Innovative AURO Natural Paints: Optimised for health, the environment and technical performance

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1 Current status of the environmental discussion in Germany and Europe

1.1 The environment movement and government responsibility

Since the start of the '70s, Europe has developed a new awareness for the significance of an intact environment for the health of its people, but also for sustainable development of the economy, science, culture and social relationships. Between the '50s and the early '70s, the increasing contamination of the ground, water and air by numerous anthropogenic pollutants had reached such an extent that the pending environmental and health problems for a growing part of the population had become dramatically obvious, even without highly sensitive analysis instruments.

One of the direct consequences of this increasing awareness was the emergence of an active environment movement which became increasingly involved in the public and political discussion of the effects of increasing chemicalisation, growing exhaustion of ground areas, intensive agriculture and drastic increases in traffic volumes, on the availability of resources, the health of all living organisms and on the ability of the environmental media – ground, water and air – to tolerate this load.

In Germany in particular, this environmental movement quickly found basic approval and support in large sections of the population. It became organised in the form of many institutions, from nature and environment protection associations through to political parties who wrote the protection of nature and the environment on their banners and rapidly became a significant parliamentary force. In the meantime, this movement and the political party behind it has also assumed governmental responsibility in Germany.

The growing significance meanwhile given to aspects of environmental and health protection for governmental activity in Germany is clearly illustrated by the fact that the Green Party has assumed responsibility for two key ministries in this field – the Ministry for the Environment and the Ministry for Consumer Protection. And the fact that the Vice Chancellor and German Foreign Minister is also a member of the Green Party indicates just how broad the general social responsibility assumed by these political forces has become. But it is also unmistakably clear that a large number of members of parliament in the larger governmental party the SPD also attach great importance to environmental matters.

1.2 Growing interest in ecological products prompted by environmental and agricultural crises

Following the initially widespread sceptical reaction of the majority of the rather conservative population to many theses proposed by the modern environmental movement in Germany and Europe, in recent months and years certain incidents and developments have illustrated just how justified their demands in fact were. For example, a broad majority of consumers now sees the cause of the BSE crisis in an extremely industrialised agriculture which is inadequately geared to environmental and health protection.

One of the consequences of this development in Germany is a boom for food and non-food products from controlled ecological cultivation. By the way, this also demonstrates just how far-sighted and future-oriented we have been at AURO AG in insisting on purchasing important herbal raw materials for our natural paints – as sole supplier on the market – from controlled ecological contract cultivation.

Another fact which has aroused an increased environmental and health awareness in large sections of the population, is the huge increase of people in industrial countries who suffer from allergies. Meanwhile up to a third of the people living in some of these countries are affected. It is quite obvi-

ous that among others, the increasing number of frequently vague chemical additives in food, chemical/technical everyday products but also in the air that we breath and the water we drink, have finally been too much for the human immune system, resulting in excessive and incorrect reactions of the organism to the many loads, stresses and pollutants.

1.3 Growing awareness for sustainable development

European countries with Germany to the fore are playing a major role in the implementation of the extensive resolutions taken for sustainable development in Rio de Janeiro in 1992 by the main governments of the world. Numerous initiatives have sprung up at local, regional and national levels for concrete realisation of the measures to implement the demands of the Agenda 21. Giving top priority to sustainable development has also become part and parcel of the program of the largest and most important environment associations in recent years.

Meanwhile even the German industry has recognised that in the long term it can only satisfy its customers' demands and needs by committing itself to sustainable development. Although in many cases this does not go any further than non-commital declarations of intent, these initiatives of the industry nevertheless develop an unmistakable dynamic progress of their very own and are gradually making themselves felt in product development, assortment streamlining, corporate communication and long-term strategic corporate decisions.

It is worth giving a special mention to one particular development here in recent weeks: the German government has meanwhile given particular emphasis to the importance of sustainable development by convening a "Council for Sustainable Development". This council consists of top level renowned representatives from the German environmental and health movement. It is a good sign that this new body is set on an equal footing for example to the long-standing "Council for Economic Matters" – the so-called "Economic Wise Men".

In this way, a central aspect of government policy is now to examine important measures before their implementation with regard to their effects on sustainable development. This trend is naturally accompanied by resistance and counter movements. In particular certain sections of the rather past-oriented industry (chemical, steel and power industry) fear that their corporate decision-making freedom could be restricted by legislation and directives geared – in their opinion – too much towards sustainable objectives. But in the meantime even the more conservative political parties in Germany now attach considerable importance to environmental protection, so that such trends will at the most have a delaying effect without endangering the overall goal.

1.4 Evaluation of products and processes according to complete product lines

For a long time in Europe, moves to examine and consider the effects of old and new technologies on the environment and on health were dominated by a retrospective approach: concentrations of the pollutants produced in industrial processes were reduced by increasingly effective filter systems. Meanwhile, this blinkered approach has been replaced by a holistic way of looking at things. It is meanwhile state of the art for science to consider the entire life cycle of a product when evaluating the environmental relevance of substances and procedures – from its origins as a primary raw material via all stages of manufacture, consumption and secondary use through to final disposal or recycling – in order to study its concrete impact on man and the environment.

This consideration and evaluation of entire product lines can help to avoid products or procedures only being optimised ecologically for isolated phases of the product biography which could shift the resulting contamination and pollution to another phase of the product life cycle. Today it is no longer acceptable for a product which emits only low quantities of contaminants in its immediate state of consumption to have caused pollution during its actual production, or to produce disposal problems at the end of the actual period of use. Paints and varnishes frequently produce numerous examples of just this approach, which are only visible when the entire product line is analysed throughout the entire value adding sequence.

1.5 Growing awareness for the need to turn away from mineral oil

One aspect of the ecological evaluation of products and processes which has been clearly revealed by the analysis of complete product lines, is the huge dependence not only of the power industry but also of chemical manufacturing of numerous consumer goods on mineral oil as primary raw material. Current studies by independent institutes indicate that the production possibilities for this central key raw material in our current world economy have already passed their apex. Meanwhile such studies are discussed and accepted not only by experts but also by the general public at large, triggered among others by the price increases in fuel which have been only too clear to everyone.

