Automotive Applications in the Distant Future

Planning Future Scenarios. It's a long journey from polymer granules to automotive parts. It's an even longer one for those whose job it is to envisage where plastics will be used in the cars of the future and which market trends providers of raw materials should follow. This is precisely the task of Bayer Polymers' Creative Center, which has just launched its latest development for the cars of the future, called smart surface technology.

MARTIN REINECKE

We are the think-tank for Bayer Polymers and see ourselves as the first port of call for partners wishing to plan and implement lucrative plastics applications for tomorrow and beyond with us", is how Eckard Foltin describes the role of the Creative Center (CC) under his management. The goal of this interdisciplinary team of chemists, physicists and engineers is to grow the market for Bayer Polymers by devising new, profitable products for a wide variety of sectors. The question is, is it possible to predict, keep abreast of or shape the future? The primary tools employed by the Creative Center are those of networks, systematic analyses of the future in the form of scenario planning, and methods for generating new polymer applications.

Internally, the Creative Center is building up a network to unlock the experience and expertise that Bayer Polymers specialists have acquired in dealing with thermoplastic, rubber, polyurethane and coating raw materials products, markets and sectors. Externally, it is seeking contact with other think-tanks as a means of gaining a varied range of viewpoints on suggestions and assessments concerning market trends and stimuli. CC experts therefore maintain close contact with "futurologists", demographers, designers, scientific institutes, health-care organizations, and ecological and legislative institutions.

Scenario planning (Fig. 1) is a systematic approach to contemplating the future and seeking out new products. It attempts to create plausible visions of the future and to conceive of developments for attaining them. For this, it identifies application areas, collates possible spheres of influence and then establishes relationships between them. Each sphere of influence has one or more factors, called descriptors, that can act on the future development and generate alternative situations. The descriptors ultimately generate a consistency matrix that forms the basis for various scenarios and can serve to derive the products of the future.

The concept is best explained with a scenario developed by the Creative Center for electrical and electronic applications in vehicles in the year 2015. Applications affected are the drive chain, modularisation, passenger compartment, lighting and bodywork electronics. Spheres of influence included telecommunications, traffic infrastructure, alternative drives, macroeconomic and technological advances and social values. Input from the "Alternative drives" sphere of influence, for example, included the descriptors fuel-cell drive, hydrogen engine and hybrid drive.

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Manufacturer

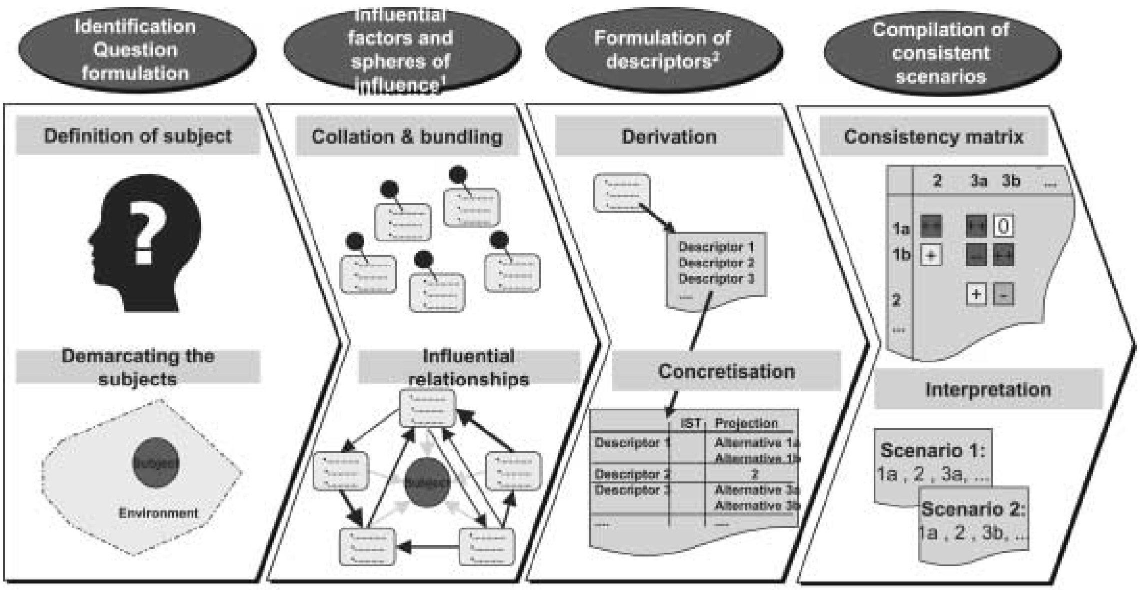
Bayer Polymers
Business Development,
Creative Center
Geb. B211
D-51368 Leverkusen
Germany
www.bayerpolymers.de

Possible applications yielded by the scenario analysis included nonbonded, flexible, flat conductor systems based on polycarbonate film (smart wiring) that is back-injected and processed into fully switched modules. Such film would be a space-saving alternative to the average 1000 m of electrical cables currently employed in each vehicle (luxury models have up to 5000 m). Further potential applications were intelligent plastic surfaces for the vehicle interior that, e.g., modify their haptic properties in response to an electric signal or that emit fragrances.

The next step is to establish the routes and milestones involved in creating a product or technology of the future. This is done with the aid of road maps, which reveal the parallel developments and key technologies that are needed in tandem with the temporal and logical dependency of the developments. "This may seem like a lot of work to generate products, but it makes the goals and related tasks more transparent, creates a schedule for projects, reveals investment and communication needs and acts as a sound basis for decision taking and risk estimation", says Foltin.

