Plastics and the Challenge of Quality — by Ezio Manzini

The world of materials and the material world

There is no doubt about it: over the past decades the "world of materials" has changed radically.

If we use the expression, "world of materials", to indicate the set of technological potentialities that make it possible to produce the system of artifacts that surrounds us, then it is not excessive to state that what has been achieved over recent years has been a full-fledged revolution. In every field of technology, from electronics to space exploration and consumer goods, there has been an incessant flourishing of solutions that allow us to do more with less, to do things rapidly which once required lengthy processes, to make what was once a complex mechanism in a single integrated piece, to vary and infinitely multiply the shapes and images that can be produced.

All of this certainly originates from the synergy created over recent years by the integration between materials science and information science. The effects of this integration have included a wide-ranging and profound transformation of the way in which materials present themselves for human use.

The transformation has been extensive because it involves not only materials of recent origin (such as advanced composites or the materials of opto-electronics) but also materials that have been around for a longer time (such as wood, ceramics, and marble…). Indeed, in the present atmosphere of intense competition between alternative solutions that has developed over recent years, even vintage materials have had a sort of second childhood, and nowadays all materials are, in one way or another, "new materials".

First and foremost, however, what we are talking about is a profound transformation because the very idea of what materials are has been changing.

If archaic materials were always entities that existed "a priori" with respect to design, this is no longer the case for new materials. They should be considered as tailor-made materials, that is, as operators whose specifications and properties can be custom designed, as a function of a well-defined program of desired performance.

That's not all. If archaic materials were capable of offering a limited range of performances, with the new materials the range of possibilities appears far broader and more sophisticated. New materials become intelligent materials, that is, "operators" capable of offering performances that are far more refined and complex in a "solid state" form (i.e., in terms of the intrinsic properties of their atomic and molecular structures).

This, then, is the new "world of materials": a world of "plastic" materials (i.e., which can take on any form whatever) and "intelligent materials" (i.e., which can offer extremely refined, "solid state" performances). A world of materials that expands the field of what is possible as never before.

At this point, however, we must wonder what relationship there is between the "world of materials" and the "material world," i.e., how the artificial environment is taking form under the effect of this remarkable surge of technical innovation.

In order to answer this question, let us turn our attention away from the glossy paper of the brochures put out by the manufacturers of materials and of trade magazines, and let us look around, at the everyday experiences that result from our interaction with the objects we use and the places where we live.

One thing that we immediately perceive is that this "material world" is not as exciting as our observation of the "world of materials" might have led us to suppose.

The world with which we interact every day is a world awash with banal products, increasingly devoid of profound cultural qualities. A world in which high-tech qualities more and more seem to take the form of an intrusive flood of ephemeral products, which tend toward gadgetry and disposability. And, what is worse, a world crammed with refuse of all sorts.

If we move now from an observation of the “world of materials” as a whole to a specific observation of the larger family of polymeric materials – which we shall call “plastics” from now on – one quickly realizes that what we have pointed out in general terms is also true in particular. Indeed, one may safely say that plastics represent the component of the new “world of materials” in which these characteristics are expressed in the clearest and most emblematic manner.

In this discussion, I will try to establish a relationship between the characteristics and potential of the “world of materials,” especially plastic materials, and the reality of the “material world.”

The idea that will be put forth is that new materials, presenting themselves as a substance endowed with an extraordinary capacity to adapt to a wide variety of requirements, have thus perfectly suited themselves to the conditions of use in which they now find themselves, i.e., to the demands made by a system of production and consumption dominated by the “culture of quantity.”

Today, there are good reasons to believe that it is necessary to shift from the “culture of quantity” to a “culture of quality” with the accent on the theme of environmental quality.

The challenge that awaits plastics is that of demonstrating that their extraordinary potential can suit them to facing the new demands that the “culture of quality” may make (and which are already beginning to be made).

As a contribution to a reflection and a practice that can lead in this direction, the discussion concludes with the proposal of three possible “scenarios of matter,” which are consistent with the new requirements of qualitative development.

The nature of plastics

In its most profound essence, the “creations” of men – i.e., man’s activity of design and manufacturing – have always involved a dialectic process between ideas and matter.

In this process, the role played by ideas has always been considered dynamic and fluid, just as the role played by materials has been seen as static and typified by inertia. It was material, therefore, that limited, with its constraints, the freedom of ideas.