It is in particular this growing awareness of our dependence on fossil energy and raw materials which has recently prompted a broader public acceptance of alternative resources. This is most obvious on the power sector: the corresponding programme of grants and subsidies made available by the German government was already exhausted in next to no time; systems for alternative power generation by regenerative means – wind power stations, biomass unit heating power stations, photovoltaic systems – meanwhile constitute a flourishing branch of the economy, creating thousands of new jobs.

The gradual but constantly growing move away from fossil raw materials is also having an increasing effect on material production. Surveys show that a large part of the population would give preference to products from renewable raw materials, on condition that these are made available without excessive disadvantages in price and performance when compared to oil-based products.

Suppliers of chemical/technical everyday products would therefore find huge market potential if they could succeed in combining the following central features in their products:

- ecologically consistent selection of raw materials
- harmless from a point of view of health
- high technical performance capability
- sustainable economical value and, last but not least,
- harmonious aesthetic quality.

At this point I would like to emphasis that at AURO Natural Paints AG, we have been working intensively and successfully since the mid '90s on implementing this combination of product advantages which is so attractive for the majority of consumers. Particularly in the equal consideration of these factors, the company has assumed an outstanding, widely recognised position on its world markets which has been honoured by many notable awards.

1.6 Reducing, shifting and increasing environment problems

An initial summary of the situation in Europe and in particular Germany indicates that in many areas, particularly when it comes to wide-spread contamination of air and water, strict legislation and directives have succeeded in achieving substantial reductions in pollution. At the same time however, it must also be said that in some areas, these reductions have in fact only shifted the emphasis so that new problems have been caused elsewhere.

Particularly when it comes to chemical products, there is a trend for chemicals which have been focussed in public discussion to be replaced rapidly by new chemicals, which can then be used for some time before being targeted by public criticism. This ominous trend can be observed particularly where chemical products are used in man's immediate surroundings, especially in the home and at the workplace. This close vicinity of emission source and affected organism, together with the large number of individual sources, means that even minor emission factors can all contribute to a negative overall effect (e.g. in the form of the so-called "sick building syndrome").

Now that in some cases considerable success has been achieved in reducing large mass flows of pollutants (e.g. emissions of sulphur compounds from power stations), in future the aim must be to achieve a drastic qualitative and quantitative reduction in the unmistakable flood of chemical pol-

lutants, present each for itself in smaller mass flows, but accumulated and expotentiated to a large overall burden. As already indicated, the development of paints and varnishes has a considerable contribution to make to improving this overall situation. This applies particularly to substituting petrochemical products with products made of natural and in particular renewable raw materials.

In view of the outstanding significance of mineral oil over the last 50 years on the development of the world economy, on international trade relations and their structures, but also on the increase in ecological, social and meanwhile also economical problems, this question will be looked at once again in greater detail in the following chapter. It is important to see the basic aspects and effects of this dominating technology in order to obtain the most reliable basis for making judgements in the search and selection of alternatives for the future of humanity.

2 Looking back without nostalgia: 50 years of mineral oil

2.1 The most serious monopoly in history

On the transition to the 21st century, mineral oil as a source of energy and raw materials has assumed a dominance which is simply without comparison in the whole of human history. And yet the mineral oil age covers a period which is far shorter than the average human life. It was only after the second world war that mineral oil saw its incredible boom as a raw material, achieving an uncontested monopoly not only for energy and fuel but increasingly as passepartout in the chemicals industry. Right up unto today, about 95% of organic chemicals (i.e. chemicals containing carbon) are made from mineral oil as sole raw material, i.e. these are petrochemical products.

But initially, most people only became aware of their dependence on mineral oil in terms of fuel and energy: the "oil price shock" of the '70s left deep traces in many people, on their conscience and sub-conscience. At first, only few were aware of their dependence on mineral oil for everyday chemical products. In fact, this universal raw material is still today like a spider in the centre of a gigantic web of substances and materials with untold cross links and interrelations.

2.2 Mineral oil: really the most unsuitable chemical raw material

From a chemical point of view, the chemical raw material mineral oil constitutes a remarkable paradox. On account of its material properties, scarcely any other conceivable raw material is less suited to act as the material basis for the whole range of everyday chemical products. Whether paints, adhesives, detergents, fibres, scents, cosmetics – the molecular structure of its ingredients means that mineral oil is far remote from all these chemical functions. It is a well-known fact that mineral oil consists essentially of a mixture of inert, in some cases highly toxic, environmentally hostile, nasty smelling hydrocarbons.

Consequently, incredible quantities of chemical energy have to be ploughed into this inert mixture with its dearth of usable properties in order to come up with the required commodity in the end. And the instruments used by chemists today to introduce lots of energy into such an inert mass are still so forcible, unspecific and unaimed that most of the energy used does not even contribute to the required chemical reactions with the required products, but results in endless quantities of secondary reactions with unwanted reaction products, which are frequently no more than special waste.

One of the favourite methods of chemists is still to use extremely reactive chemicals such as chlorine and ozone to bring inert mineral oil hydrocarbons into an intermediate chemical state in which they are willing to react, a state which these raw substances would never assume voluntarily. Even such apparently harmless plastics, such as polyurethane which we use as a soft covering for our car steering wheels, reveals an almost continuous pedigree of ultra-poisons in its biography.

But it is not only the structure of today's synthesis methods and the continued use of aggressive, environment-hostile intermediates which are causing problems. We frequently also find a grotesque distortion between the quantity of chemicals used and the eventually resulting quantity of useful final product. One example here is the production of a commercially available Azo dye. Editors at the

Öko-Test magazine took data provided by the manufacturer to draw up a balance of just one of the numerous synthesis stages involved in the chemical production of the dye: with the result that alongside the required final product, the quantity of toxic, environment-hostile waste chemicals produced was 7 times larger.

