that their R&D staffs are remaining more-or-less intact—and only some of them are emphasizing new concept creation, prototype design and product development.
- Perhaps even more importantly, where are the marketing people? True marketing people are the antennae of an organization—they are equipped by both training and temperament to—
  - Look farther down the road than the rest of us
  - Seek new segments for the company's products and platform technologies
  - Sense product changes that will need to come about to keep satisfying current customers and regulatory requirements

Transforming the "Interesting" into the "Essential"

  - Identify areas in which new products will need to be developed for sustainable growth, etc.
  - Ferret out unarticulated customer needs
  - Determine future trends
- While the ideal is for "everyone to work together as a team" in every company, this rarely happens. The two groups that absolutely *must* work together, however, are R&D and Marketing—this is the combination that really creates the opportunity for strategic, transformational product development to happen.
- Unfortunately, during the past decade-and-a-half, R&D and Marketing people have been the earliest casualties of "re-engineering" and "right-sizing" efforts in our industry.

Transforming the "Interesting" into the "Essential"

- In 2014, more paint, coatings and raw material suppliers are discovering that it is therefore wise to add to this technical/marketing partnership an independent third party—a consultant knowledgeable in both coatings and also markets and technology in adjacent industries—and magical things can begin to happen, because
  - Existing products can be extended into new market areas
  - Existing technology can be extended into new products
  - Technology from other market areas can be identified and applied within your own market
  - Market areas for future technology development can be identified
  - The list goes on. . . .

Transforming the "Interesting" into the "Essential"

- None of this happens, however, as long as you are confined to the box in which almost all companies and corporate cultures tend to place themselves.
- The coatings industry needs to "get out of the box." It's a box in which we imprison ourselves, and contains all of the resins, additives, pigments, solvents and all the rest of the tools and materials with which we are familiar.
- When we attempt to develop new products and/or concepts, we automatically reach for the materials and tools on the shelves in our box.
- Boxes are good for preserving some things, like music from the past.

Transforming the "Interesting" into the "Essential"

- The great operatic soprano, Maria Callas, once described re-creative performing as taking place in a box—the musical artist lives in a box constructed of the written notes and instructions, the composers own style and the style of the period in which the music was written. He or she can make certain artistic choices within the confines of that box, but they cannot change the shape of the box without destroying the music. This is good, because it means that generation after generation will hear the original creation, without change.
- In product development, however, we need to do just the opposite—we need to get ***outside*** of the box, or we'll forever be producing the same products without change.

Transforming the "Interesting" into the "Essential"

- Be honest—if you are in industrial coatings, how often do you read the house paint literature? How often do you talk to a sales representative from the leading suppliers of waterborne latex resins for house paints?
- How often do you read the literature from ***outside*** the coatings area? When was the last time you had a conversation with an adhesive chemist? Do you even know any adhesives chemists?
- If you did, they could tell you very interesting things about adhesives, which are, by and large, just coatings designed to stick to two surfaces, rather than one. . . .

Transforming the "Interesting" into the "Essential"

- There is, for instance, a very interesting class of structural acrylic adhesives in which polymerization is initiated in a mixture of acrylates by a blocked organoborane catalyst like triethylborane/3-diaminopropane. Such materials exhibit amazing adhesion to low energy surfaces. The trick? Organoborane catalysts are activated by abstracting oxygen from the low-energy surface. Ever try exploring this type of material in coatings?
- Ever take a look at vapor deposition coatings which are used so effectively to impart barrier properties to both rigid and flexible packaging? They are basically made out of silica and alumina.
- These sound pretty far-fetched from the realm of traditional coatings, but what if you could impart a truly damage-resistant surface by applying a thin, invisible layer of glassy-hard, yet flexible silica?

Transforming the "Interesting" into the "Essential"

- Increasingly, paints and coatings are being called upon to be multi-functional
  - Aesthetic appeal coupled with anti-bacterial properties
  - Durability coupled with anti-corrosive properties
  - Corrosion-resistance coupled with aesthetic properties
  - Chemical resistance coupled with ductility
  - Ductility coupled with hardness and damage resistance
  - Durability coupled with self-cleaning properties
  - Aesthetic appeal coupled with anti-mold characteristics
  - Corrosion-resistance coupled with thermal properties
  - The combinations are endless. . . .but they all spell "value," they don't come about by accident, and they all involve. . . .

Transforming the "Interesting" into the "Essential"

- . . . . Creating a world of new opportunities and possibilities by using transformational thinking—by transforming the "interesting" into the "essential."

“What’s Out There”?

What's Out There?