Therefore, traditionally, the “culture of creation” has been based on the concepts of effort and compromise: effort in the work necessary to bend the constraints of material to our aims, compromise as an inevitable necessity of taking into account those constraints in our imagination of the final results.

Thus, over the centuries, this inertia of material has stabilized shapes over time; it has reduced the number of alternatives; in the final analysis it has delayed the introduction of the new and it has worked to refine the possible solutions within the context of the given constraints.

And, on the other hand, it is this inertia of material that led us to dream of a world in which anything was possible, where new shapes – and therefore new performances – could be obtained effortlessly and without compromises. A world in which the ancient dialectic opposition between ideas and matter could be resolved into a monologue of ideas - ideas that produce themselves exactly, the materialization of ideas.

This dream has never come true and never will come true.

However, with the remarkable development that has taken place in the world of materials over recent decades, and in particular with the advent of plastics, we have moved much closer to that dream.

It is often said that it is incorrect to refer to the entire family of polymeric materials with the term “plastics.” It is pointed out, in fact, that this family is too extensive and variegated to be indicated by a single name: if a space-flight component is made of “plastic,” and a container of yoghurt is made of “plastic,” then the term winds up losing its meaning. The breadth of the term is such that there is a risk of it losing its meaning entirely.

It is also true, however, that in this everyday and extensive use of the expression “plastics” there is an intuition of a character that links all these uses, no matter how different they might be and how different the forms in which they appear on various occasions – their effective, shared, extraordinary “plasticity.” That is, their exceptional capacity to take on a variety of different forms and to produce a variety of different performances, thus adapting themselves to a great variety of design intentions.

With the advent of plastics, in brief, matter seems to have lost much of its traditional weight and resistance to transformation, to have become far lighter and more pliable – a “plastic material,” in the narrow sense of the term.

It should be pointed out as we present these characteristics of plastics that this is no more than one aspect of a more extensive phenomenon – over recent years, the entire artificial environment seems to have come closer to the world we dreamed of in which “everything is possible.” The integration between science and technology, with its applications to all fields, and its penetration to all levels of production, has indeed stimulated man’s involvement in the increasingly rapid and profound manipulation of matter. This manipulation has become so profound and rapid that, from our dimensional point of view, i.e., the dimensional scale upon which our sensory system operates, matter seems to have become “fluid,” i.e., suited for the production of all sorts of shapes and performances – matter as a “continuum of possibilities.” Matter has become a “medium” that is available as a support for any possible human intention. By increasing the range of performance and by decreasing the constraints, new materials have emphasised their evident potential in terms of possible performance, with a declining emphasis on the physicality of their presence and the importance of the role that they play.

In reality, if we can define modern society as a “society of information,” it is because there are materials that make it possible (there would be no information processing, no telematics, and no artificial intelligence without silicon crystals).

Likewise, the slogan “less material and more information” which typified the whole approach to recent innovative manufacturing, would not have been practical without the presence of such high-performance materials as to offer more (in terms of performance, and therefore in terms of information) with less (in terms of the quantity of material employed). Lastly, the widespread awareness of a sort of “de-materialization of products” is nothing other than a reflection of the limited “intrusiveness” of new materials in the everyday (and of our consequential loss of awareness of their presence and their role).

In this overall scenario, polymeric materials take on an emblematic value. Indeed, they not only compete with other high-performance materials in the production of the most sophisticated performance that the technical and scientific system makes available (electronic and aerospace technology), but they also pervade the everyday environment, and constitute the most visible and tangible aspect of that environment’s transformation.

The transformability of plastics can in fact be quite useful in the production of an enormous quantity of objects and components endowed with extreme efficiency in terms of performance. With them, it is possible to produce complex shapes, rapidly and cheaply. A structural or mechanical component that would have required complex operations of assembly with traditional materials can, with the technology of polymers, be conceived in a monolithic form (integration of functions), made with less material and in a single manufacturing operation. And it can emerge from the machine finished and ready for use. All of this is compatible with considerable advantage in terms of overall performance and, all things considered, at remarkably cheaper costs.

The formability and cheapness of plastic, with its application to a variety of manufacturing sectors, has profoundly modified not only the physical nature of a great many products (which today appear lighter and more integrated), but also to their positioning in the marketing context and in the imagination of the consumer.