2.3 The distorted relationship between the generation and the consumption of mineral oil

Together with the actual methods used in petrochemical synthesis with all the negative ecological and toxicological circumstances involved, there is also further reason for concern when it comes to availability of the resource itself. Ernst Schwanhold, chemist and long-standing chairman of the enquête commission of the German parliament responsible for implementation of the Agenda 21 in the chemicals industry, summed up the basic dilemma of the petrochemical and petro-energy industry in one laconic sentence: "The fact that the quantity of mineral oil currently consumed in the world in one year is the quantity generated in about one million years clearly demonstrates the extent to which resources are being abused."

In view of this fundamental distortion between consumption and regeneration of a key industrial raw material, the question arises not only as to the ecological sense but also the pure economical sensibility of our current behaviour. The root of the word "economy" basically means "economic behaviour according to the rules of sensible budgeting". From this point of view, the current quantitative distortion between income and expenditure (or generation and consumption of the raw material) is totally remote from any kind of budgeting precaution and therefore from any kind of economic sense.

Only the huge profits earned over 50 years from the exploitation and utilisation of this raw material for which quite definitely no-one will pay a price which is anywhere near oriented to the true costs of regeneration, made it possible for this intermezzo (and this is what we must consider the age of petrochemistry and petro-energy to be) in the history of industry and civilisation to take place. One of the most urgent tasks to face humanity throughout its history is to terminate this unfortunate dependence on such an easily exhaustible and such an environmentally hostile raw material as quickly as possible. Here the concepts of AURO AG, as modest as they may be from a quantitative point of view, have an important role to play as models and pioneering products for a sustainable supply of everyday commodities.

3 Construction and building material as main source of environmental & health problems

3.1 Quantitative and qualitative aspects of the environmental relevance of construction materials

During its work on implementing the demands of Rio's Agenda 21 in the chemical industry in Germany, the enquête commission of the German parliament already mentioned above, which turned to AURO AG as expert consultants for this parliamentary task to present their concepts for "gentle chemistry" to the members of parliament, identified the complex of "building and living" as an area with particular environmental and health relevance and thus as an area where attempts to introduce sustainable development are not only urgently necessary but would be particularly worthwhile.

Construction methods and living environments have been identified as a main source of environmental and health problems on the basis of two facts. Firstly, the quantitative volume of substances put in motion for construction projects is extraordinarily large: the materials flow set in motion here exceed in total almost all other material flows triggered by all economic processes altogether. Even if this materials flow in the construction industry consists to a considerable extent of earth excavation and movement, nevertheless the remaining mass flows of the building materials themselves are still in such huge quantities that they are surpassed by practically no other human activity.

But from a qualitative point of view too, the relevance of building and living for material flow data in developed societies is quickly apparent. Scarcely any other aspect of life sets such unimaginable multitudes of materials of such different types in motion. And the materials used for building and

living have naturally not escaped the general chemicalisation of our everyday life. On the contrary, chemical products have triumphed here more than in practically any other sector. These chemical building products are not always immediately obvious. For example, today almost all apparently "mineral" bulk building materials, such as concrete, plaster etc., have been refined with a large number of chemical additives which in turn usually consist of the results of research and development efforts in the laboratories of the organic chemicals industry.

This is also one reason why the type and quantity of substances from non-renewable (fossil and mineral) sources has constantly increased over recent decades. This alone produces considerable materials flow problems, as there is no means of securing medium- and long-term supplies of the corresponding products.

These modern synthetic building products also have other negative effects in addition to the resource problems. As a rule, they contradict all ecologically necessary endeavours for re-use of the building materials at the end of the actual service life of the house or during alteration and refurbishment work. Although they can be recycled in some cases, this usually results in a considerable decrease in the potential characteristics of the material so that this is really "downcycling" rather than "recycling".

However, many synthetic building materials resist even this kind of secondary use so that they already constitute potential special waste at the point in time when they are installed in the building. All conventional methods of material disposal cannot be used for products of this kind, or only at disproportionate expense. For example, many chemical synthetic building materials cannot be composted because they are inadequately biodegradable. Such waste products can frequently not even be put to thermal use because the incineration process would convert their pollutants (e.g. chloroorganic substances) into dangerous environmental toxins (e.g. dioxin and dibenzofuran).

This fact is in particular a cause of regret when building substances which are actually ecologically highly beneficial, such as wood, are rendered completely unsuitable for any sensible secondary use by basically tiny quantities of deliberately added pollutants, e.g. wood preservatives or coating substances. The building substance processing industry will be faced with a flood of problems particularly in this respect once current draft legislation in Europe comes into effect, dealing with the manufacturer's obligation to take back and dispose of wooden windows, for example.

Many of the problems briefly referred to here can only be avoided in the long term if building and living in future turn increasingly to products from renewable, natural resources. These are not only renewable and thus available in the long-term. Thanks to their composition which is compatible with the biosphere, they also constitute an entirely different potential for sensible, environment-friendly recycling, secondary use or disposal.

3.2 The need to save energy and the health aspect

With the exception of just a very few countries, there is world-wide agreement on the need for drastic reductions in the consumption of fossil and nuclear primary energy media. This need is known to arise not only from the fact that the easily recovered resources threaten to dwindle out completely in the near future, but also from the need to reduce the man-made concentrations of trace gases such as carbon dioxide in the atmosphere in order to protect the climate.

Whereas Europe and in particular Germany is seeing a gradual trend in current new building projects to use energy saving methods and heating systems, certainly when it comes to wide-spread energy requirements the large quantities of old, poorly insulated houses and apartments in eastern Europe which also use outdated systems of energy generation and production give far greater cause for concern. Although the costs for fossil energy media in the last two years have increased drastically, here apparently there are still not sufficient incentives to save primary energy.

With a view to the need to save energy by better thermal insulation of houses and apartments, and with regard to the other ecological problems posed by conventional insulating materials based on mineral wool, hard polystyrene foam, polyurethane and other petrochemical products, it is particularly pleasing that in recent years increasing quantities of insulation systems have been developed and launched on the market based on renewable raw materials such as wood, used paper, hemp, coconut, linen, cork and wool, etc. The insulating performance of natural insulating materials of this kind today can be compared to that of conventional products.

