CDAE 1993/1994

DESIGN REPORT
Compulsory project: ECOLOGIC
Project involving a choice: BICYCLE

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Date
September 27th, 1993 (Revised for web site: September 2001)

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Project period
Week 29-38/1993

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1 INTRODUCTION

This report describes my entrance for the CDAE design competition 1993. The project started at the end of July 1993 and was finished two months later, at the end September 1993.
The project consists of a compulsory project (an ecologic car) and a project involving a choice (a bicycle with randonneur-appeal). Both vehicles are designed with a similar philosophy and therefore point at the same market niche.
The design philosophy is defined by a market study. This was done briefly before the start of the design activities. In this report (Chapter 2) it is detailed further. It was interesting to define the criteria of not only the possible users, but also take in account tendencies in environmental and infrastructural demands.
Besides design criteria a number of style aspects are defined too. Here the life style is linked to the style of the vehicle. Thus the market niche is defined (summarised in Section 2.6).

The designing of both the car and the bicycle is mixed, but the car had the highest priority. In general both projects began with a initial definition of the keypoints, followed by the initial/global design phase in which ideas where generated and evaluated. Details were worked out for the global design before continuing with the definition of the formal design.
Finally a set of presentation drawings is made.

2 MARKET STUDY

2.1 Introduction

To come to the definition of the market (niche) a market study has been carried out. The study started with a evaluation of recent market tendencies. What were the trends in the last years, and what can be expected for the years coming. Those tendencies can be described as a general life style (an average of the community). Market tendencies describe the change from the viewpoint of the user. However, other tendencies do also influence the settling of future market. These tendencies are more or less controlled by the governments. They not only decide about future developments in infrastructure, but also will develop a policy in which the environmental problems have to be reduced. The question is how this will reflect on the future mobility and thus on the strategy of the automotive industry. New products and technic probably have to be introduced and further optimised. But, who will buy it (first)? In other words: What is the market niche?

The next sections will try to give answers to these questions. If you only want the results, please read the summary (Section 2.6)

2.2 Market tendencies

The last years of the eighties were the years of economic growth. Increasing purchasing power and as a result of that a tendency to more expenses. Bigger houses, faster cars etc. Individualism became more prominent and image building was rather popular. These were the years of the 'Yuppies'. But time has changed. Still the luxury goods are popular. But besides this, an awareness the raised problems caused by this gets more and more influence. Look in the supermarket, watch TV commercials: ecofriendlyness has become a marketing instrument. It is very interesting to follow these tendencies and notice how good alternatives are launched, which also have a better functionality.

Of course, a lot of work still has to be done to come to a balance, which ensures the livability for longer than the next 20 or 40 years. But at least a start has made. Let us hope it will continue rapidly.

Of course I am not promoting a policy of turning back time. Let that be clear. Please don't destroy the sportscars and other exclusive exciting product, which stimulate our fantasy. Let's keep personality alive and try to achieve the goals by optimising the big majority.

Presently, also in developing, buying and using cars a tendency is leading to a philosophy with more care for our environment. All new cars have a catalysator and fuel injection to lower the emission. Further the use of the materials does not only increase safety but also the recyclability. Airbags and seatbelts for each passenger is almost a standard. Besides this, and that is a result of the individualism of the community, designs and styling has become a more important selection criterium. Especially also because of the high technological and quality level of modern cars (as a result of this all cars are good, which makes other criteria, like design and style, more important). Tendencies in automotive design are nowadays more linked to tendencies in for instance fashion and interior design. This creates a market for products with a direct link with life style and image. Japanese car manufacturers were in front in creating cars for these niches. Small sportscars, funny compactcars and roomy space cars.
Considering the 'eco'-trends combined with the 'retro'-trends it is expected that a niche will arise in which both trends are combined. I found this a very interesting niche for the design of the competition. However, 'eco'- and 'retro'-trends mostly affect the personality/character of the product. It does not define its usability, which defines the main dimensions. Further infrastructural and environmental tendencies have to be considered in defining the keypoints of the design.