Products that were costly in the past (and therefore relatively rare and difficult to acquire) have become available to one and all and have become banal products. And this – their banalization – occurs not because the performance that they provide has become to any degree less important than before or because that performance is offered in a less effective manner (indeed, for the most part, these products, measured from the point of view of efficiency, show a great increase in terms of functional quality). But this is only because their very low cost and their consequential spread makes their performance "obvious" and "normal".

On the other hand, once their efficient performance has become obvious and is taken for granted, what sets one product apart from another comes to be only its communicative potential. And here too plastics, and the products that can be made from them, represent an emblematic case of a broader phenomenon.

Plastics, by their nature, are entirely consistent with the proposition that objects have become mere media for communication in an information-based society – they are materials that become true media for information. Indeed, the drastic reduction of the technical constraints on their formability makes of them "neutral" physical supports, capable of becoming the signifiers of every possible meaning – screens upon which every possible sort of image can be projected.

The "culture of quantity" and the discovery of environmental limits

As they appear with these characteristics in a social and manufacturing environment that is dominated by the imperatives of quantitative development, the polymeric materials have invaded the system of objects, extending and transforming it, and taking to extreme consequences the values of what we might call the "culture of quantity" – reduction of costs, increase of production, acceleration of the product life cycles, multiplication of shapes.

What thus emerged is a "plastic world" typified by an extraordinary diffusion of products that are economically and functionally advantageous, as well as a world of products that are ephemeral and devoid of cultural substance. A world of products that tend to be gadgets, and disposable.

This "quantitative world," in the last two decades, has been forced to deal with something that was available to one and all, but which no one had yet glimpsed – the fact that the physical environment is not an exhaustible medium for manufacturing and consumption. That we cannot simply input a continually growing quantity of materials and degraded energy into that environment. And, moreover, the fact that the physical environment is not only limited, but also that the "semiotic" environment is limited (i.e., the immaterial environment in which the flow of information circulates). Inputting an excess of messages and images also brings about a form of pollution (which we could define as "semiotic pollution").

Plastics, due to their having been the privileged medium of quantitative development, have obviously been profoundly involved in the problems that this "discovery of the limits" has imposed on our common attention. The remarkable combination of formability and cheapness that typifies these materials, and that led them to become a decisive factor in the multiplication of products, and in the reduction of their life cycles, has implicated them in the issues of energy and material waste within the current system of manufacturing and consumption.

At the same time, the combination of cheapness and chemical/physical stability, which makes them potentially durable products that can be advantageously employed in all applications that require hygienic guarantees, becomes a problem when the products are no longer used, because it helps to produce growing and durable quantities of refuse (the same characteristics that make a material "hygienic" also render it invulnerable to attack by chemical, physical, and biological agents, and therefore, not biodegradable).

Lastly, their capacity to serve as a cheap medium for every sort of image, a quality that led to their important role in the multiplication of shapes and messages channelled through products, also made them guilty of "semiotic pollution" to which we referred earlier.

In brief, what has emerged is that the three fundamental virtues of plastics (cheapness, formability, and chemical/physical stability) have in the end turned into problematic factors.

Indeed, the aspects that tend to characterise polymers, in terms of what they intrinsically signify do not *per se* imply a problem of any sort, either in social terms or in environmental terms. Indeed, we may safely say, and it has been said, that these are considerable virtues. Indeed, they make it possible to achieve a variety of light, functional, hygienic, and durable products.

The problem that has developed around them is therefore not a problem concerning plastics *per se.*

It is a problem concerning the relationship between plastics and the economic and cultural environment in which they have developed – it is the fact that manufacturing with plastics is so cheap that there has been an invasion of plastic products, and that these products could be easily thrown out or replaced with others before they reached the point of physical decay (or that, in line with the functionalist tendency to simplify the distribution of merchandise and facilitate the use of same, these products were planned from the outset for just one use, i.e., they were designed as disposable products).

It is the fact that the "liberalisation" of the shapes and functions that plastic makes possible has led to an uncontrolled multiplication of these products which, in turn, has rapidly led to a saturation and pollution of the semiotic environment.

The definitive outcome is that products made of plastic (especially mass market products) have become the most emblematic expression of industrial manufacturing, both in its more positive aspects (the "democratisation of consumption" through the large scale production of inexpensive – and therefore broadly accessible – merchandise) and in the negative aspects (the banalization and the superficialisation of the relationship with the end user, the waste of energy and materials in the relationship with the environment).