Of course I should point out here that the climate problems cannot be solved just with progressive insulation systems, but should be developed in a positive, sustainable direction above all using energy systems based on renewable forms of energy, such as passive and active solar heating systems, photovoltaic systems, wind, wave and tidal energy, geothermic solutions, biomass heating systems etc.

But the perfectly sealed and insulated building is not the sole remedy for all ecological problems, as a completely different consequence of such building measures now reveals. Doctors specialising in environment and living problems have recently reported drastic increases in health problems particularly among people living in perfectly sealed and insulated houses and apartments.

The very latest findings indicate that the causes for such health problems are to be found in two completely different sources. On the one hand, in many such houses the air exchange has been drastically reduced, so that the air in the house is only replaced and renewed once in five to ten hours. This results in an increased development of microorganisms on the inevitably somewhat less well insulated wall surfaces (outer corners, wall sections behind furniture, under beds etc.) Here in particular mould fungi and their spores contaminate the room air and can cause health problems such as allergies right through to bronchial asthma.

Another apparently even more frequent consequence of the extremely impervious sealing of modern buildings is the increased concentration of contaminants in the indoor air. The increased use of synthetic building materials and additives already described above, together with increased use of other high-emission commodities such as furniture, detergents and cleaning agents, disinfectants, cosmetics etc. combines with the low air exchange rates to produce in some cases a huge increase in the concentration of such contaminants in the indoor air.

Particularly when it comes to surface treatment products, the solvents, plasticizers, monomers, preservatives and other additives constitute one of the prime sources of health disorders in houses today. It is a paradox that this applies in particular to today's modern water-soluble, acrylate-based coating systems with reduced solvent levels, because their unavoidable residual contents of auxiliary solvents (glycol derivatives) cause particularly toxicologically problematical and long-lasting contamination of the indoor air.

This was then one of the prime aspects which has turned the development of extremely low-emission paints and coating substances from renewable natural raw materials into a crucial element of modern, future-oriented ecological building and living. This is the only way to achieve indoor air qualities with tolerable levels of content substances in houses and apartments which are highly insulated and imperviously sealed in order to save energy. Here I should also like to point out that in this context too, the use of synthetic solvents (isoparaffin) in some natural paints also constitutes a dangerous dead-end. Pollutants of this kind today are one of the essential contamination factors in modern eco houses, giving cause for concern to indoor air quality and hygiene experts.

It would therefore appear to be quite obvious that when it comes to paints, impregnation agents and coating systems, particular value must be attached to innovative sustainable solutions. Given the special significance of this sector in building and living, I would now like to take a more detailed look at AURO AG's major research and development project for the production of solvent-free

natural paints. The first results were launched on the market mid 2000, and dominate increasingly the range of products available from AURO.

4 Health and environmental relevance of paints and varnish

4.1 The varnish discussion since the mid '70s

Paints, varnishes and impregnation agents count among those chemical/technical everyday products with a most pronounced effect on health and the environment. Over the last 25 years, there has therefore been a critical technical and public discussion of the toxicological risks, ecological compatibility and sustainable development of modern synthetic chemical products, particularly when it comes to paints, coating systems and wood preservatives.

Certain product components played a major role in this discussion, above all solvents, plasticizers, monomers and biocides. The properties of these components in the product were queried critically together with their toxicological and ecological effects during production, manufacture, use, during the service life and during disposal.

4.2 Consequences from the varnish discussion: changed recipes

In retrospect, the discussion itself and subsequent changes in the corresponding legislation have resulted in a considerably changed approach in the paints and varnish industry, and in some cases to a fundamental revision of the product formulae. These changes aimed to reduce the levels of critical components, or to eliminate them completely or replace them with substitutes.

In addition to these changes in the paints and varnishes industry itself, which led among others to the low-solvent acrylate systems, since the mid '70s completely different materials have emerged on the market which attempted to satisfy the fundamental criticism by introducing a drastic change in the raw materials basis with consistent use of renewable natural raw materials with an absolute minimum of chemical modifications, which became known as "natural paints", "organic paints" or "plant chemistry paints". This then gave the consumers and users of such products two fundamentally different development lines to choose from when it comes to "eco paints and varnishes".

4.3 The AURO innovation project: years ahead of the market

4.3.1 Previous weaknesses of eco paints and varnishes

These two development lines for eco paints and varnishes had been formulated on the basis of clear requirements stipulated by users, consumers and scientists for contemporary materials, so that since the '80s they enjoyed considerable market success, although this was distributed initially between clearly differentiated groups of customers and distribution channels.

Acrylate-based products appealed above all to the painting and varnishing trade where solvent problems play a special role with regard to extreme contamination with dangerous working materials. On the other hand, the natural paints enjoyed remarkable market success among DIY customers with an ecologically progressive approach and pronounced awareness for health aspects. Here special distribution channels rapidly emerged in the form of specialised natural building material traders, but these were soon joined by the first conventional DIY stores eager to establish a new, credible ecological profile.

4.3.2 Declining growth in the '90s

However, this dynamic growth underwent a noticeable decline for both sectors during the '90s, with an increasing number of critical voices to be heard for many different reasons so that the compromises made by both material groups were increasingly queried. In the water-soluble synthetic resin systems, the queries concentrated on weaknesses to do with indoor air climat, room hygiene and ecological aspects, whereas the natural paints were queried not only with certain criticisms of the

toxicological aspects of the solvents used, but particularly with regard to technical application weaknesses.

4.3.3 Weaknesses in the acrylate products

When it comes to conventional water varnishes and other acrylate-based coating materials, two points in particular were subject to increasing criticism. On the one hand, extensive tests in real living situations revealed that the persisting content of relatively low-volatile solvents in acrylate products (including glycol compounds, with concentrations in the product between approx. 4-10%), which cannot be reduced any further for technical application reasons, caused considerable and above all persistent indoor air contamination in rooms with these chemicals which are in part harmful to the health and to the environment.

On the other hand, during the discussion about sustainable economic development following the environment conference of Rio de Janeiro in 1992, the question repeatedly emerged whether it was possible in particular for acrylate-based products which are tied 100% to the non-renewable basic raw material mineral oil and potentially environment-hostile synthesis processes, to be at all capable of making a contribution to sustainable development.