- There are many on-going technological approaches to making coatings more environmentally compliant:
  - Powder
  - High Solids
  - Radiation-curable—UV, EB, Visible
  - Waterborne—lower VOC or no VOC
  - 100% solids
  - *Et al.*
- At the end of the day, however, all of these technologies still have petrochemical parents. . . .although certain non-VOC, non-HAPS materials like Oxsol 100 (Parachlorobenzotrifluoride—a solvent) can be extremely handy, but are seldom used.

What's Out There?

- What about truly renewable materials? Twenty years ago, we had symposia *ad nauseam* on the subject, but I'm not sure that the times were really right for people to get serious about the subject. Things are different now, however. . . .
- What about coatings based on materials that are based on green polymers? Here is a random sampling of materials that I've read about in the past few years, although I have no personal knowledge of their value, with one exception. Have you ever tried exploring:
  - Palmer International's Cashewthane™ reactive diluents and resins, derived from cashew nutshell liquid, a non-food source.
  - BASF/Cognis Sovermol®—linear and branched hydrophobic branched polyether/polyester polyols made from renewable resources.

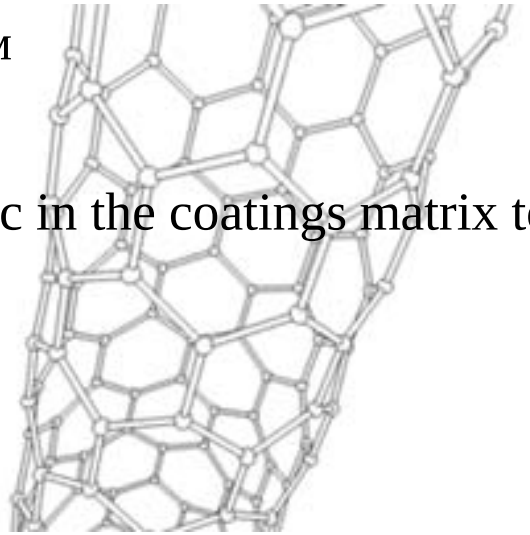
What's Out There?

- EcoSynthetix EcoSphere® dry biopolymer nanoparticle agglomerate powders made from annual crops—claimed as alternatives to petroleum-based latexes.
- Alberdingk Boley's polyurethane dispersions based on castor oil and linseed oil.
- VertecBio EL™, ethyl lactate solvent derived from corn—non-HAPS, non-VOC and, in certain systems, can affect rheological properties in very interesting and useful ways; supplied in a variety of blends to replace common paint, coating and ink solvents such as methyl ethyl ketone ("MEK"), xylene, ethylene glycol monobutyl ether ("2-butoxyethanol," "Butyl Cellosolve™," etc.), isophorone, tetrahydrofuran ("THF"), cyclohexanone, and many other solvents.
- Many, many others in the literature.

What's Around the Corner?

What's Around the Corner?

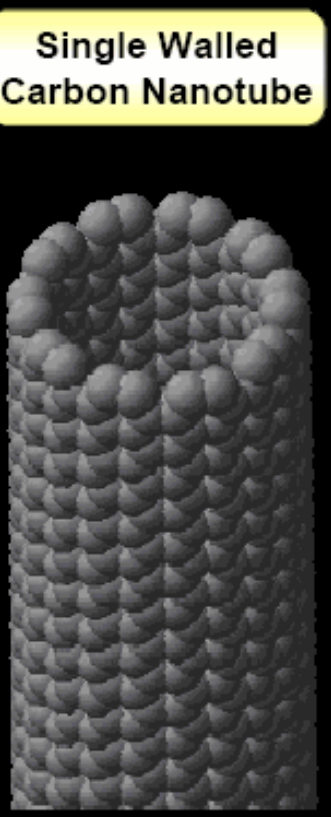
- Jeanette Gittens and colleagues, Sheffield Hallam University
  - Microbially-influenced corrosion (MIC) of metals at sea is a big problem—produce compounds such as hydrogen sulfide
  - Encapsulated spores from a bacterium in a sol-gel coating
  - Protected aluminum alloy from microbial corrosion
  - Environmentally-friendly—no biocides or toxic inhibitors
  - In early stage of development
- Tesla NanoCoatings Limited--TESLAN™
  - Single-walled carbon nanotubes
  - Conduct electrons from aluminum and zinc in the coatings matrix to the steel substrate
  - Converts anodic sites into a cathodic sites
  - Stops steel corrosion



TESLAN™

How ?

- Pioneered by Nobel Laureate Richard Smalley
- **Structure**
  - electrical
  - mechanical properties
- Current-carrying capacity
  - **1,000x** greater than copper
- Tensile strength
  - **50x** greater than steel



What's Around the Corner?