The overall image that we can form is that of an "excess of success" that plastic – though we can say, in more general terms, the new materials – have had within the context of the "culture of quantity." A culture that was formed through the challenge – as we have seen at the outset – of the "inertia of material" (and with the effect of reduction, stabilisation, and refinement of shapes over time which this implied) and which did not succeed in controlling its operation in a situation in which material lost this traditional character, reduced its constraints, and became "fluidified."

In other words, in the encounter with new materials whose way of dealing with transformation is very similar to the "all is possible" that had always been dreamed of, the "culture of quantity" has lost control of its own actions.

Thus, only now that we tangibly recognise the problems that this loss of control has brought about, do we recognise that, at the point at which "all becomes possible," it is not necessarily true that everything should be done. One comes to the realisation that it is necessary to decide in a clear manner what is truly worth doing, and that it is necessary to introduce new values and new criteria of quality that are capable of leading manufacturing and consumption in new directions. In brief, one realizes that the “culture of quantity” must evolve into the “culture of quality.”

The scenarios of environmental quality

Now that we have discovered the physical and semiotic limitations of the environmental system in which we are operating, the “values of quantity” must therefore be replaced with the “values of quality.”

This is the great cultural challenge of the Nineties – the way we design, manufacture, and consume must be rethought in the context of this discovery. We must turn the necessity of facing the limits of the system into an opportunity to propose and produce a world endowed with new qualities. Qualities that are at the same time socially acceptable, culturally acceptable, and suitable for the environment.

In this context, new materials – and the polymeric materials in particular – must accept a new and enormous challenge: to use the “plastic” character and the “intelligence” with which they can be endowed to demonstrate an ability to generate products that are quite different from those that have been created hitherto.

The topic, therefore, is the following one – how can we reconcile the question of the environment with the potential of plastics?

If it is true that new materials – and the polymeric materials in particular – can be designed, with a view to what performances should we design them?

The answer is not simple, and above all, it is not unequivocal.

The discovery of limits is also the discovery of complexity – a discovery of the inescapable complexity of the systems in which we are forced to operate, as well as of the necessary complexity (which means articulation) of the answers to the problems that arise in the course of events.

Plastics – as already stated – have been more than capable of answering the questions formulated by the “culture of quantity” – offering performances in the cheapest manner in terms of corporate economics and for individual advantage.

Today, what the “culture of quality” requires of materials is to continue to respond to the demand for performances regarding their use, whilst also offering a new ability – that of providing these performances while affecting as little as possible the equilibrium of the ecosystem.

In order to move toward this result, we can imagine three paths that are based on complementary approaches (the principle of the articulation of the responses in fact leads one to flee from “monological” solutions).

They can be defined in relation to these three different scenarios:

1. The scenario of “minimum matter” (minimisation of the physicality of a product or its replacement with a service),

2. The scenario of “eternal matter” (production of objects that last for extremely long times),

3. The scenario of “matter as medium” (production of objects that last for a brief period, but within the context of a system that ensures maximum recyclability, and therefore, durability of the materials with which the various shapes are produced).

It appears immediately evident that research into the field of materials can play an important role in the actuation of each of these three scenarios (even if, as we shall soon see, the intrinsic potential of materials are already quite close to the objectives proposed than is the design, manufacturing, and consumer culture which is expected to make use of them).

In the “minimal matter” scenario reduction of the physicality of the products, or their replacement with services, is closely linked to the availability of high-performance materials that make it possible to produce this new generation of “dematerialized” products and services. This is the theme of the replacement of material with the information that we discussed at the outset. A design and manufacturing theme that works on a great many different levels – from the replacement of physical products with informative products (from physical phone books to telematic services), to the replacement of the physical transfer of things and people with the transfer of information (from letters and business trips to telefaxes and videoconferences), to the reduction of the consumption of material and energy made possible by a greater control over processes (both for the major industrial processes and for the “small processes” of the home, such as washing cycles in washing machines), all the way to – taking the term de-materialization in a more extensive sense – the reduction of all masses in movement, with a consequential reduction of energy required (from trains and automobiles all the way to moving parts in machinery).

In terms of materials, all of this culminates in the replacement of low-performance materials with extremely high-performance materials. In this scenario, therefore, the materials of electronics, properly speaking, can be utilised, as well as – in a broader sense – all of those materials that help to lighten products, to reduce the amount of energy required to run or move them.