Another ecological weakness to emerge as new point in the discussion was that the acrylate products constitute a type of bonding agent with extremely poor biodegradable characteristics which after exposure to the elements can result in a further increase in the concentrations of synthetic resins in the soil.

4.3.4 Weaknesses in the natural paints

It is not surprising that the conventional competitors have considered the natural paint manufacturers and their increasing market significance with a critical eye. But parallel to the increasing sales figures, during the '90s critical remarks and queries about commercially available natural paints were also to be heard from the trade and private users of such products as well as from scientific institutes.

One level of criticism concentrated on the fact that many natural paint products, particularly paints, laquers, stains and impregnation agents, in some cases contain levels of solvents which closely approximate the VOC levels of comparable conventional synthetic resin products. Although at least among the more consistent suppliers these are solvents of purely plant origin (e.g. citrus peel oils), it was rightly stated that these volatile natural substances could have a neurotoxic potential and in some cases also a dermatological irritation potential.

The second level of criticism dealt with the technical application properties of the natural paints available on the market. Although in some cases these had achieved a highly respectable technical quality thanks to intensive development work throughout the '90s, there were still certain typical weaknesses. This included for example a clear blocking tendency, a relatively rapid loss of gloss and, in the products rich in oil, the coating films showed a higher than average tendency to swell with water. In the eyes of particularly critical users, these weaknesses could not be balanced out fully by the technical advantages, for example excellent substrate adhesion or controlled, well-balanced thickness loss of the paint film in outdoor climate.

4.3.5 Paradox situation: increasing popularity with declining growth

The paradox situation emerged that in spite of the relatively high level of popularity among natural paints and the clearly growing number of suppliers (although some of these were very small), towards the end of the '90s these companies were nevertheless confronted by declining growth figures. Although some suppliers managed to achieve certain growth levels on certain foreign markets or by the acquisition of smaller competitors and concentration measures, the natural paint market nevertheless at the turn of the century started to show signs of stagnation.

4.3.6 New impulses from innovative research and development

This situation transpired in spite of the fact that representative consumer surveys from this period clearly indicated that in extensive consumer groupings, consistent natural paints were principally preferred to synthetic coating materials.

However, it would appear that solvent levels and technical application deficits of the natural paints on the market prevented widespread acceptance for trade and private use. It became increasingly clear that the natural paint branch desperately needed impulses from innovative product developments to eliminate existing weaknesses and at the same time to tidy up the product profile.

4.4 Development project "Solvent-free natural paints"

4.4.1 Basic aspects of the development project

Following detailed analysis of the weaknesses of our products and those of competing companies and in line with the known priorities set by users and consumers, in 1995 AURO Natural Paints AG in Braunschweig, one of the leading manufacturers of natural paint products, drew up the concept for a demanding research and development project to elaborate a fundamental innovation for natural paints. It quickly transpired that this project would involve a considerable workload and expense in terms of time, personnel, investments and financial funding.

Firstly attention concentrated therefore on examining which public grants and subsidies could possibly be available for this kind of project. In view of the considerable relief on the environment to be expected from the intended total elimination of organic solvents from natural paints, and with regard to the intention of working according to the well-established principles of regenerative and natural raw materials, an application for project subsidies was submitted to the German Federal Foundation for the Environment (DBU).

4.4.2 Core aspects of the first project draft

Already the first project draft submitted to the DBU mid 1996 clearly emphasised the essential objectives of the project. I quote:

"The subject of the project is to research and develop new technologies for the production of solvent-free paints, stains and coating materials on the basis of preferred biogenous raw materials. The aim of the project is to establish a range of impregnation agents, primers, waxes, stains and lacquers ready to be launched on the market which, given the consistent ecological alignment of the entire product line, is comparable in its technical application characteristics with conventional materials based on petrochemical synthetic polymers".

4.4.3 Subsidies granted by the DBU and successful project start

After the initial positive reaction to the project draft, the actual project application was submitted to the DBU at the start of 1997. A positive decision was received in October 1997. During the following weeks, the 4 members of the project team were selected and appointed so that the 3-year project could start on January 1, 1998.

Following an initial evaluation phase to look at the strengths and weaknesses of the previous natural paint products made in our own company and by main competitors, the second phase in the first project year consisted in identifying and selecting suitable raw materials. Intensive contact and cooperation with the raw materials industry resulted in the selection or new development of suitable binding agents and additive components all based on renewable raw materials.

4.4.4 From theory to practice: the first pilot products

So by the time the second project year started, it was possible to formulate initial practical recipes for newly developed, completely solvent-free coating materials exclusively from renewable raw

materials and mineral pigment/filler combinations, to produce these on a laboratory scale and subject them to initial open-air weather exposure tests.

During this development phase we worked deliberately and exclusively on top coat systems. The fundamental presumption that successful formulation of a water-soluble solvent-free top coat system could be used as basis for the other intended systems (clear lacquers, wood stains, wax coatings and primers) was then confirmed throughout the project.

This is why it was a complete range of top coat products with primers, undercoats and different colours of top coats which was launched punctually on the market as the first results of the project, on July 1, 2001. Pilot models of these products had already been presented to the trade and general public media at a press conference back in April 2000, and roused plenty of trade and public attention because of their novel, optimised characteristics profile.

In the following months, numerous other products based on the fundamental innovation in the binding agent sector were launched on the market, including mid February 2001 the highly significant wood stains – naturally once again water-soluble, entirely solvent free products.

4.5 Toxicological, ecological and technological optimisation

4.5.1 Based on the tough demands of the European standard EN 927

The aim of the demanding research and development project was however not only the sustainable optimisation of a complete range of natural paints from toxicological aspects. In addition, the technological characteristics profile of the new products was to be brought onto a high performance level. Development work was based therefore not only on dispensing totally with organic solvents but also on aiming at the very maximum possible technological standards.