- The U.S. National Institute of Standards and Technology (NIST) formed the NIST Coatings Service Life Prediction Consortium with industry in the 1990's, resulting in the design of the **2 m Integrating Sphere (2mIS).**
- Concept borrowed from the medical field—*i.e.*, that effects of total lifetime dosage of U.V. can be predicted.
- Irradiance levels, in the 290-400 nm region equivalent to 60 or more "suns" can be achieved at the sphere exit apertures.
- Temperature and relative humidity can be independently controlled, and samples can be placed under mechanical loading; all factors can be cycled during the testing.
- Accelerated weathering results can theoretically be predicted for anywhere on the face of the earth.

NIST 2 m integrating sphere

What's Around the Corner?

- Classic example of the need for transformational thinking:
  - In the metal container coatings industry for food and beverage, the so-called "BPA" (bis-phenol A) and "BADGE" (bis-phenol A diglycidyl ether) issues are not going to go away—and it should be quite interesting to see if/how epoxy acrylates and epoxy phenolics can be replaced. . . .because. . .
  - . . .They will only be able to accomplish their goals through the use of a combination of new materials and existing materials that are viewed—and utilized—in a different way from in the past. Success in this endeavor will require. . .
  - . . . .truly transformational thinking, and may change how we think about container coatings forever.

What's Around the Corner?

- Raw material suppliers have once again cautiously begun to develop new coatings and adhesives components to add value to both classes of materials.
- Some of these are merely "tweaks"—minor improvements that probably have more to do with perception than with reality.
- Others, however, are genuinely new and innovative materials, in most cases the products of transformational thinking—of looking at existing chemistry and uncovering ways in which to use it in a different and more productive manner.
- Following, in no particular order, are new and innovative raw materials of many types that have been introduced within the past 18 months—and some as recently as last month at the American Coatings Show in Atlanta, George, USA. Contact information in Asia-Pacific, Europe and the Americas (where known) is indicated.

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **Sun Chemical Corporation** (www.sunchemical.com): 100% Post-consumer black elostomeric pigment, useful to impart unique sheen for coatings on plastics and wood; also imparts insulating properties and improved corrosion resistance to coatings on metal—**Sunfast® Elastomer Black**; Small particle encapsulated aluminum pigments that can be used to replicate the look of anodized aluminum **extrusions—Benda-Lutz Maxal EC**; solid state solution version of Violet 55 that is redder in color, and closer to Violet 19; exceptional light-fastness—**Quindo® Violet 55;** solid phase dye dispersions that can be printed onto transfer paper using inkjet equipment similar to standard liquid inkjet inks—**Jetsperse® DS Dispersions.** Phone: +1 800-543-2323, Ext 287 (USA); +32 1023-1500 (Int'l Operations); +52 55 5358 7247 (Mexico and Latin America).

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **Huber Engineered Materials** (www.hubermaterials.com)**:** Ultrafine Alumina Trihydrate claimed to increase solids, lowers cost, reduce Volatile Organic Compounds (VOCs) without impacting jetness, color saturation or durability in thin-films (coil coatings, inks, etc.); to enhance fire-retardancy in elastomeric roof coatings; maintain thermal conductivity (epoxy encapsulating compounds); and improve transfer properties (powder coatings), etc.—**Hydral® Coat 2.** Phone: +1 866-564-8237.
- **King Industries** (www.kingindustries.com) **:** A novel new catalyst that can reduce the cure temperature of solventborne, amino-crosslinked coatings, especially those used in coil and metal decorating, to as low as a 25-second cure at a metal temperature of 180-200℃-- **NACURE® XC-305.** Phone: +1 204-866-5551 (N. America); +31 182-631360 (EU); +86 760-88229866 (PRC).

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **Taminco bvba** (www.taminco.com) **:** High-boiling, polar, aprotic, non-reprotoxic solvent for use in specialty coatings, photo resist strippers, pharmaceutical synthesis, Agrochem formulations, etc.—**TAMISOLVE® NxG.** Phone: +1 610-366-6730 (N. & Latin America); +32 9 254 1580 (EU); +86 21 5109 7998 (AP).
- **Micro Powders, Inc.** (www.micropowders.com)**:** Fine particle-size aromatic polyamide powder designed for high-specification abrasion resistance and greater over-all toughness—**NyloPine 1000;** resilient polyurethane powders used to enhance the tactile properties of various coatings systems, and also improve burnish- and **mar-resistance**—**MicroTouch 850XF.** Phone: +1 914-793-4058.
- **Chemguard** (www.chemguard.com)**:** Fluoropolymer emulsion surfactants (predominantly C6) based on telomer synthesis with no known pathways to PFOA—**FE-2210; FE-2221; FE-2222; FE-2311; FE-2312.** Phone: +1 817-473-9964.

