Precaution or arbitrariness?

Plasticizers in political crossfire

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The EU ban on plasticizers in toys

Despite the enormous health benefits brought by the use of DDT, which provided an extremely effective insecticide and was instrumental in the fight against malaria, a total ban was imposed on its use in 1972 on the basis of unsubstantiated health and environmental threats. International bans have since been introduced on other substances and, once in place, they are virtually impossible to reverse.

Similarly, unfounded suspicions and accusations led the EU to impose a total ban on the use in children's toys of three plasticizers employed in the manufacture of PVC (DEHP, DBP and BBP). It also has prohibited the use of three additional plasticizers (DIDP, DNOP and DINP) in babies' toys intended to be put in the mouth. This is not the EU's first attempt to impose a substance ban motivated primarily by politics – as opposed to a decision made on sound scientific principles. Yet this case forms a precedent which would serve to create lasting, fundamental, and possibly irreversible flaws in EU policies on technology and the environment.

Only one of the substances, DINP, is currently in general use in children's toys. This material has been subjected to a thorough risk assessment in the EU and again in the US, and has been found to be quite safe. Industry has spent over 130 million Euros in total to assess the health and environmental risks of plasticizers such as DEHP. A core reason for these tests was these plasticizers' widespread use in medical equipment. All have now been in such longstanding use that if there had been any

harmful side effects from their application these would have long since come to the fore. The EU now forces manufacturers of pacifiers, plastic ducks and baby equipment to switch to alternative plasticizers, which have not been investigated as thoroughly, have often not been tested for these applications and are often considerably more expensive.

Adipates are one possible substitute. Their possible impact on human health and the environment to appear to be slight, but so far they have not been subjected to such exhaustive examinations as have the six banned substances. Other alternatives, although extant for some time, have a high migration tendency, and are clearly much less suitable for these applications.

Citrate esters, touted by environmental groups as more environmentally and health-friendly, migrate from treated materials so quickly that these objects easily become brittle. Toys manufactured using citrate esters as plasticizers will therefore put children at risk of swallowing broken-off fragments. Are we therefore justified in substituting a (theoretical) health risk with the much more concrete risk of a child choking?

Greenpeace activists, on whose arguments the EU's actions were based, don't appear to be losing any sleep over such questions. In fact, they are demanding that toy manufacturers abandon the use of PVC altogether. According to them, soft PVCs in toys should be replaced with rubber. However, the effect of heat during the vulcanization process of rubber results in carcinogenic nitrosamines, and the substitution of organic for petroleum-based rubber will simply substitute a new, 'natural', set of carcinogens.

This raises the question of who decides which materials may be used: Greenpeace? The EU Commission? Science? Nature? And just who is 'Nature'? Aren't humans also part of nature, including the average consumer who weighs up product choices and then consciously chooses PVC? Wouldn't it be better to choose the winner out of several competing market-based solutions?

As I see it, the debate over the advantages and risks of plasticizers boils down to one question: "Can safe and sustainable solutions be developed through the interaction between inventors and the needs and wishes of consumers?"

Mankind has been using plasticizers since the Stone Age, when plant oils were worked into stiff animal pelts to make soft leather. With the advent of different types of soft PVC in the twentieth century, researchers found that PVC performed better when combined with phthalates than with other materials on the market. Plasticizers are used to achieve desired qualities such as flexibility, flame retardation or low-temperature resistance.

In hindsight, it is clear that modern industry would not have been able to develop without both the development of synthetic plastics, and, secondly, inexpensive plasticizers that improve the processing ability and durability of natural materials. However, this development required a long and somewhat painful process of trial and error. And, had this been hampered by bureaucratic 'precautionary measures', it simply would not have taken place.