These standards were incorporated in the new European standard DIN EN 927 which was currently being published, together with the accompanying directives issued by the association of window manufacturers for coatings on precisely dimensioned wooden structures. The new standard therefore provided a totally up-to-date set of criteria and test features which acted as guideline and yardstick for the intended technical application properties of the new natural paint products.

4.5.2 Successful implementation of the toxicological and ecological project aims

The newly developed paints, stains, waxes and primers based on a new water-soluble natural resin oil binding agent comply fully with the original development aim in that they do not emit any solvent vapours into the indoor air, and also show a technical application quality previously unattained in natural paints. Surveys and extensive tests meanwhile verify both the technical performance characteristics according to essential points of the European standard EN927 and also the extremely low emission values as well as the absence of all typical pollutants in coating materials.

4.5.3 Neutral verification of achieving the project objectives

Neutral tests (for example by the leading Ökotest-Magazine, Ökohaus) have judged all product series launched on the market up to now as being unconditionally "recommendable" which is the best asessment level. The very positive data referring to indoor air quality were evaluated by the Fraunhofer Society for Wood Research (Wilhelm-Klaudnitz institute).

The products have been optimised from a technological and toxicological aspect, and in particular, no compromises were made during the development process with regard to ecology. The binding agent comes exclusively from renewable raw materials. In addition, no synthetic biocides are used as pot or steam room preservatives. This means that for the very first time, now a complete range of paints and coating materials is available which comes as close as possible to sustainable development when it comes to health, ecology and technology.

4.6 The 3-pillar strategy of AURO's present and future assortment

The large number of products free of solvents that have come onto the market in the past months since July of 2000 as a result of the development project of AURO Natural Paints described under the category of "AURO Aqua" will be supplemented in the coming months with more products that are also completely free of solvents. This means that shortly there will be a complete assortment of ceiling paints, clear varnishes, impregnations, primer coats, waxes, floor coatings, wood glazes and other products with a specialised area of application (for instance, garden furniture oil). The only dilutant they contain is water, so that they are especially suited to ensuring a healthy interior climate. This assortment will be the focus of the future product portfolio of AURO Natural Paints. This puts us in the very favourable starting position for the future market development of having one of the most modern and continually forward-looking product assortments to be found anywhere in the world.

AURO Aqua's assortment is complemented by two other pillars that are also products completely free of solvents: AURO PurSolids and AURO Powder products. AURO PurSolids are products that neither contain organic solvents nor water as dilutants. As you may assume from the name, they consist of 100% pure solid matter. The colourless products are therefore made of pure binding agents. PurSolid products are very sparing in use because of this composition. They therefore almost ideally help extend the material flow with chemical and technical products. The quantities consumed per area are down to factor 10 below the quantities of conventional lacquer coatings.

You can do the "classical" oil-wax treatment of furniture, section coverings and floors in interiors with PurSolid products without having the high solvent content of the natural paint products used earlier for this purpose. Because they neither contain organic solvents nor water, they are especially welcome to customers who are sceptical about water-thinned products. Because of their composition, they are generally of a high consistency and therefore they require some different types of coating techniques (bale application, processed hot). Furthermore, sometimes they have to be polished afterwards. Although some of PurSolid products can be worked excellently by laypersons, another portion of the products should be left up to pro's.

As a third pillar in the portfolio of AURO's products free of solvents are AURO Powder products. Some of them have been in our assortment for many years and they primarily cover the needs of customers who wish to stir the material desired by adding water to a finished powdery mixture (wall paints, binders, stains) at the construction site or in their flats. Because water is available everywhere and you do not have to transport it together with the binding agents and pigment components for these products, these powder products are suited for groups of customers who are especially open to the idea of ecology. It is obvious that a material that is only stirred to be ready for use on site cannot have the coating refinements that are possible with a factory preparation. In spite of this, these powder products have been able to secure themselves a respectable part of turnover from the natural paint assortment and that is still growing.

For the sake of completeness, we would like to mention that some of the optimised products from AURO's assortments containing solvents that have proved their worth for decades will be available to our customers upon request in the coming years in spite of our company's clear strategic direction to products completely free of solvents. This is a service for customers who have only recently invested in special application techniques based upon AURO products containing solvents or who have other reasons not to initially change over to AURO products free of solvents.

We wish to also give these customers the opportunity to prepare themselves for this at their own pace. In the middle term, this change will be inevitable because of the intensification of legal regulations for solvents. You can recognise all of AURO products containing solvents that will continue to be in our assortment with a "9" in the front of the article number. As much as possible, we have retained the other numbers of the previous article number. For instance, this means that the product

wood glaze 130 will become wood glaze number 930. Of course, we will continue with pure plant solvents based upon citrus peels with the remaining products containing solvents. Petrochemical solvents such as isoaliphates are not used in AURO's products because they are environmentally damaging and because of their poor solubility, which forces especially high concentrations of solvents.

5 AURO Natural Paints as the motor of ecological innovation.

5.1 The impulse for its foundation and its development since 1972.

The innovative AURO Natural Paints research and development project, which has led to a new generation of solvent-free paints and varnishes in a consistently ecological selection of raw materials with a high paint-practicing performance, is only the temporary highlight in a long series of innovations in the course of the company's history.

One of the success stories of the modern ecological movement began in 1972 with the start of research into vegetable dyes by AURO's later founder, the chemist Dr. Hermann Fischer. After the co-foundation of a first ecologically-oriented company, which was based on the concept of a community of idealistic young researchers and teachers and failed after a few years, the AURO Natural Paints company was founded in 1983 and quickly rose to become the leading, best known and most famous enterprise in the industry. Today it employs around 65 people at three European locations in the research, development, production and marketing of natural paints and related ecological products.

With a clear concentration on renewable ("solar") raw materials, on the processing of the natural materials according to the guidelines of "gentle" chemistry and on the control of the materials in independent circuits, it appears that AURO's concept exactly meets the needs, hopes and yearnings of the people for a healthier, more harmonious living and life environment. As a result of this concentration on sustainable future capability, the AURO trademark has become one of the best known in the ecological sector within Europe and large areas of the world.