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **Jesons Industries Ltd.** (www.jesons.net)**:** General-purpose anti-corrosion emulsion binder for mild steel surface, engineered especially for storage tanks—**Bondex® CR-1G.** Phone: +91 22 6651 5253 (India).
- **Organik Kimya** (www.organik.com.tr)**:** New product line of highly-branched, carbon-rich, non-linear organic redispersible powders—**ORP.** Phone: +90 (212) 331 00 00.
- **Oxiteno** (www.oxiteno.com)**:** New lines of non-HAP, low-VOC solvents and coalescents that are 60-100% carbon from renewable resources, such as sugarcane—**Ultrasolve® M 1200 and Ultrafilm® ECO;** surfactants sourced from renewable **resources—Alkonat®, Alkonol®, and Oximulsion®** (APE-free) lines. Phone: +55 (11) 3177-6102 (Brazil); +1 (281) 909-7600 (North America); +32 (2) 761-0360 (EU); +86 (21) 5403-5533 (PRC).

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **Lonza Ltd.** (www.lonza.com)**:** Line of controlled-leaching, antimicrobial and anti-fungal additives based on zinc pyrithione—**Densil® ZOD.** Phone: +1 800-523-7391.
- **OMNOVA Solutions** (www.omnova.com)**:** Functionalized emulsion for hydrophobic direct-to-metal (DTM) paints, APE-free with very low coalescent demand—**PLIOTEC HDT 2 ®.** Phone: +1 330-869-4323 (N. America); +33 (0) 1 69 29 27 00 (EU/MEA); +86 (21) 6473 2525.
- **Croda International Plc.** (www.croda.com)**:** Epoxy-functional toughening agent for epoxy coatings; greater toughness and flexibility at equal hardness—**B-Tough C2x.** Phone: +44 (0) 1405 860551 (EU—Global Headquarters).
- **US Polymers-Accurez, LLC** (www.uspolymers.com)**:** Low-VOC siliconized hydroxyl polyester for high-performance yacht/ship coatings—**LA-8543;** Low VOC hydroxyl polyester reactive diluent with good adhesion to aluminum—**LA-8586**. Phone: +1 314-638-1632.

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **NYCO Minerals Inc.** (www.nycominerals.com)**:** Wollastonite barrier anti-corrosive pigment for powder coatings—NYAD® **M9000;** Aluminosilicate barrier anti-corrosive pigment for powder coatings—**PHYLLOMAT™.** Phone: +1 (518) 963-4262 (N. America); (52) 662-289-1000 (L. America); +32-10-88-13-02 (EU).
- **Myriant Corporation** (www.myriant.com)**:** Bio-based, ultra-low-odor, high-efficiency coalescing agent—**Myrifilm® Zero-VOC Coalescing Solvent**; **Bio-succinic acid.** Phone: +1 617-657-5200. To order samples: +1 855-697-4268.
- **Unimin Corporation** (www.unimin.com)**:** Small particle size (3-15 mμ), reduced-fines nepheline syenite filler to contribute higher solids and lower-VOC with minimum viscosity increase in Protective Coatings—**MINEX® EP-315.** +1 203-966-8880 (North America).

Selected New Raw Materials Introduced Within the Past 2-18 Months

- **Gelest, Inc./BIOSAFE Inc.** (www.gelest.com and www.biosafe.com)**:** Family of +EPA Registered silicon-based (organosilane) antimicrobials that impart bacteriostatic, fungistatic and algistatic properties for formulated coatings and compounded polymers**—BIOSAFE®.** Phone: +1 215-547-1015/+1 412-770-1302.
- **Air Products and Chemicals, Inc.** (www.airproducts.com)**:** Family of chemically-unrelated "super-wetting surfactants," for a abroad array of coatings chemistries and substrates**—DYNOL™ 300, 600, 800 and 900 Series.** Phone: +1 610-481-6799 (N. and L. America); +31 30 2857100 (EU); +86 21 38962000 (AP); +81 44 5421550 (Japan).
- **PCCR USA, Inc.** (www.pccrusa.com)**:** APE-free, polyester dispersion designed for 2K near-zero VOC coating systems with low isocyanate demand**—Hydreau 290-1201.** Phone: +1 847 428 2657.

New—but Introduced Slightly Farther in the Past—Raw Material Introductions

Selected New Raw Materials Introduced Within the Past 24-42 Months

•**Grace Material Technologies** (www.grace.com)**:** Titanium dioxide extender, **SYLOWHITE™.** NOTE: This particular example does not represent new technology introduced within the past 42 months, but it is the author's understanding that it has not been broadly available, and is likely, therefore, to be unfamiliar to many people in the industry. Phone: +49 6241 40300 (EU); +86 215467 4678 (AP); +1 410-531-4000 (North America)

•**Essential Polymers** (www.essentialpolymers.com)**:** 40g/l hydroxyl-functional urethane/acrylic hybrid, **R4400.** Phone: +1 (262) 538-1122 (North America)