Three-dimensional, Luminescent Plastic Parts

The aforementioned electrical/electronics scenario additionally corroborates a result of trend analysis, namely that there is a tendency in vehicle interiors to optimise ambient illumination while simultaneously using light as a functional and design element. Bayer Polymers is supporting this trend with the introduction of its smart surface technology, which was



1) Sphere of influence: Bundling of factors that influence the subject
2) Descriptors: Quantitative and qualitative values of the influential factors

Fig. 1. The various stages of scenario planning

developed in collaboration with Lumitec AG, Switzerland. It combines in-mould decoration with electroluminescence to produce very flat, shaped decorated plastic parts that light up fully and evenly when A.C. voltage of, e. g., 110 V/400 Hz is applied. They consume hardly any energy, emit no heat, require no maintenance and are extremely long-lived. There is no need to use bulbs. The light can be generated optionally as blue, green, orange or white.

The parts are made by taking a transparent polycarbonate film and performing multi-layer screen-printing. The print comprises a transparent polymer electrode which is isolated by a non-conducting layer, called a dielectric, from the counter-electrode beneath (Fig. 2). The light is emitted by special inorganic crystals incorporated into the dielectric layers.

The decorated film is then moulded, punched and back-injected with thermoplastics. "You can't do that with the polyethylene terephthalate (PET) film which has been used up to now for flat, luminescent parts and which is sputtered with indium-tin-oxide (ITO) to act as a transparent electrode", says Roland Künzel, an in-mould decorating specialist in the Business Development section. In a separate operation, the inverter – the only electronic element – is applied to the back of the part (Fig. 3). It is fed with direct current from a battery or from the vehicle's on-board system and generates the requisite alternating current.

Lumitec has filed a patent application for the electroluminescence system with the requisite flexible layer structure and has tailored it to the high-pressure cold-forming technique patented by Bayer Polymers. Additionally, Bayer Polymers devised the basic process for producing the moulded parts (rheological part design, gate design, back-injection parameters, etc). The moulds were also modified for mass production. Lumitec developed the inverters.

The manufacturing process offers huge design scope that enables parts to be adapted to any spatial conditions at the point of installation and to design specifications. Moreover, they can be produced in one operation as fully functional modules, a fact which promotes high levels of automation combined with minimum assembly. "These process strengths ensure that we keep in touch with the trend towards modularisation and automation", enthuses Künzel.

A showpiece part used by the Business Development experts and Lumitec to test the performance of the production methods is a vehicle heating/ventilation system control panel (Fig. 4, title photo). It consists of Makrofol (PC) and Bayfol (PC+PBT) films, a transparent electrode made from the electrically conducting polymer Baytron poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate), Noriphan HTR screen-printing inks from Pröll AG, which are based on the heat-resistant polycarbonate Apec HT, and the PC+ABS blend Bayblend. The inverter on the back side was encapsulated in polyurethane. "As a solution provider, we wanted to provide a one-stop solution from our polymer range, to show our customers that they can call on all our expertise in the areas of materials selection, design, development and processing", explains Winfried Kohl, in charge of developing in-mould decorating in the Injection Moulding business development unit. The following comparison shows how economical the one-step process is: Up until now, at least five different parts were needed for a comparable system control panel, along with the requisite outlay on assembly, logistics and quality assurance. The Development Team is certain that overmoulding of the inverter, which has so far been a separate process, can be integrated into the manufacturing process.

At the moment, the smart surface technology is being demonstrated to major European car makers. The experts from Bayer Polymers have been targeting different applications in passive illumination. For instance, they have thought about the manufacture of entire centre consoles. Other attractive possibilities are metallised, translucent parts, such as decorative strip and rings, handles, handle recesses and logos that look metallic during the day but light up in the dark. Glove

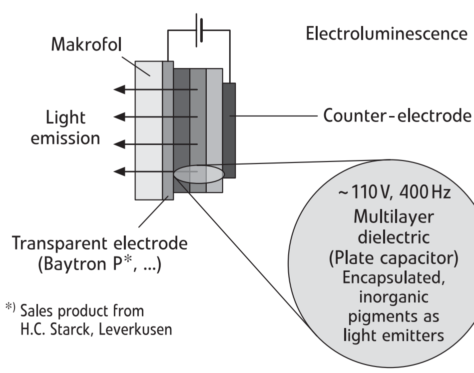


Fig. 2. Structure of a flat, luminescent smart surface technology film

compartments, map holders, parcel shelves and boots could be lit up by such surfaces. Also feasible would be back-lighting of textiles in roof liners, floors and door trim. For greater safety during reversing, a warning film integrated into the rear-view mirror could flash when the tail comes too close to an obstacle.

Even if smart surface technology is now ready for marketing, Foltin believes that it still has a bright future. "We see it as the first feature on a road map for developing flexible, integrated displays based on organic light-emitting diodes (OLEDs)." ■

THE AUTHOR

MARTIN REINECKE is a freelance science journalist and lives in Wuppertal.

Title photo. Smart surface technology in the vehicle interior

Fig. 3. The various stages of making a luminescent heater/ventilation system control panel Folie = Film; durch Siebdruck… = made by screen-printing on the back side: Baytron P, design, electroluminescent layer; HPF-Verformung = HPF shaping; fertiger Insert = finished insert; Vergießen des Inverters nach dem Hinterspritzen = Encapsulating the inverter after back-injection

Fig. 4. The 3 dimensionally shaped and punched film is back-injected with thermoplastic