PVC began to lose its innocence in 1961 as experiments carried out on rats in the US showed clear indications of the highly carcinogenic potential of the vinyl chloride monomer (VCM), used to manufacture PVC. Even in low concentrations, VCM provoked a rare form of liver cancer. In the early 1970s, numerous workers exposed to VCM developed various conditions including liver cancer. Strict measures and exposure limits were immediately introduced. However, an undercurrent of fear took hold in the public's mind that PVC products could leech out insidious poisons. And this same fear has most probably since attached itself to plasticizers as well.

In subsequent decades, this undercurrent grew. In the American biologist Barry Commoner's book *The Closing Circle – Nature, Man, and Technology* (1971), PVC plasticizers play a similar villainous role to the (unfounded) accusations weighed against the insecticide DDT in Rachel Carson's *Silent Spring* (1962). Pressure from environmentalists came to a head following the escape of the 'super-poison' dioxin into the environment at the chemical plant at Seveso, Northern Italy in July 1976.

The accusation of being carcinogenic has been levelled in general against plasticizers used in PVC, and particularly against DEHP. In the early 1980s, DEHP was classified as 'potentially carcinogenic' by the International Agency for Research on Cancer (IARC) on the basis of experiments on rodents which showed a tendency to develop liver tumours following exposure to high doses. It was later proven that humans and higher mammals are not at risk because they metabolize DEHP differently. The IARC has since reclassified DEHP as "not classifiable as to its carcinogenicity to humans."

The German Parliament created a special Enquete Commission to investigate the influence of chemicals on humans and the environment. The Commission also covered chlorine and PVC. The findings from the first phase were published in 1994 (pages 362–364):

> …following years of intensive debate, PVC is today far and above the most researched materials in respect of its environmental impact. (…) the commission cannot recommend the substitution of other materials for PVC without sound economic or ecological reasons to support this. Any such substitution would carry the risk of creating new problems – and would possibly lead to a worsening of the overall situation vis-à-vis the present.

How risk assessment became a political issue

In 1993, the EU issued the 793/93/EEC Directive analyzing the risks associated with around 100,000 'old' chemicals – substances registered prior to September 1981 in line with the (then) EEC's Dangerous Substances Directive (67/548/EEC). In 793/93/EEC, Article 15 now called for the testing of substances arousing particular suspicion. Later that year, they also published a priority list of 134 substances. This list included phthalates used as plasticizers for PVC. Four further PVC plasticizers appeared in the two subsequent priority lists. If decades of suspicion had not already fallen on these substances, then nobody would have been able to fathom just how phthalates found their way onto this list. It would suggest that their inclusion owed less to scientific scrutiny than it did to political pressures.

Given that environmental groups and political parties were already on the warpath; firms, industry associations and scientists targeted in this attack had no other choice but to play ball. They were confident, though, that the toxicological and ecological risk assessments would bear out their own conclusions. However, well before the risk assessment had been completed, the debate on these materials was forced by pressure from media campaigns and the protestations of environmental groups.

The health and environmental risks for **Di-butyl-phthalate (DBP)** were tested by the EU in 1994. DBP is only used in small quantities as a plasticizer in PVC. The toxicologists found that DBP posed no health risk to consumers, even when it was smeared directly on the skin. In test-tube experiments (though not in animal experimentation) DBP showed a weak oestrogen-producing effect ('feminizing') and was therefore characterized as "possibly affecting fertility" and given a Category Two ("harmful to fertility") rating. In addition, DBP was found to cause potential harm to vegetation.

In 1995, the EU tested **Di(2-ethylhexyl)phthalate (DEHP)** which had previously been the standard plasticizer for PVC, which had appeared in the second list of high-risk chemicals (noted above). This risk assessment has only recently been completed and has proven a tug of war between the various stakeholders. During this assessment process, a group of doctors specializing in occupational and community medicine published new research findings which suggested a completely new assessment of the legacy of DEHP in the broader population. The German Federal Institute for Risk Assessment's (BfR) and the CSTEE's (European Commission Scientific Committee on Toxicity, Ecotoxicity and the Environment) conclusions from this study, needed to be revised on the back of studies conducted in Erlangen on volunteers, even before the CSTEE's published its findings.