•**Patcham (FZC)** (www.patchamltd.com)**:** Zero-VOC, anionic, APE-free polymeric wetting agent for use in dispersion paints and colorants, **Pat-Add DA 202**; polymeric, mineral oil-, polysiloxane- and fluorocarbon-free defoamer based on green chemistry for both solventborne (S/B) and waterborne (W/B) paints, **Pat-Add AF 5210**; No-VOC coalescing agent for waterborne dispersion systems, claimed to be similar in performance to 2,2,4-trimethyl-1,3-pentanediol mono(2-methylpropanoate), **Pat-Add COAT 77.** Phone: +971-6-5570038 (UAE); +91-22-28788371 (India); +1 201-293-4282 (North America)

Selected New Raw Materials Introduced Within the Past 24-42 Months

- **The Dow Chemical Company** (www.dow.com)**:** Waterborne series epoxy hardeners with very low odor, increased water-vapor permeability, rapid drying and curing and processing ability at lower temperatures, Dow **D.E.H.™ Series 800** polyamine adducts Phone: +31 11567-2626 (EU); +60 3 7958 3392 (AP); +1-989-832-1426 (North America); +55 11 5188 9222 (L. America)
- **Solvay Rhodia** (www.rhodia.com)**:** Biodegradable vegetable oil defoamer for low/zero VOC for flat-to-semi-gloss waterborne coatings, **Rhodoline® 621**; APE-free, zero VOC additive that promotes extended open time, **Rhodoline® OTE-500. Phone:** +33 (0) 1 53 56 50 00 (EU); +65-6291 1921 (AP); +1-609-860-4000 (North America); +55 11 3747 7886 (Latin America)
- **Allnex** (www.allnex.com)**:** Ultra-low (<0.1%) free formaldehyde, high-solids (98%, minimum) melamine crosslinker for ambient and low temperature cure coating applications, for solventborne and cationic waterborne coatings, **CYMEL® XW 3106** Resin. Phone: : +39-0424-516-611 (Italy); +1-973-357-3100 (North America); +86-21-5448-4471 (PRC); +61-2-9846-6200 (Australia); +55-11-4745-8569 Latin America (Brazil)

Selected New Raw Materials Introduced Within the Past 24-42 Months

- **Alberdingk Boley GmbH** (www.alberdingk-boley.de/en.html)**:** Water based UV curable, hard elastic PU-dispersion with short flash-off time, high scratch- and chemical-resistance, high gloss, good pigment and extender wetting, **LUX 255**; Self-crosslinking, multiphase emulsion with superior water barrier, excellent adhesion properties and superior corrosion resistance, very low MFFT and good blocking resistance, **AC 2403**; and Lignin-reactive hydrosol for wood protection, that significantly increases the weathering resistance in comparison to conventional primers, **Lignocure 2010**. Phone: +49 (0) 2151-528-0 (EU); + 1-866-220-4750 (North America)
- Emerald Performance Materials (**Emerald Kalama Chemical LLC**) (www.emeraldmaterials.com)**:** Low VOC, superior wet edge (flat), increased scrub resistance proprietary blend of three dibenzoates**, K-Flex® 975P** Coalescent for Coatings. Phone: +90 216 524 12 12 (Turkey); +31.88.888.0500 or +31.181.249.224 (EU); +1.360.673.2550 (North America)
- **HALOX** (www.halox.com)**:** Low odor, water-soluble organic-based, tannic-, phosphoric- and gallic acid-free paint additive which converts red rust to black iron oxide**, Halox® RC-980** Phone: +1 219- 933-1560 (North America)

Selected New Raw Materials Introduced
Within the Past 24-42 Months

- **Dow Corning Corporation** (www.dowcorning.com)**:** New acrylic slip aids for waterborne systems**, 401LS**, 402LS and 205SL. Phone: : +90 216 4677645 (Turkey); +49 611 237 1 (Germany); +1 989 496 4400 (North America); +55 11 3563-4300 (Latin America)
- **Troy Technology Corporation, Inc.** (www.troycorp.com)**:** VOC-free, formaldehyde-free, broad-spectrum wet-state preservative, **Mergal® 758**. Phone: +31-10-592-7494 (EU); +66-2-398-5036 (AP); +44-789-189-7717 (MEA); +55-115575-0090 (Brazil); +1-973-443-4200 (North America)
- **Arkema** (www.arkema.com)**:** Associative neutralizing and co-dispersing agent for ultra-low or zero VOC aqueous coatings, also said to contribute anti-corrosion performance and reduce the amount of anti-flash rusting agents required, **Reverlink® NoVOC**. Phone: +90 212 276 2471 (Turkey); +44 1634718588 (UK); +82 (2) 3703 6852 (Korea); 00 54 11 47 88 41 17 (Argentina); +1-610 205 7000 (North America)