2.3 Infrastructure tendencies

The present tendencies, in which an increase of the use of cars is predicted, will, especially in city-areas, result in more traffic-jam. Increasing the capacity of the infrastructure is not a good long-term solution, because it will not stop the tendencies to more emission.
The infrastructure in city-areas is based on as well the use of public roads and the use of the railway. At this moment the big majority of the transportation takes place using public roads. Governments, in for instance the Netherlands, are promoting the use of the train for (daily) travel. This is done by on one hand optimising the railsystem, and on the other hand by increasing the costs of using cars (taxes). Further the use of bicycles for short distance travel is a solution.
The highroad system is optimised too, using traffic regulation systems. The aim of these systems is to increase the safety (decrease risk of accidents) by regulating the traffic speed, and secondly using the same regulation of the traffic speed for optimising the traffic flow.

All infrastructure tendencies will lead to a more efficient/rational use of the overall transportation capacity. So as always the optimum is a compromise.

Compact cars, prepared for navigation systems and traffic regulation systems will have a future in this tendency.

2.4 Environmental tendencies

The automotive industry plays a leading role in finding solutions for the environmental problems. Recently a number of prototypes is launched. This tendency leads to a compact car, based on electrical, combustion as well as hybrid concepts. The body is built up using aluminium because of it low weight, good durability and recyclability. Further plastics are used for the coverparts.
All these new technic cannot yet be introduced to a big market segment, because of the price and the need for further development. Therefore new technic first have to be introduced to a selected number of users, to be available for general use later.

2.5 Characterising the market niche

2.5.1 Introduction

As also introduced in Section 2.2 a trend is expected to retro-eco-market niche. In this trend buying goods like cars directly reflects the opinion and personality of the user. Therefore, for the exact definition of the market niche a personality-sketch is necessary. What is their life style, what is their age, how is their social situation, do they demand a high mobility or not and how do they use a car?

2.5.2 Life style

Before defining the life styles, the market is divided in a number of market groups.

- Conservatists;
  These people are satisfied with the present situation (and want to keep it like this), and are therefore not interested in new trends.
- Low interests;
  These people do have low affection with new tendencies. They are not conservative, either

progressive. Choosing products is more based on financial (value for money) then idealistic criteria.

- Followers;
  These people are interested in new tendencies and follow these as second group.
- Individualists;
  These people have own ideas about what to do. Individualistic criteria are more important then the general opinion.
  Within the individualists group there are subgroups:
  1. Exclusive use for mainly own satisfaction. This group is more interested in the result (drivability, imagebuilding), than in the way to come to the results.
  2. Exclusive use which strengths their personality, combined with a responsibility for environmental aspects etc. They follow new trends or initiate them.

The market niche for which the ecologic is designed is last one. This is pioneers group which, after a few years, will be followed by the followers and perhaps also the low-interests.

Some general characteristics are:

- Age: 20..35.
- Higher income.
- Living as single, or in small families.
- Daily travel over short distance (less than 50 km/day).

2.5.3 Mobility

The user group will be living in a city-area. There are alternatives for using the car (using bicycle, or train/metro/bus). The group will use the car rationally: when dedicated transport is needed. For 'daily' travel the car is used for short distance. However sometimes a higher action radius is needed.

2.5.4 Usability

Most of the time a 'two seater + some additional room' is sufficient. Sometimes it is not and therefore a bigger car would be needed. Finding a combination of both could be the solution.

2.5.5 Additional interests

The usergroup has an active life style with a mixture of activities. In general they are interested in sporting and cultural life. Vacancies are to find new inspiration for daily routines.

2.6 Description of the market niche (summary)

The market niche on which the philosophy of the ecologic is based consists of users who want to fulfil a leading role in using concepts based on future demands for the infrastructure and environmental aspects of humans' mobility. The infrastructure tendency will lead to a rational use of the car and its alternatives (train/metro/bus and bicycle). It is expected that in the near future traffic-regulation systems will optimise the traffic flow and thus the capacity of present network of roads.
The environmental tendency will lead to a demand for low- and/or zero-emission cars. The concepts will be built up using light materials with a good durability and recyclability.