CSTEE's final Risk Assessment Report does not exclude the possibility that DEHP absorption could have a potential impact on occupational health. Both adults and children could theoretically suffer health damage as a result of the use of DEHP in

medical apparatus. Toddlers are put at risk through sucking toys containing DEHP. On these grounds, the report supports the EU's pronounced ban on materials and calls for strict workplace protection measures. And on the back of experiments on rats, DEHP joined DBP in being designated as "impairing fertility" and was also given a Category Two rating, and has been totally banned from use in toys.

In 1995, it was the turn of **Diisononyl phthalate (DINP)** and **Diisodecyl phthalate (DIDP)** to be assessed. Both were increasingly important standard plasticizers for PVC also placed on the EU's second priority list. However, the risk assessment of these materials was much less controversial than that of DEHP, and the political conclusions drawn from this study seem all the more baffling as a result. The EU toxicologists have not found the slightest exposure risk for these substances – not even in their use in babies' toys. In the case of DIDP, they only found a theoretical risk for its universal use in children's toys. This conclusion was confirmed in April 2006 by the EU Commission in the EU's Official Journal. The EU has nevertheless imposed a ban on the use of both plasticizers in children's toys.

In 1997, **Butylbenzyl phthalate (BBP)** was assessed. This plasticizer is used in tubes, cables, artificial leather and food packaging. On the results of animal experiments, it was given a Category Two "harmful to fertility" rating. The obligatory fish test used in assessing environmental risks had to be abandoned as BBP proved to biologically degrade much more rapidly in the environment than other phthalates discussed. That these plasticizers find their way into the food chain is a myth. The opposite is the case: the concentration of these phthalates declines as organisms higher in the food pyramid break these substances down in their digestive systems and excrete them.

In order to understand the dichotomy between the scientific risk assessments and their political evaluation we have to look back once again to the 1990s. In November 1997, well before the EU completed its risk assessments, Greenpeace published the following warning:

> Greenpeace has carried out random tests on 23 toys manufactured by Mattel, Fisher Price, Tyco and Safety First. In 12 of these toys, the amount of plasticizers given off exceeds the recommended limit of 3mg per cm^2 surface area as set by the Federal Institute for Consumer Health Protection and Veterinary Medicine (BgVV).

The Working Group on PVC and the Environment (AgPU), in conjunction with Mattel, and three recognized independent analysis institutes, set out to refute Greenpeace's findings. It quickly became clear that Greenpeace had not been able to measure any phthalate emissions but instead has measured the total amount of volatile organic compounds (TVOC). Greenpeace was tacitly going on the assumption that the amount of TVOC was equivalent to the phthalate emissions. It

was however known that TVOC normally stems from solvent emissions. But the laboratory contracted by Greenpeace had not even set this according to the then valid measurement standards.

All three of the laboratories commissioned by AgPU and Mattel established that the amount, if any, of DEHP and DINP emissions from children's toys was too small to be measured. It was also evident that the EU had no generally accepted method to simulate the sucking out of phthalates from babies' toys. However, the offer by the PVC and toy industries to develop a joint verification process was met with the following reply by Greenpeace spokesperson Judit Kamthak:

> in your communication of 28 January 1998 you suggest a joint verification process. In our opinion this is not necessary and would take the discussion backwards. In addition, we do not believe that this path would corroborate Greenpeace's migration findings.

Not just the toy industry but also a significant section of the press shook their heads at this.

Greenpeace continued its reply with a big campaign, timed to interfere with the pre-Christmas sales period, using the slogan "no environmental poisons in our babies' mouths". Parental concern for their children's wellbeing turned broader segments of the population against PVC and its additives. To this end, activists for the fundraising organization even dug up the IARC's carcinogenic suspicions regarding phthalates made in 1982 – although these had long since been refuted.