Selected New Raw Materials Introduced Within the Past 24-42 Months

- **Cardolite Corporation** (www.cardolite.com)**:** A novel class of epoxy curing agents called phenalkamides has been developed to fill a gap between polyamide and phenalkamine chemistries that are said to offer the benefits of both while mitigating their limitations; coatings formulations based on phenalkamides are said to have the desired color stability, overcoat window, and flexibility of polyamides, but with the outstanding corrosion protection and fast low temperature cure of phenalkamines, **Lite 3000 series.** Phone: +32 (0) 92658826 (EU); +86-756-726-9066 (AP); +1-609-436-0902 (North America)
- **Falcon Technologies** (www.faltech.net)**:** A polysaccharide-based sustainable colloid technology that is able to replace HEC (hydroxyethyl cellulose) at 100% with similar viscosity at a lower average particle size distribution, enabling improved mechanical properties, **LPC100.** Phone: +34 649 85 75 50 (Turkey, Southern/Western Europe); +44 1925763166 (Northern Europe); +1 905 878 2833 (Americas, AP, Africa)
- **King Industries** (www.kingindustries.com)**:** Solvent-based, tin-free 2K polyurethanes**, XK-635 and XK-639;** Waterborne Blocked Isocyanate **XK-635;** 100% active polyester polyols **XM-360 and XM-366.** Phone: +31 182-631360 (EU); +86 760-88229866 (AP); +1 203-866-5551(North America)

Selected New Raw Materials Introduced Within the Past 24-42 Months

- **Croda International Plc.** (www.crodacoatingsandpolymers.com)**:** New bio-based dimer diamine functional building block designed for use in epoxy systems, **Curing Agent Priamine™ 1071**.
- **BYK Additives and Instruments (Altana)** (www.byk.com)**:** New Inorganic additive based on surface modified silica nanoparticles (20 nm) for solvent, solvent-free and radiation curable coatings for wood, furniture and industrial coatings to improve scratch and abrasion resistance, **NANOBYK® 3605**; new water dispersion of multi-wall carbon nanotubes to impart conductivity and antistatic behavior to waterborne coatings, **CARBOBYK® 9810**. or +49 281 670-0 (EU); +81 533 82-4486 (AP); +55 11 4547 9940 (South America); +1 203 265-2086 (North America)

What's on the Horizon?

On the Horizon

- As coatings components derived from petrochemical sources become scarcer and subject to greater regulation, they must be replaced by “greener,” more sustainable raw materials.
- This requires transformational thinking on the highest level, because it calls for true innovation, but the starting materials will still need to be common and abundant—we must simply look at them in a new way or in a “different light.”
- An excellent example of this type of transformational thinking involves materials like biomethanol, which can be made from forage grasses, trees, and residues of crops, without endangering sources of food supply.
- Another is sugar cane, from which an astounding array of starting chemicals can potentially be produced, even most of them are not yet developed to the point of commercialization.