The ecologic-concept will fulfil a pioneer's role in automotive world. The concept has to be suitable for mass-production, but it's design and styling points at a selected group in the market. This group is characterised by individualism being in front with, or setting up, new trends (I chose for the retro-trend). Their life style is dynamic sharing a great number of interests. They prefer exclusive products which style is in line with each other. The design of the ecologic had to be based on these principles forming a combination of the sportsmanship and 'grundlichkeit' of the Germans, the frivolity and elegancy of the French, the temperament and classicism of the Italian and the friendliness of the Nissan Micra.

It is expected that most people in the ecologic market niche are living as single or in small families. Their (feel like) age is below 35 years. Mostly they live in a city-area.

3 COMPULSORY PROJECT: ECOLOGIC

3.1 Introduction

For the project following phases are executed:

- Phase 0: Initial definition of the keypoints.
- Phase 1: Initial design exterior (generate initial ideas).
- Phase 2: Global design exterior (defining global shape).
- Phase 3: Work out technical details.
- Phase 4: Second keypoints definition
- Phase 5: Initial design interior (generate basic ideas)
- Phase 6: Formal design exterior (define formal shape)
- Phase 7: Presentation of the design.

The formal design phase for the interior was not executed because the time was needed for other activities. For the same reason a number of details had still to be defined in the phase 7.

3.2 Phase 0: Initial definition of the keypoints.

Referring to the description of the market niche I choose a city-car concept for two adults + two small children. It is expected that this suit for most of the use. Nevertheless, sometimes more capacity is wanted (when having more luggage or adult-passengers). Therefore the concept has a variable length.

Because most of the time it is used as a city car the ecologic is a hybrid car with a rotary engine and an electric motor in each wheel. Using these elements not only results in a ultra-compact drive line (actually it has no drive line). It also can be used for regeneration of the brake energy, the further improvement of the vehicle handling (Longitudinal (brake/acceleration) wheel slip regulation, four wheel steer, drive by wire) and even vehicle motion control by traffic regulation systems.

The choice of the concept enables the use of old ideas (rotary engine) but also made it necessary to invent new ideas.

In drawing 0A and 0B the basic ideas are worked out. The layout (four wheels and 2+2 persons) is rather classical but gives the best possibilities for a optimal use of abilities of the concept.

The standard wheelbase is 2000 mm. In the long version it increases to 2500 mm (same wheelbase as for example a Golf/Astra/309). The height is also more or less standard: 1400 mm. For the interior space the 95%-rule is used which (maximum length of adults is 1950 mm).
The initial width of the car was about 1650 mm.

3.3 Phase 1: Initial design exterior (generate initial ideas).

Refer to drawing 1A to 1L.

All drawings are 2-hour-drawings. The design was made by first defining the profile (scale 1:20) directly followed by a 3/4 front view. In designing it took some time before original ideas were generated. Some designs are inspired by earlier ideas (1J by 1C and 1H, 1K by 1I and 1L by 1E). The retro-trend has been introduced by using materials like chromium and by making some reference to classic designs (1H:Citroën 2CV). Some designs are not in line in with the niche defined in Chapter 2, but have their function as fantasy-stimulator.

Before continuing with Phase 2, the ideas were evaluated. The designs on drawing 1A, 1G and 1J were chosen for further definition. The main criteria used here was the originality.

3.4 Phase 2: Global design exterior (defining global shape).

From the selected ideas 1A, 1G and 1J new drawings were made. The aim of these drawings was to select one design further development. To be able to make a good (objective) choice all three designs are drawn using the same, view, colours and drawings technic (drawing 2A to 2F).

It is always difficult to choose in this stage. The design on drawing 2A and 2B has an original friendly look. I think it is a good design to be worked out further, but not for the market niche eco-retro. Somehow it missed some exclusivism (retro) and does also not really appeal on a dynamic lifestyle. Still it could support the eco-trend, but for other user groups (non-individualistic idealists).
The design of drawing 2C and 2D has elements that fit in the definition of the market niche. Its shape has smooth lines that refer to designs of the late sixties and fifties (Citroën 2CV, Renault 4, Fiat 500). Chromium is used to create a more exclusive (retro) character. Further I find this design more dynamic than the other two designs.
The design on drawing 2E and 2F is very solid. It has clear straight lines. Actually this design is based on a design of a few years ago. It has a no-nonsense personality that strongly appeals to the dynamic aspects, more then to retro-trends.