Unfortunately, they managed to impress the health authorities of a number of EU member states and parts of the EU Commission. The *Bundesanstalt für gesundheitlichen Verbraucherschutz und Veterinärmedizin* (BgVV), predecessor of the German Federal Institute for Risk Assessment, warned in December 1997 against babies' toys containing plasticizers, without concrete evidence of these exceeding the designated exposure limits. Scandinavian countries and Austria demanded an immediate ban on phthalates. In Germany, many major department stores removed toys made from soft PVC from their shelves. The following year, much of Europe introduced national bans on soft PVC in babies' toys.

The EU Council for Consumer Protection ordered the CSTEE to establish scientifically-based limits for the Tolerable Daily Intake (TDI) for phthalates for both adults and children. The CSTEE established the NOAEL (No Observable Adverse Effect Level) for the six most often used phthalates and determined their TDI, for which they set the baseline for the safety margin at 100. For DINP, the plasticizer most often used in PVC toys, CSTEE set the TDI at 0.15 milligrams a day per kilogram of body weight. Toxicologists in the Netherlands attempted to estimate if this level could be reached by toddlers weighing 8 kg chewing and sucking on a ten

cubic centimetre piece of soft PVC for three hours a day. This proved difficult; as discussed there was no EU-wide established methodology to measure plasticizer migration. The permitted safety margin between the NOAEL and the TDI was only 75 for DINP and not 100. For DEHP, which is not permitted for use in toys, it only reached 19. In April 1998, the CSTEE could not exclude the possibility that the TDI could be significantly exceeded given unfavourable circumstances (particularly active toddlers who get poor quality PVC between their teeth).

CSTEE took the view that this did not pose a serious threat. Following a proposal from the Health Ministry of the Netherlands, the committee supported tackling the issue of the compromised safety margin through introducing limits on plasticizer migration for various types of PVC. The EU States' universally-accepted Risk Assessment Report set the safety margin at 220 and did not believe any threat was posed.

The European Parliament and the relevant EU Directorate General took quite a different view and chose to adopt the Precautionary Principle. In April 1999, the EU amended the EU Directive 76/769/EEC to include a ban on phthalates in toys for children under the age of three. The EU Committee for Product Safety decided, after fierce debate, in December 1999 (right in the midst of the pre-Christmas sales) to adopt Greenpeace's arguments. The Committee recommended that the EU Commission impose an immediate ban, in the form of an Emergency Decree, on all toddlers' toys containing phthalates. In line with this, the DINP, DEHP, DBP, DIDP, DNOP or BBP content has been limited to 0.1% of their weight in toys which are designed for toddlers up to the age of 36 months.

These emergency measures were limited to three months and were supposed to bridge the gap prior to appropriate amendments to the EU Directive 76/769/EEC being brought in. That there was no scientific basis for this action did not stop this Emergency Decree being renewed every three months right up to Summer 2004, a total of nineteen times. In the meantime, the EU's Joint Research Centre (JRC) carried out a risk assessment. This established no discernible risks for either DINP or DIDP that would warrant any restrictions on their use – not even in toddlers' toys. Only DBP came out of the study badly. But this substance is not used in toys.

In 2003, the JRC's Institute for Health and Consumer Protection wrote:

> The end products containing DINP (clothes, building materials, toys and baby equipment) and the sources of exposure (car and public transport interiors, food and food packaging) are unlikely to pose a risk for consumers (adults, infants and newborns) following inhalation, skin contact and ingestion.

In September 2004, the EU Council on Competition decided to go along with the Dutch proposal to ban DINP, DIDP and DNOP from all toys and objects that children under three years could put in their mouths; and to impose a total ban on the use of DEHP, DBP and BBP in toys. This was a big step up from the Commission's original decision which was only aimed at toys such as babies' soothers or pacifiers which are intended to be put in the mouth. Through this action, the EU Council on Competition had put one over on the European Parliament. On 6 July 2005, the proposal had the second reading in the European Parliament (five years after the first reading!). MEPs voted with an overwhelming majority in favour of the commission's tighter proposals. If the EU Council does not stop the procedure, the new Directive will come into force in autumn 2006. Since the EU Commission itself has in the meantime, in a communication published on 11 April 2006, confirmed the conclusions that the JRC drew in 2003, it seems difficult to explain to the public why a substance classified as safe can nevertheless be mandatory excluded from certain applications.