Basic Chemicals that Can Be Derived from Sugar Cane

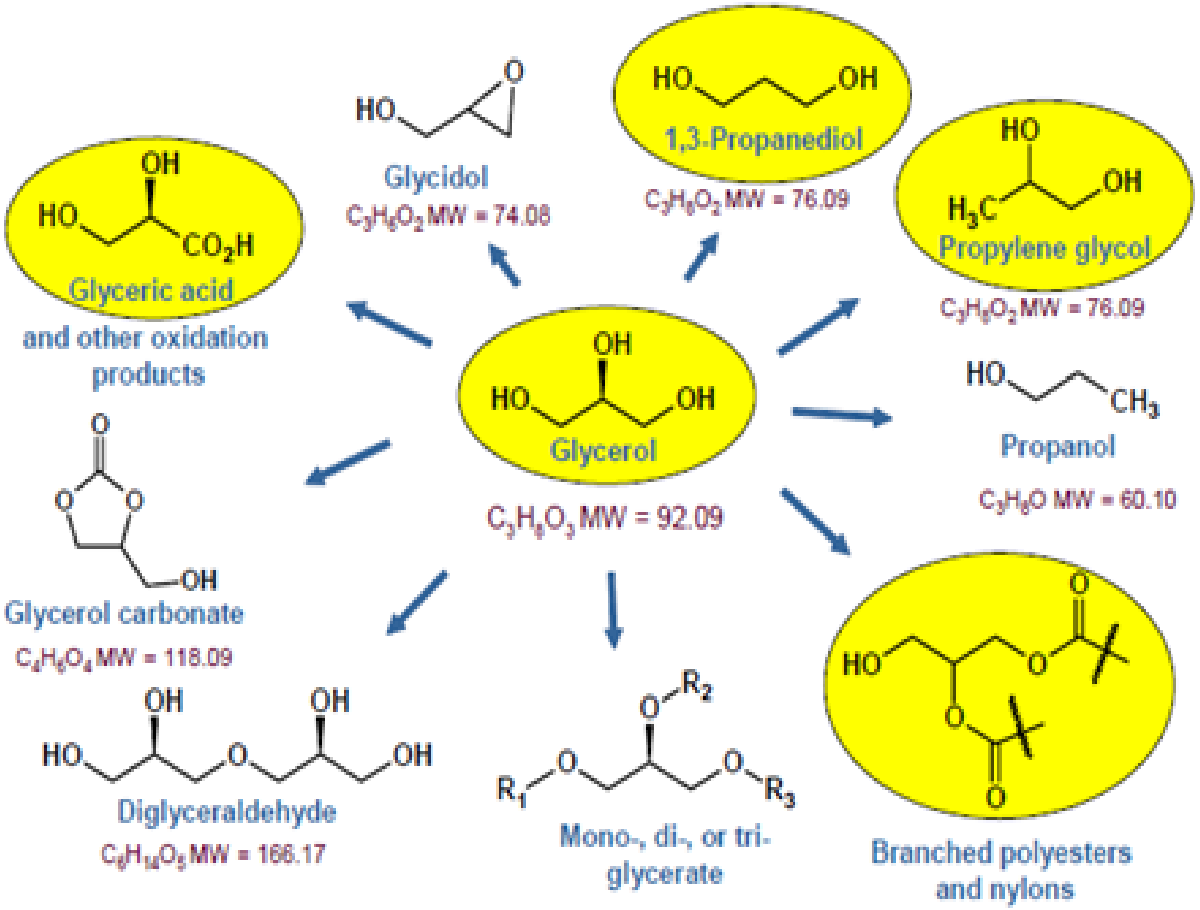
Building Blocks
1,4 succinic, fumaric and malic acids
2,5 furan dicarboxylic acid
3 hydroxy propionic acid
aspartic acid
glucaric acid
glutamic acid
itaconic acid
levulinic acid
3-hydroxybutyrolactone
glycerol
sorbitol
xylitol/arabinitol

Source: http://www1.eere.energy.gov/biomass/pdfs/35523.pdf

Basic Chemicals that Can Be Derived from Sugar Cane

- Looking at just two of these starting biomass chemicals, glycerine ("glycerol,"; "propane-1,2,3-triol") and 3-hydroxypropionic acid, we see that glycerine can serve as a starting material for a broad variety of organic molecules, including
  - Branched polymers
  - Nylons
  - Propanol
  - Diglyceraldehydes
  - Glycerol carbonate
  - Starting material for the synthesis of propylene glycol, which is currently produced from propylene, which is obtained from fossil fuels
  - Several others

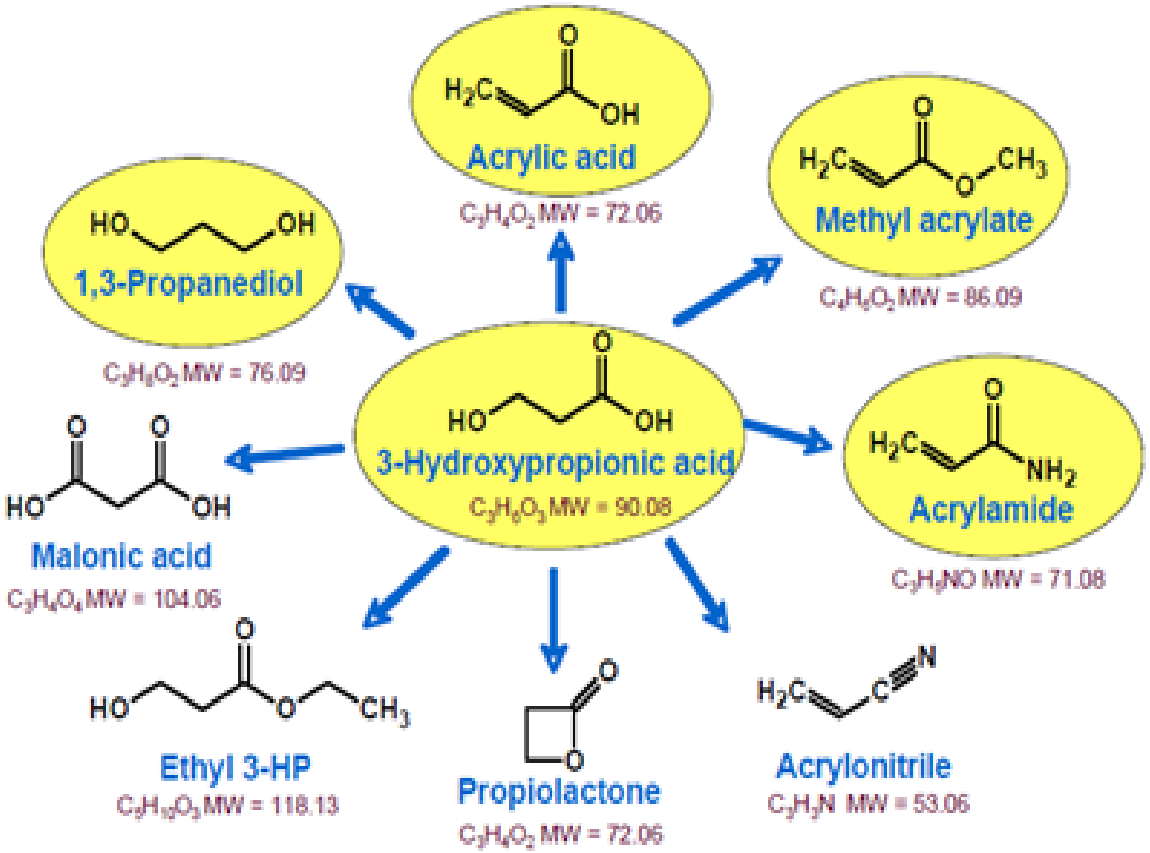
Basic Chemicals that Can Be Derived from Sugar Cane