The second design was my favourite followed by the third design. Actually it was already my favourite after phase 1.

3.5 Phase 3: Work out technical details.

3.5.1 Introduction

The Ecologic is based on a hybrid concept. In its daily use it can be considered as an electrical zero-emission car with a action radius of about 50 km. For larger distances a rotary internal combustion engine combined with a generator is used. The rotary engine is an own invention of about 10 years ago, which is

not ideal for use in conventional cars (because of a limited rotational speed), but could be very useful in a hybrid concept.
The concept has no driveline because electro motors that fit in the rim drive the wheels. This also enables the length variations and gives some other advantages.

Please note that all technical details only represent basic solutions.

3.5.2 The rotary engine

In the first year (1982) of my study at the Institute for Automotive Engineering I invented the basic idea of the rotary engine. Later the idea was worked out further and I intended to finish my study with it. However there were some expected lubrication problems at high rotation speeds. As this should be the main advantage of the rotary engine, I decided not to continue with the idea. Another engine was invented, the rotary engine II, but at that moment I already had decided for another subject (vehicle aerodynamics) to finish my study on.
For the ecologic concept, the good old rotary engine, came back to live. Because the engine only has a function as a stationary engine, high rotation speeds are not applicable. The other advantages of the rotary engine (mainly rotating parts, compact) make the idea very suitable for a hybrid car like the ecologic.

Using this a 1000 cc rotary engine has the outside dimension of 300*300*150 mm. This is without the in and outlet system for gasses, cooling water and lubricant. The engine has no flywheel and is started using the generator as electromotor.

For a vehicle middle-class car, with a total mass of 1000 kg and a cx of 0.35 driving 120 km/h at constant speed, a 25 kW engine would be just enough. Additional power is needed in case of not ideal situations. Therefore the rotary engine should have a power 35 to 40 kW at 3000 to 4000 rpm.

3.5.3 The semi-active suspension

The ecologic concepts demanded (especially for the rear axle) a compact suspension system. Thinking about this I invented a semi-active suspension (see drawing 3C). The basic idea of this suspension is rather conventional (McPherson principle). In normal use it works like that too. However in some situations a additional spring is added by turning the red spring from a horizontal to a more vertical position. The clue is that the spring does only affect the vehicles behaviour in the non-horizontal position of the spring.

The additional spring is turned using a electro motor. There are 4 basic situations in which the vertical stiffness of the suspension is increased:
- When cornering.
  Additional stiffness is added to the outside wheel to prevent the roll of the vehicle body.
- When braking.
  Addition stiffness is added to the front wheels to prevent 'forward' pitching of the vehicle body.
- When braking.
  Addition stiffness is added to the rear wheels to prevent 'rearward' pitching of the vehicle body.
- When weight compensation is needed.
  Hereby the stiffness of the complete suspension is increased.

A central unit controls the position of the additional spring. It is important that the position of the additional spring anticipates on the expected movements of the vehicle. This can be achieved by measuring signals like the steering wheel angle, or accelerations of the vehicle.

3.5.4 The electro-rims

Electro-rims are not new and even recently used by Fiat in its Downtown prototype. However there are some differences between the principle Fiat uses and the ecologic principle.

My principle is based on the theory that a electro motor is a constant torque motor. But in the same way it should be usable as constant torque generating, thus used as brakes. A short calculation:
Let's assume that the (loaded) vehicle weights about 1000 kg. In case a full brake action I assume the about 80% of the vehicle weight is on the front wheels. Using a friction coefficient of 1.0, the braking force of each front wheel becomes 4000 N (1000*0.8/2*1.0*9.8=3920 N). If the vehicle drives at its maximum speed (120 km/h) and a full brake action is made, 130 kW (4000*120/3.6) is needed for each front wheel. This is a very high power, and I doubt if it can be realised with such small electro rims. It should work if the electro-rim has a constant maximum torque of 1000 Nm (assuming wheelradius of 250 mm) over its full range of rotation speeds. Otherwise it could be necessary to add conventional brakes to the electro-rims.

I think a specialist could help me finding answers for these questions (and admit that I had to face these questions in a earlier stage of the project).