The European Council for Plasticizers and Intermediates (ECPI) sees the decision to also include the extensively researched plasticizer DINP in the ban, a dangerous parallel in REACh (Registration, Evaluation and Authorization of Chemicals). The risk assessment for DINP, which cost the industry more than 10 million Euros, was simply ignored. 'Intrinsic' characteristics of these materials served as the deciding factor and assumptions were extrapolated from this, but real appraisals were not conducted. Through this, the EU Commission, either deliberately or otherwise, encouraged the blanket demonisation of an entire group of substances. And, in doing so, it encouraged those who believe that they can improve the world through outlawing all materials and production methods that do not fit in with their narrow and ultimately religious-based concept of nature.

If they don't stop it, they'll go blind…

As was to be expected, this ban on phthalates escalated into calls for further bans. TV and mass circulation magazines brought out sensationalist reports on the supposed health dangers of plasticizers.

In 2001, *Stern* magazine carried a cover story on blow up dolls and other sex toys made from soft PVC. Author Gerd Schuster put forward that those men who used these phthalate-containing products to achieve sexual satisfaction were putting their potency at risk.

The Frankfurt based *Öko-Test Magazin* really took the prize for running scare stories on plasticizers. Almost every month, the magazine's editors discovered suspect phthalates in everyday objects and ran a consumer scandal story on these, often taken up by other media. In July 2002, the summer-themed headline "throwing the

baby out with the bath water" threw the spotlight on children's paddling pools. Of course, the laboratories which undertook this analysis found high concentrations of phthalates in all the brands they examined, and in some they also found organotin compounds. According to the editors, that should have been enough to put the children and their parents off playing in paddling pools.

The Vienna-based cancer researcher Professor Wilfried Bursch examined the published findings of the *Öko-Test* under the worst case scenario of young children drinking the paddling pool water or sucking and chewing on the sides of the paddling pool to see if these posed a serious health risk to children. Bursch came to the conclusion that reaching the current TDI limits would be highly unlikely. He reproached the *Öko-Test* editors with having contented themselves with the very presence of suspect substances and to not have actually considered if the amounts found actually posed a health risk. The industrial study group AgPU and the VKE German Plastics Manufacturers Association calculated that a 1 year old child weighing 10kg would have to drink at least 167 litres of pool water per day for an entire lifetime to approach the TDI level for DEHP.

In January 2003, the Federal Institute for Risk Assessment (BfR) officially confirmed this estimate. "The BfR has found that the levels of phthalates, butyltins, tributyltins and other organotin compounds contained in plastic found by *Öko-Test* through the normal use of paddling pools represent no health threat to small children."

In August 2002, *Öko-Test* played the same game with inflatable arm bands and also plastic beach sandals ('flip-flops'). Once again, the magazine contented itself with the presence of the substances demonized by Greenpeace, and did not attempt to ascertain at the outset whether these substances could be taken up into the human body in amounts which would give rise to concern – despite the fact that a calculation model for the take up of DEHP into the human body through skin contact had already been established in the US in 1984. Dr. Sabine Lindner of AgPU performed calculations using the American model as a basis and employing the figures published by *Öko-Test* in 2002. Her conclusion: "A person would need to walk around in flip flops for 15,000 hours a day in order to absorb the lifetime TDI through their skin."

A scientific study on 20 adolescents led by Khodayar Rais-Bahrami appeared in *Environmental Health Perspectives*. These adolescents had been born prematurely and had been placed on respirators and fed artificially through soft PVC tubes and thus had come into contact with high doses of DEHP. This study came to the following conclusion:

> Our results imply that adolescents who have been exposed to considerable amounts of DEHP as premature babies show no discernible influences on their growth rate and sexual maturity as a result of this

> exposure. (…) Their male and female sexual functions showed no deviation from the norm.

