PATHS TO INNOVATION IN THE PLASTICS INDUSTRY

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PRESENTED AT:

ANTEC 2015
MARKETING/MANAGEMENT SIG
MARCH 24, 2015
ORLANDO, FL
USA

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“Innovate or die” – Peter Drucker

The Luddite hypothesis is wrong: Technology actually creates jobs--after Walter Isaacson, “The Innovators”

Find quicker routes than the conventional R+D lab/Testing process

Managing ideation and product development processes

Role of the product life cycle

Evolving paths to innovation

Role for artificial intelligence

Innovation drivers

Some plastic innovation examples and technology platforms

Exploring market spaces
TWO TYPES OF INNOVATION TARGETS

• Extensions of current core business via:
  - Improving current product line
  - Improving internal operations
  - New process technologies
  - Tailoring quality/performance levels

• Generation of new growth via:
  - Reaching new customer segments in an existing market
  - Creating (and shaping) new applications in existing markets, possibly disruptive technologies
  - Reaching new markets
  - New technology platforms ➔ new product families; new process technologies
  - May require:
    - new business model
    - identification of internal barriers to innovation
• Crowd sourcing:
  - Role of the internet “community”
  - Innovation implementers (Quirky Inc., Invent Help)

• Ideation sessions /Artificial intelligence
  - AI role in speeding innovation
  - Role for cloud computing

• Extension/Combination of capabilities examples:
  - Example: Borealis’ 20% long glass fiber grades utilizing integral foaming
  - Core-back injection molding → multilayer (skin/foam/skin parts)

• Clever fixes:
  - Irritation the mother of some inventions
ROLE FOR ARTIFICIAL INTELLIGENCE (COGNITIVE COMPUTING)

• Conventional ideation:
  - Identify target sector
  - Search for solutions via creativity or ideation sessions rely on group participants’ experience/knowhow/test for validity

• Computer/artificial intelligence can:
  - Do it faster and more broadly
    databases for products/properties, scientific articles, conference papers, prior art
  - Examine many alternative scenarios and combinations

• New era of the supercomputer (e.g. IBM’s Watson Cognitive System)
  - Humans: data overload → biases and shortcuts). Computer can handle the data
  - Evolutionary steps in computing: counting → programmable → the machine learns
  - Generates and evaluates hypotheses. Way beyond key word searches
  - Not governed by human boundaries, AI:
    collects information
    forms hypotheses (millions of them) and tests
    learns over time what data is reliable (the learning process)
    tests the hypotheses with all the available data
    avoids human-generated siloed information
‘open source’ knowledge

- Nobody will be isolated and everybody will have access to knowledge, education will be possible remotely.
- More knowledge (and know-how) is being ‘shared’ rather than ‘protected’.
- The internet makes it available for everybody.
  - Tesla opens patents
  - SPE Journals

Global competition will increase Accelerated technology development

SOURCE: SPE
A Fast Drying Technology to Bind Paper Sheets
Seeking a portable technology to bind sheets of paper or light cardboards...

A Blue Light Absorber Technology
Looking for a technology for absorbing or blocking blue light transmission at 450 nm and...

Low Temperature Removal of Solid Fat from Fabric
Seeking to remove solid fat such as triglycerides from fabric substrates...
MANAGING THE INNOVATION/PRODUCT DEVELOPMENT PROCESS

MARKETPLACE INPUTS/COMPETITIVE POSITION

IDEAS

FEASIBILITY

DEVELOPMENT

SCALEUP

LAUNCH

Project/sector 1

Project/sector 2

Project/sector 3

Project/sector 4

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
LIFE CYCLE EXAMPLE: TPE APPLICATIONS

- TPO BUMPER FASCIA
- SOFT TOUCH IN SPORTS/LEISURE, APPLIANCE/TOOL
- SBC-TPEs IN HOUSEWARES
- s-TPVs UNDER-HOOD SEALS/GASKETS (AUTO)
- o-TPVs AUTO RADIATOR HOSE
- TPVs IN AUTO BODY/GLAZING SEAL
- SEVERAL TPEs IN WIRE/CABLE
- SBC-TPEs IN FOOD/PHARMA PACKAGING
- SBC-TPEs IN AUTO BODY/GLAZING SEALS
- SBCs IN MEDICAL FILM/TUBING
- BIO-TPEs
- TPE IN MEDICAL TUBING
- TPVs IN AUTO BODY/GLAZING SEAL
- SBC-TPEs IN AUTO BODY/GLAZING SEALS
- SBCs IN MEDICAL FILM/TUBING
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DEMAND VOLUME

MARKET INTRODUCTION GROWTH MATURITY SATURATION (DECLINE)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015

r/mydox/Visio/Prod Life CycleTPEs 081512.vsd
EXAMPLE DRIVERS FOR PLASTICS INNOVATION

• Catalyst innovations
  - Metallocene EPDM
  - POEs

• **Compounding:** Broadening the performance envelope

• **Plastic process technology improvement examples**
  - Foaming
  - Co-processing (co-blow, co-extrusion, co-injection)