In addition to the emphasis on the strictly ecological consistency and the human-ecological compatibility of its products, AURO also geared its research and development efforts very early on towards as much technical efficiency in its products as possible, because this is also a contribution towards saving resources and thus sustainability due to the consequent durability of the products. Owing to the fact that Dr. Hermann Fischer, founder and head of the company, is a chemist and passionate scientist himself, AURO has built up an R&D department over the last few years with an average staff of 10 to 12 researchers and developers that is unusually large for a company of its size and is also exemplary in direct comparison with its competitors.

5.2 Consistent selection of raw materials

With its restriction to natural raw materials of a preferred vegetable origin, AURO was and is a pioneer in the area of a chemistry directed towards a long-lasting future capability. While other companies in the paint and varnish industry regard these regenerative raw materials at most as a minor addition to their raw materials spectrum, from the day it was founded AURO has concentrated on those raw materials, which - in contrast to fossil raw materials like mineral oil - can still form the basis for human value chains in the distant future.

Numerous different vegetable resins, oils, waxes, aromatics, dyes, swelling and thickening agents, emulsifying agents, adhesives and proteins form the basis for our product developments. In addition, where there are already sufficient qualities and quantities available, raw materials from controlled ecological farming - despite their significantly higher price - are used. To our knowledge, AURO AG is the only company on the market that has been making such a contribution to the ecologicalization of agriculture for many years in the non-food sector as well.

However, not all conceivable or technically suitable natural materials are used. Rather, from the vast selection that nature has to offer, only those raw materials and particularly vegetable products are used that are also harmless and non-toxic in direct contact with people. Incidentally, consumers can convince themselves of the type of raw materials used, as the complete composition of the product is revealed on every product label and product leaflet. This way, product users will also realize very quickly that we even do without the admixture of biocides for product preservation in our products; we do not of course use biocide wood preservative agents either.

5.3 Careful Process Engineering

Even the best natural substances can lose a lot of their original ecological advantages through defective processes, unsuitable preparation methods, or aggressive chemical modifications. That is why a great deal of importance is placed on the process technology that is employed. One good example for such careful process engineering is the method we use to produce our new, solvent-free products. Namely, the basis of these products is a binding agent emulsion composed of plant resins, vegetable fats, botanically-based surface-active agents and water, which is made in a plant according to a technology otherwise used principally in the cosmetics industry in the production of high-quality lotions and creams.

In the meantime, three of these plants with a capacity of 3.5 and two times 1.0 tons of product are in use; a fourth plant of the same kind is ordered and will commence operations in the early summer of 2001. All plants have a multi-wall, completely closed containers that can be gently heated with warm steam and cooled with water, as well as several separately multi-stage adjustable agitators and dispersing agents. The basis for a further increase in the particularly environmentally friendly assortment of solvent-free products that can be diluted with water is ensured from the plant side as well. With this installed technology, AURO has not only made an important contribution to the introduction of progressive, raw material-friendly process engineering in the natural paint sector, but is also exemplary here in comparison to its competitors.

The process technology of AURO is also a decisive step ahead of the remaining paint and natural dye market in another ecologically significant respect. Although the manufacture of AURO natural paints - apart of course from the packaging of the supplied raw materials - always takes place completely waste-free, unavoidable product waste in the form of washing water from the required thorough cleaning of the sediment containers come about in the course of the production washing process. This washing water, loaded with original residue and self-produced cleaning agents is now centrally collected and treated. During the treatment the solid and liquid materials are flocculated and filtered off; the filtered water is of almost drinking water quality and is drained into the normal sullage with official approval and after strict official controls.

The filtercakes, loaded with residue, are dried to compactability and then brought to a compost preparation facility. Namely, in a costly neutral appraisal, whose preparation alone cost a six-figure amount, the outstanding quality of the production waste of AURO has been proven with regard to a possible compost preparation and consequent recycling into the material cycle. AURO is therefore to our knowledge the only company in the paints and coatings industry at all whose production waste does not have to be disposed of as hazardous waste, but is allowed to be composted. In this respect too, AURO acts as a pioneer company and ecological motor for a whole industry. However, the additional costs that the company incurs through the consistent raw material selection, the lavish process technology and the guarantee of compostability, represent a noticeable disadvantage towards the competition if the direct competitors employ less costly ecological techniques in this sector.

5.4 Consumer-friendly transparency - Open information policy

"Do good things and talk about it" - according to this motto, we at AURO Natural Paints work with an open information policy, which is surely unique, especially in the chemical industry sector.

The first step towards this was the already mentioned disclosure of all dispensing components on the product labels ("Glass Dispensing Index") as early as 1984. Every consumer, every commercial user - and unfortunately every competitor as well - can read the exact composition of the products. With this important step, we have sacrificed our own confidentiality interests for the good of those people who, for example, have to avoid certain substances due to incompatibility, and for the good of the general public, in order that it may come to know the raw material philosophy of a supplier of ecological products. A quick glance at the labels of conventional competitors shows that this by no means applies accordingly to all suppliers of paints and coatings.

At the same time as we introduced the positive full declaration, we opened the company gates to all those persons ("Glass Product Biography") who wish to convince themselves on-site, directly and with their own eyes of the ecologically-oriented company management, the process technologies, the raw materials used and not least of the openness and friendliness of the personnel. Over the last two decades, countless thousands of people, in smaller and larger groups, have made use of this rare possibility of experiencing "live" the birth of a chemical product.

In 1994 we added another decisive step to the transparency of the company management. With the implementation of the Eco-Audit method according to European Union standards, the successful neutral certification of this method by outside experts, and after publication of all company data in an environmental report, everyone can see exactly which materials and energy quantities come into and go out of the company ("Glass Material and Energy Balance Sheet").

Incidentally, in the neutral ranking of all published environmental reports, the AURO report was ranked number 1 of all companies in the paints and coatings industry. In the meantime, the only other natural dye competitor also certified according to the Eco-Audit method a few years ago has no longer been re-certified, which means that AURO is the only company in the industry that has continued to successfully pass this certification procedure, thus accounting to the public for everything it does, right down to the last gram of raw material and waste, and to the last kilowatt hour of energy.