A study by the University of Rochester, also published in *Environmental Health Perspectives* (May 2005), claimed that there was a clear link between the concentration of plasticizer-metabolites in the urine of 85 pregnant women one (possible) predictor of later male infertility noted in their male offspring. However, these metabolites did not include those for DEHP, and the Statistical Assessment Service (STATS) at George Mason University in Washington DC found serious flaws in the research methodology and the statistical analysis of University of Rochester's findings.

Disempowering the consumer

The refusal to recognize that almost nothing in this world is gained for free has taken widespread hold of the EU powers-that-be in their interpretation of the Precautionary Principle. They have interpreted the Precautionary Principle similarly to the universally adopted "Rio Declaration" made at the end of the UN Conference on Environment and Development in 1992. This is the source of oft quoted "Where there are threats of serious and irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

This is surely going too far. Even the old proverb "an ounce of prevention is worth a pound of cure" implies curbs on preventive measures: the seventeenth ounce of prevention will be a wasted effort. This prevention-cure calculation becomes even more difficult when, as is often the case in science, the costs of the cure are far from certain. Taken to extremes, Rio's Precautionary Principle would condemn us to inertia in order to avoid all risks. Indeed, shortly before the Rio Summit numerous Nobel Prize winners warned in the 'Heidelberg Appeal' against a surge in irrationalism.

Above all, environmental and other groups wanted the application of the Precautionary Principle to not only be limited to cases where full scientific certainty regarding environmental threats had not been established, but to have the Principle used in a way that would reverse the burden of proof. The 1992 UN report did not establish just how serious a threat needs to be in order to justify draconian measures. Suspicion alone counted in principle as sufficient reason to justify costly precautionary measures or production bans. Using that logic, chocolate would need to be banned – any competent chemist could combine chocolate with everyday ingredients to manufacture dangerous explosives.

As a reaction to this illogic, the EU Commission issued a paper in 2000 indicating that the Precautionary Principle should not be involved in risk assessment, but

rather should play a part in the decision-making processes for risk management. The Principle should not be subverted either through vague suspicions, or through capricious misrepresentations with protectionist ulterior motives.

But the Commission could not establish in which cases the Precautionary Principle should be applied and in which it should not. The Commission's papers said simply:

> An assessment of the potential consequences of inaction and of the uncertainties of the scientific evaluation should be considered by decision-makers when determining whether to trigger action based on the Precautionary Principle.

Taken to extremes, the Precautionary Principle contradicts the age old insight that all human behavioural choices imply an element of risk and incur costs. Therefore the good needs to be weighed up against the bad. If an individual, a company, or the state decides against particular actions on the grounds of caution, or chooses to prohibit such actions, that does not mean that in doing so they are reducing the risks and the costs. Taking any particular risk out of an equation necessarily means accepting another one; someone who decides to stay home for fear of having an accident on the way to work has decided to accept the risk losing his job. A person who tries to avoid all risk will wrap themselves in a cocoon, and miss out on life altogether.

The lesser evil is most often evident only in hindsight. Whether or not someone agrees with (or likes), the idea, the fact remains that the discovery process is affected by market forces – i.e. we need to include market forces in our approach, even if we find the idea abhorrent. This does not, however, mean that we must, or indeed should, remove the Golden Rule from our decision making processes.

Risk assessments cannot be divorced from prevailing cultural, socio- economic and political contexts: your attitude to risk will depend on whether you are a man or a woman, young or old, living in poverty or extremely wealthy, an individualist or a collectivist. However, even with these caveats, the weighing up of good and bad consequences leads to an assessment according to clear criteria. By comparison, the strategy of minimizing evils is not based on rational thinking.