• **3-D printing:** Speeding prototype production and evaluation

• **Drive for “green” solutions:** Driving bio-plastics and natural fiber substitution

• **Smart plastics and TPEs:** Sensory applications in food and beverage packaging

• **Automotive MPG regulations:** Driving metal substitution

• **Medical:** Drive for efficient delivery
TWO EXAMPLES OF PLASTICS PROCESSING INNOVATIONS

• DYNAMIC VULCANIZATION

• FOAMING

• Both have had staying power:
  - Technology platforms for product and process development
  - Broad application range
  - Continuing evolution of applications
  - Basis for evolution of process variations
DYNAMIC VULCANIZATION

• Crosslinking elastomer “islands” in a plastic resin “sea” or matrix during extrusion

• Fundamental breakthrough was crosslinking of fine dispersion during extrusion

• Example of innovation driven by intensive investment and creative marketing to “shape” new markets

• The basis for:
  - olefinic TPVs (o-TPVs e.g. Santoprene from ExxonMobil) based on EPDM in PP
  - other island/sea, elastomer/plastic compositions

• Broad range of applications in:
  - automotive (seals, hoses, body/glazing seals), boots/bellows
  - soft touch in tools, appliances
  - construction
  - etc

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
• Understand the incumbent target:
  - In the case of o-TPVs target was rubber (initially)
  - Know price/performance limits
  - Compare material/processing “couple” don’t get into the $/kg trap
  - Make sure price/properties/finished part comparison is apples-to-apples

• Understand the incumbent business model:
  - Material
  - Application
  - Forward looking trends
  - Paths to market
  - Quality/performance tier (varies from region to region)

• For new disruptive technologies:
  - Be prepared to do what is necessary to “shape” the market

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
FOAMING

- **Two types:** Competitive and complementary to each other in the marketplace

- **Benefits:**
  - Weight reduction 5-50%; cycle time reduction
  - Dimensional stability; warpage reduction
  - Reduction of clamp pressures

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- **Physical foaming (injected gas-e.g. Trexel MuCell® process)**
  - Innovation based on fundamental breakthrough (supercritical gas in molten resin)
  - Broad applications range
  - Currently at several stages of the product life cycle:
    - non visible parts (e.g. auto fan shrouds): mature
    - visible parts (e.g. auto center console): growth
    - interior grained parts and glossy surface parts: development

- **Chemical blowing agents (CBAs - e.g. Reedy Chemical Foam)**
  - Endothermic or exothermic decomposition → gas
  - No up-front capital costs or equipment modification
  - Currently at several stages of product life cycle:
    - non visible parts (e.g. auto HVAC duct, interior headliners): mature
    - visible (e.g. auto bumper: mature; interior console: developmental)
    - glossy parts (achievable with gas counter pressure or induction heating)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
BENEFITS OF COMBINING FOAMING METHODS

PP With Nitrogen gas

Polypropylene with direct gas injection, no additive
Cell Size = 163 micron

Polypropylene with direct gas and Reedy KN additive
Cell Size = 45 micron

SOURCE: REEDY INTERNATIONAL, 2015
SOME INNOVATIONS ARE PRODUCT IMPROVEMENTS

**Verseur wine opener**
Separates foil while pulling cork

**Pivot flexible power strip**
Inspiration: Plugs block adjacent receptacles

**Pawset pet drinking fountain**
- Inspiration: Adaption of drinking fountain for humans
- Thirsty dogs left alone

**Egg yolk separator**
- Squeeze and release bulb

**Stem citrus spritzer**
- Inserted stem becomes push-button spritzer-maker

PHOTO: QUIRKY INC./ NEW YORK TIMES
Scoring or die cutting: facilitates opening toothbrush package, avoids frustration

PACKAGE: COLGATE-PALMOLIVE CO.
PHOTO SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
Graphene and Carbon Nanotube Make Fully Transparent, Rollable Electronics Possible.

Target market: wearable electronics is driving the need for fully transparent circuits on a rollable substrate.

Challenges:
1. The temperature restriction of plastic substrates (less than 100°C) → polyimide + semi-conductor choice.
2. Difficulty of handling flexible electronics during the fabrication process.

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
PVC SUBSTITUTION: INFUSION BAGS/BOTTLES

Application: IV bag
TPE type: H-SBC (SEBS)
Key properties: Elasticity, Low temp, Clarity, PP compatibility, Melt strength
Processing: Co-Extrusion

PHOTO: KRATON

Application: Infusion bottle closure
TPE type: H-SBC (SEBS)
Key properties: Re-sealing, Bond to polyolefins
Processing: 2 component injection

Note: TPV, silicone competition in pharma septum market

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
Ceramic cube:
50 micrometers per side, ultralight-mostly air
Strong, not brittle
Precise control of structure at nanoscale
  - increased energy density of batteries with weight save
  - space at nanoscale to precisely control flow of heat and light
  - others?