5.5 Intensive Consultation and Training Work

Those friends of the AURO company who have already had the opportunity of visiting us, know: hardly a week passes in which there is not some kind of training course, seminar or lecture in one of our conference rooms. In our large conference hall, up to 250 people can learn about the latest developments in the field of ecology, building biology or natural paints. Around 350 of our trading partners alone from all over the world take part every year in one to two day seminars of this kind, as well as numerous specialist groups, from chemists to painters to apprentices from different trade groups. Seminars of a similar kind are conducted by our employees all over the world.

In addition to training courses in larger groups, we do of course also offer individual consultation for consumers and industrial users, mostly by telephone, but also on the construction site as well. We have an employee especially for this job, who is also supported from case to case by other members of staff from the AURO laboratory.

5.6 Social and honorary work at AURO

Traditionally, information and consultation work at AURO AG is not restricted to its own direct business purposes. At events held all over the world, it also always concerns an integral view of ecological problems, the hidden causes of the ecological plight, new concepts for a gentle chemistry of the future, as well as ecological building and living outside the special field of paints, coating materials and adhesives. In this respect, the company and the people responsible for it regard themselves as representatives of a new source of information, through which as many people as possible should learn of essential circumstances and acceptable strategies for a sustainable, organized future that is worth living.

All these subjects have also been discussed over the past decades in countless publications, both in the specialist media sector as well as in newspapers and magazines directed towards consumers. Time and time again we are visited in our company by television and radio reporters, who have often, and not seldom in great detail, reported on the concept of AURO Naturfarben.

So it is no surprise to us that representatives of our company are often invited to specialist congresses, political parties, Federal and State parliament functions, environmental protection associations, consumer organizations, self-help groups, e.g. persons suffering from allergies or who have been harmed by wood protection agents, to speak about the company, its concepts, products and visions. It is hardly likely that even significantly larger middle-class enterprises will achieve such intensity in their PR work and social involvement; we are practically the only natural paint manufacturer to take on this kind of work so intensely.

This work is supplemented by a substantial honorary commitment by many of our employees. On their behalf, here is a list of just some of the honorary advisory committee work of the Chairman of the Board of AURO AG:

- Presidency of "Federal Association for Healthy Building and Living"
- Founding member of the "Natural Paints Association"
- Competent expert for an investigating commission of the German Parliament (Bundestag)
- Scientific counsellor for the Ministery of Ecology of Lower Saxony
- Presidency of the Environmental Counsellors Committee of the Government
- Election counsellor for the "Braunschweig Award for Sustainability"
- Member of the Board of Trustees of the Nature Conservation Association Germany (NABU)

In addition to the intricate, unpaid work in important ecologically oriented advisory committees of environmental organizations, our staff also actively takes part in numerous environmental and natural protection associations.

5.6.1 Environmental prizes

Over the past few years, the entrepreneurial and honorary work of our employees has been acknowledged by numerous awards from famous environmental organizations. Here is just a selection:

- WWF/ Capital: Eco Manager of the year (1992)
- ASU Environmental Award (1992)
- DEUBAU Product Price for "Innovative Environmental Quality" (1993)
- Environmental Award frm B.A.U.M. for eco-friendly management (1994)
- First producer of natural paints certified after ISO 14000 (EU Eco Audit, 1994)
- No. 1 branch ranking of Public Environmental Reports (1996)
- Environmental Award from Friends of the Earth, Hong Kong

5.6.2 Test results

As a result of the strict choice of raw materials, the good development quality and the careful quality assurance in the production of its products, the AURO Company has achieved outstanding results in numerous commodity and eco-tests since its foundation. Here is a list of just a few of them:

- AURO Wall Paint rated "good" by Stiftung Warentest Magazine (1989)
- AURO Wood Protection rated "recommendable" by Ökotest Magazine (1994)
- AURO Lacquers rated "recommendable" by Ökotest Magazine (1988 & 1994)
- AURO Woodstains rated "recommendable" by Ökotest Magazine (1996)
- AURO Paint No. 260 rated "recommendable" by Ökotest Magazine (2000)
- AURO Rust Primer rated "recommendable" by Ökotest Magazine (2000)
- AURO Tile Adhesive rated "recommendable" by Ökotest Magazine (2000)

- AURO Woodstain No. 160 rated "recommendable" by Ökotest Magazine (2000)
- AURO Paint No. 250 rated "recommendable" by Ökotest Magazine (2001)
- AURO Plaster Primer rated "recommendable" by Ökotest Magazine (2001)

It should be particularly emphasized that since July 2000, the new, solvent-free AURO products from the innovation project, which has already been discussed in detail, have without exception achieved the best marks in several product tests.

6 The future of the natural paint market

"In future, paints will be natural paints, or not at all". This brief sentence summarises the future of paints and varnishes in the next few decades. But this forecast based on the decreasing availability of mineral oil as raw material, on the decreasing ability of the environment to absorb synthetic substances and above all on the decreasing acceptance for petrochemical products among consumers, needs further qualification: "In future, natural paints will be consistently ecological, solvent-free and technically high-performance paints, or not at all".

A summary of both tendencies indicates an outstanding strategic starting position for AURO. Today the company already has the right concept with the right products at the right time, whereas its former prime competitors are still arguing about the most favourable solvent, the tolerable upper limits for petrochemical ingredients and acceptable synthetic preservatives. In addition, AURO with its future-oriented, strictly sustainable programme already more than fulfils future requirements and statutory regulations in tomorrow's main markets (Asia, Europe and America). In addition, in these countries, particularly in Japan, Korea and China, AURO works with committed successful sales partners with many years of experience, who are capable of implementing these progressive concepts on the marketplace.

In view of the favourable strategic position, for the next few years up until 2004, AURO AG has set itself the target of achieving high double-figure growth rates on all relevant markets. This ambitious but realistic growth target is not an end in itself serving only the interests of the company. On the contrary, when all is said and done every barrel of paint from the petrochemical sector or less consistent natural paint sector which can be replaced by consistent AURO products means a noticeable relief for the environment and vital progress towards more health and well-being for the consumer.