Should the EU Commission's decision regarding the ban on the use of plasticizers in babies' toys, which largely disregards both scientific fact and reason, become the accepted principle behind new legislation, then the EU would undoubtedly shift further towards the behaviour of an authoritarian state – where scientific research and findings are overruled by political pressure.

Fortunately, the Treaty of Maastricht already requires that all EU Directives are subjected to a comprehensible cost/benefit analysis to establish whether they are

commensurate with the underlying legal principles. This was reinforced in February 2000, when, in order to avoid market intrusions prompted by arbitrary suspicions and the bad-mouthing of products and materials, the European Commission stated that employing the Precautionary Principle would always require a sound scientific risk assessment.

In 2001, the EU published a White Paper which set out the blueprint for a new Chemicals Policy. Among other things, the White Paper decided to call a halt to the separate treatment for Old and New substances. The Paper also examined their unprecedented regulations project REACh (Registration, Evaluation and Authorization of Chemicals), which applies to millions of substance applications and tried to determine, on a cost/benefit basis, whether REACh was actually justified.
The EU Commission ordered a study by the London-based consultancy Risk and Policy Analysts, which predicted that REACh would cost between 1.7 and 7 billion Euros in the first eleven years of its introduction, but that the EU stood to gain a possible cost saving (following the expected fall in occupation-related cancers) of up to 54 billion Euros over the next 30 years. However, these figures appear to be plucked from thin air, as around 80% of all occupation-related cancers in the EU stem from the asbestos legacy. This example shows the importance to effective risk management of input from occupational health specialists and other experts.

The position of the Green lobby appears to be that political application of the Precautionary Principle and the aims of sustainable development are core drivers for new innovations. But how do they know which materials are inherently safe and which have a lasting impact on the environment … when even water can be deadly under certain circumstances? Do the Greens and their political friends consider themselves better able to judge what will prove itself on the open market than market participants themselves? The Greens seem perfectly happy with the authoritarian undercurrents inherent in their position.

Unfortunately, some people cling to the erroneous belief that the expansion of knowledge implies that there is an end – a point where society has attained 'ultimate knowledge'. This is not the case. The accumulation of knowledge can even lead to total confusion.

However important science may be as a reconnaissance and early warning system for society, the most important source of information in a market economy is not science but the market itself. This information is not transferred without cost, but rather set against the cost of the risks undertaken. Both PVC and tested plasticizers have not proven themselves to be harmful, while their attractive cost / price ratio means they have won in a fiercely competitive market. Millions of consumers who, on the basis of sound human reason freely weigh up costs and benefits, could scarcely be wrong. Clearly, putting pressure on the market by pushing forward

alternative materials on the back of product bans or market subsidies constitutes a clear case of consumer disempowerment.

The average consumer from the silent majority does not need such incentives or help with decision-making in an open marketplace. This is demonstrated by the fact that in open competition PVC has easily won through on a number of sustainability criteria such as durability, energy and resources efficiency according to 21 key indicators of the German National Environmental Sustainability Plan set out in 2002. (This is far from my endorsement of this plan; as this cannot be sustainable as long as it fails to include, except for liberalization of international trade barriers, any further moves towards the development of economic freedom.)

Future perspectives

When discussing innovations through the filter of sustainable development, we need to ask if there are any sound reasons *not* to use proven products. As we have already indicated, innovation cannot be a goal in and of itself. In evolution in the natural world, attributes that have proven useful are not abandoned unless dictated by need; there are many cases of survival features that have remained unaltered over millions of years existing alongside far more recent developments. This is true not least of the genetic code which has been maintained virtually unchanged over the course of evolution from the simplest micro-organisms right up to the most highly developed land plants and mammals.