SOURCE: MIT Technology Review, vol 118 no.2, Caltech
INNOVATION EXAMPLE: COMBINING MATERIALS TECHNOLOGIES → SYNERGY

HIGH STIFFNESS/LIGHTWEIGHT SHEET

Combination yields:
- high stiffness from graphene-like layers
- lightweight and thickness effect of polyolefin foam
- easily molded

Target applications:
- auto
- building/construction
- electronics

PHOTO: SEKISUI CHEMICAL CO., LTD

GRAPHENE

Scanning probe microscopic image of graphene, an allotropic form of carbon in a 2-dimensional, atomic scale hexagonal lattice. One atom at each vertex.
- 100x stronger than steel
- efficient heat, electrical conductor
- nearly transparent
- used in semiconductor, electronics, battery, composites industries

PHOTO: WIKIPEDIA
• Increased modeling rather than development testing

• 3D prototyping

• Pressure for faster speed to market

• Apparent willingness to do open innovation (to cut costs, reduce timing)

• Better management of the innovation process

• Globalization of markets: broadened quality/performance levels
EXAMPLE DRIVING FORCES IN AUTOMOTIVE INNOVATIONS

• Increased joining via bonding → adhesives growth and functionalization of polyolefins

• Improving acoustics (acoustic barriers, seals for wind noise, buzz/squeak/rattle)

• EMF shielding via conductive fillers, back injection, films

• The usual current drivers:
  - Weight save via
    thin-walling
    metal substitution
    lighter weight plastics
    glass substitution (e.g. with polycarbonate)
    filler substitution (e.g. with natural fibers or lighter fillers)
  
  - Improved esthetics (eliminate “cheap plastics”)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
INTERIOR TPO/PP/TPE COMPOUND TARGET EXAMPLES/COMPETITION

**Seals:** o-TPV, SEBS

**Pillar Trim:** PP, TPO

**Roof Liner Ducts:** FOAM

**IP:** SKINS (TPO, SEBS?, TPU)

**Foam Substrate**

**Ducts:** FOAM

**Door Seals:** o-TPV, SEBS

**Window Encap**

**SEBS, o-TPV**

**PKG Tray/Trunk Liner**

**NFIB/PP**

**Seat Trim (Coated Fabric)**

**Seat Back**

**Acoustic Barrier**

**Medallion:** FOAMS

**Door Trim Panel**

**NFIB/PP**

**Door Hardware Module, GF/PP**

**TPO Skins**

**SEBS, TPO**

**Targets:** ROBERT ELLER ASSOCIATES LLC., 2015
ANALOGIES BROADEN THINKING ➔ INNOVATION

Bicycle ➔ airplane concept
SOME APPROACHES TO PLASTICS INNOVATION

• **Functional analogies:** The bicycle principle ➔ airplane

• **Systems analogies:** Meat cutting plant ➔ Ford’s assembly line

• **Process extensions:** e. g. Blow molded bottles ➔ 3D blow molding of extruded hose

• **Adapting from nature:** Balsa wood, natural cork ➔ foam cork

• **Target over-engineered products:** EPDM replacement by TPVs; SBC challenge to TPV

• **Match offerings to quality/performance tiers (lessons from developing regions):**
  Global, Glocal, Local, Bottom-end

• **Exploit trends and their secondary effects:**
  - Metal replacement ➔ ETPs and TPEs
  - Foam growth ➔ foam TPEs

• **Position contacts with respect to the 3 Cs:** Competitor, collaborator, customer

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015
Look for the opportunity holes: expanded TPE market example

- Globalization
- Supply chain economics
- New entrants
- Opportunity holes
- Commoditization
- Regional economics differences
- Quality/performance tiers

Source: Robert Eller Associates LLC, 2015
EXPANDING GLOBAL TPE OPPORTUNITIES

GLOBALIZATION/REGIONAL MARKET SECTOR SHIFTS
- CHINA (STRONG AUTO GROWTH)
- PATH-TO-MARKET DIFFERENCES
- QUALITY/PERFORMANCE TIER DIFFERENCES

ECONOMICS
- REGIONAL MFG COST DIFFERENCES
- REGIONAL SUPPLY CHAIN DIFFERENCES
- GDP/CAPITA DIFFERENCES
- INVESTMENT FROM ASIA/EUROPE

SUBSTITUTION EFFECTS
- CASCADE EFFECT → LOWER COST TPEs
- BIO-TPEs STARTING
- CHALLENGE TO RUBBER CONTINUES

PROCESS INNOVATIONS
- FOAMING APPROACHES
- MULTI-SHOT MOLDING/CORE BACK
- SLUSH MOLDING
- TEXTILE COATING

BROADER PROPERTY RANGE
- SOFT TOUCH
- IMPROVED ADHESION
- HIGHER TEMP CAPABILITY
- SURFACE QUALITY
- ENTRY OF POEs

NEW APPLICATION DRIVERS
- GROWTH VIA BOTH ORGANIC GROWTH AND SUBSTITUTION
- LUXURY (SOFT TOUCH/SILKY FEEL APPROACHES)
- RIDING ETP SUBSTITUTION’S COATTAILS
- RIGID/FLEXIBLE COMBINATIONS

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2015