Basic Chemicals that Can Be Derived from Sugar Cane

- If we turn to 3-hydroxypropionic acid, we see that a number of monomers that are vitally important not only to paints and coatings, but to a number of other fields, as well, can be derived from this bio-based material, including:
  - Acrylic acid
  - Methyl acrylate
  - Acrylamide
  - 1,3-propanediol
  - Acrylonitrile
  - Propiolactone
  - Malonic Acid
  - Others

Basic Chemicals that Can Be Derived from Sugar Cane



On the Horizon

- Finally—an example of truly transformational thinking, insofar as it involves the humble paint component, titanium dioxide, and two materials that were common pigments in paints and coatings until the relatively recent past: cadmium sulfide and cadmium selenide.
- These pigments have been in use for decades around the world, but—looked at “from a different angle” or “in a different light”—hold the long-term promise of the possibility that someday the paint on our roofs may be able to generate the electricity for use in our homes and businesses.
- A team of researchers at the University of Notre Dame [in South Bend, Indiana, USA] has made a major advance toward this vision by creating an inexpensive "solar paint" that uses semiconducting nanoparticles to produce energy.

On the Horizon

- How have they done it?
- By creating “quantum dots”—nano-sized particles of titanium dioxide, which are coated with either cadmium sulfide or cadmium selenide, and suspended in a water/alcohol mixture to form a paste.
- When this “paint” is brushed onto a conducting surface and exposed to light, it generates electricity.

On the Horizon

Source: http://www.sciencedaily.com/releases/2011/12/111221211324.htm

Into the Future via Transformational Thinking

Into the Future via Transformational Thinking

"As new products and processes are added to a firm's assets, intellectual property is created. Although they do not generally appear on the balance sheet, product management and commercial exploitation of such property has a dramatic effect upon a company's profitability."

—Anthony O'Lenick, Jr.

Into the Future via Transformational Thinking

- **ENCOURAGE AND REWARD INNOVATIVE THINKING—** Educate your employees by sending them to technical conferences like *Coatings Science International (* CoSI) in Noordwijk, The Netherlands; The European Coatings Show in Nürnberg; the American Coatings Show; the semi-annual meetings of the Polymeric Materials: Science and Engineering Division of the American Coatings Society (PMSE), paint**ist**anbul and the annual Fusion UV Technical Seminars.
- An educated, well-informed, continually challenged and clearly appreciated employee is an innovative employee, capable of innovative thinking.
- ***TRANSFORM*** that innovative thinking into practical, profitable products, processes and services.
- APPLY A CONCERTED EFFORT BY THE ***ENTIRE ORGANIZATION*** to work together, looking at processes, technologies and products from a different angle and in a different light—to make transformational thinking part of the corporate culture.

Into the Future via Transformational Thinking

TRANSFORMATIONAL THINKING IS THE PRODUCT OF A BUSINESS CULTURE, NOT A "PROGRAM OF THE MONTH" OR A PASSING FAD! IT IS

THE ONLY WAY FORWARD…

Into the Future via Transformational Thinking

→INTO the FUTURE

. . .AND IT WILL BE WELL-WORTH THE EFFORT—THERE ARE EXCITING DAYS AHEAD!

Thank You!

TM

The ChemQuest Group, Inc., is an international Strategic Management consulting firm specializing in Adhesives, Sealants, Paints & Coatings, as well as the constituent Raw Material value streams.

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