Today there are many interesting alternatives to phthalate plasticizers such as adipines and alkyl sulfonic acid. These materials are already often mixed with phthalates used in various products, as they improve specific qualities such as flame retardation, or flexibility at cold temperatures. But these substances do not necessarily present fewer problems than phthalates. A few of these such as chlorinated paraffins are even poisonous or carcinogenic. For example, DEHA, used in food packaging and regarded as harmless, has been replaced by some adipates which demonstrate a higher degree of volatility and migration. Similarly, citric acid esters and their derivatives have been increasingly used in toys and food packaging, despite the disadvantages of their higher price and lower microbial resistance.

The plastics industry currently has great hopes for **Di-isononyl-cyclohexan-1.2-dicarboxylat (DINCH)** a substance developed through computer modelling by BASF in co-operation with customers from other industries. This substance is somewhat more expensive than DEHP, and it can also be almost seamlessly substituted for DEHP without the need to rebuild production plants. DINCH also does not include any of the aromatic hydrocarbons defined as suspect by toxicologists so we can expect it to have a much more benign toxicological profile. BASF has confirmed this in a far reaching programme of tests. These tests indicate

that DINCH does not affect the development of sexual organs or fertility, nor does it harm the environment. DINCH has a rate of migration which is 8 times lower than that of DEHP, although it has disadvantages such as higher volatility.

The quest for innovation or substitution in the case of these alternative plasticizers cannot be pursued without consideration of the costs, as we would end up substituting the proven with the unproven through ideologically driven wishful thinking. Society needs to pursue fulfilment of consumer demands in a way that balances benefits against the costs to the economy, the environment, and to health.

Our proven sound basis for rational decision-making would clearly be lost if materials or indeed entire product lines and production methods were to be condemned lock, stock and barrel without a rational cost / benefit analysis.

The history of technology shows us that we can seldom regard any solution to a problem as permanent; legs were complemented by horses, then wheels, then rail. It goes without saying that "good will be superseded by better" in the case of plasticizers. Already it has been demonstrated that in the near future the manufacture of not only hard PVCs but a very broad range of soft PVCs will be possible without the use of special plasticizers.

The American research company Teknor Apex has succeeded in manufacturing polyolefin elastomers. These compounds can be used to make highly elastic and soft PVC manufactured parts without the addition of plasticizers, but are 80% more expensive. Their use will initially be limited medical or specialized technical applications, where the use of plasticizers is a disadvantage and cost is not the deciding factor. Should it become possible to manufacture these compounds more cheaply, then they could take over in a number of markets. However, there is no reason for the artificial acceleration of their market introduction as long as they prove themselves sufficiently against market competition. In short: Current standard plasticizers will probably be replaced one day. What is important is that they are replaced by something really better and not by something declared political correct before being tested by the competition between different solutions on the market.

Conventional plasticizers could also see possible competition from nanotechnology. Nanotechnology has already proved itself in number of cases as a cost-effective physics-based replacement to existing chemical solutions. It is not inconceivable that nanotechnology could soon provide original proposals to solve the problem of plasticizers that we could scarcely dream of today. The name "nanotechnology" also highlights the fact that new solutions to problems could also carry new risks, as nanotechnology is already primarily regarded in the media as "the technology of risk". No such intelligent technology would free humans from the torment of choice – the weighing up of relative evils.

Biography

Edgar Gärtner was born in 1949 in Magdlos near Fulda, Germany. After completing an apprenticeship in electrical engineering, he studied hydrobiology and political science in Frankfurt am Main and Marseilles. After graduation, he worked a researcher and lecturer at the University of Münster in Westphalia and also taught at a high school in Kassel. In the 1980s, he was a regular contributor to the Paris-based scientific magazine *Science & Vie*. In 1989, he co-founded a specialist information service based in Frankfurt focused on the economic impact of environmental issues and served as its Managing Editor from1989 to 1992. Between 1993 and 1996, he was the Editor-in-chief of a conservation magazine. In 2005, he was appointed as head of the Environment Forum for The Centre for the New Europe (CNE), a classical liberal think tank based in Brussels. He has worked as a specialist freelance editor and advisor to the chemical industry since 1993.

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