A practical point: If no conventional brakes are added, it is necessary that the electro-rims can be locked as parking brake.

3.6 Phase 4: Second definition of the keypoints

Drawing 4 shows the second keypoints definition. View I and III on this drawing show the principle of the length variation. In the final stage of the project it was detailed further. In the drawing it is shown that the main ridigity of the body is achieved by using a kind of I-frame (high central tunnel) combined with additional strength beneath the doors. These parts are also used to bare the rear part when it moves backwards. The open parts of the body are filled using hard-plastic cover parts.
View II and IV show the packaging in the standard and the long version. A folding-cycle for use in the centre of the city couldn't be worked out any more in this project and was therefore cancelled in the definitive keypoints definition.

3.7 Phase 5: Initial design interior (generate basic ideas)

Drawing 5A to 5F show the basic ideas for the interior. I was not really satisfied with the level of the designs. On one hand I tried to link the design to the retro trend (see 5A and 5B), and on the other hand I didn't yet have the formal design of the exterior to which the interior had to be linked.
If you compare these drawings with the presentation drawings of the interior you can see that only the sub-solutions of the basic interior ideas are used and that the basic shape of the interior is more a continuation of the exterior design.

On drawing 5E, I used my new airbrush. It is clear that I need a lot of practise before using it in presentation drawing. Therefore I postponed the use of the airbrush for more low-stress times.

3.8 Phase 6: Formal design exterior (define formal shape)

It was the end of August when I continued with phase 6. Making a number of 2D and 3D-sketches optimised the exterior. The most important are included (drawing 6A to 6C). It is always interesting to see how a design evolutes. In drawing 6B an idea of the initial design phase (drawing 1F) was adopted. As a result of that more circles were introduced in the design. Not only in the exterior but also in the interior the circle/ellipse is repeated a number of times.

After the formal design of the exterior the design should be fixed, I believe. In practise I believed only that I had a reasonable formal design, but was also aware that 'details' (especially the rear end) had to be worked out further.

3.9 Phase 7: Presentation of the design

Before phase 7, to be sure, the basic idea for the second project (the bicycle) was generated. For the presentation drawings first I made a list of all planned drawings. Secondly I began with setting up the most important drawings. After this all presentation drawings were finished one by one.
In the following I will give a brief comment to each drawing. The sequence is not the sequence in which the drawings were finished.

- Drawing 7A: Packaging drawing (standard and long version).
  When comparing the second keypoints definition with the final one, only a few differences are found. The position of the passengers and driver has changed by moving about 5 cm backwards. This was necessary because the generator and rotary engine are placed side by side in the final layout. The spare tyre and toolbox were not yet drawn in drawing 4. On the other hand the ecocycle is kept out in the final packaging.

- Drawing 7B: The general construction+use of materials.
  This drawing is pure functional and shows the use of the materials in the ecologic. As is shown the body consists of a aluminium frame with hard-plastic coverparts. Aluminium has been chosen to achieve a lower weight of the vehicle. Further it is known that aluminium, compared with steel, has a much better durability (corrosion) and it recyclability is better (probably because of the less complex mixture of elements and its lower melt temperature). The strength and stiffness from aluminium is less than steel. However, using special profiles can compensate this disadvantage. Aluminium is also used for the rims. The coverparts are made of a hard and soft-plastic. Soft plastic is used for the bumpers. The plastic coverparts have no technical function; so can be kept thin and more flexible.
  Steel is used for those parts where strength and stiffness is important, such as the front-, rear- and side impact protection, but also for the rear module.
  The complete vehicle is build up from three modules:
  . the main body +
  . the power and suspension unit in the front part +
  . the rear end module, including batteries and fuel tanks.
  Special attention has been payed to the isolation of the battery units (because of the high temperature of the batteries when operating).
  The tyres used are new 'green' tyres with low rolling resistance, low tread wear and good recyclability.
  Chromium (like) coverparts are used to strengthen the 'retro-look' of the ecologic.

- Drawing 7C : The rear end construction.
  All yellow and yellow-brown parts in this drawing are moving backwards if the ecologic is extended. The rear part is bared on 5 places (one central, , one beneath each door, and two in the roof (telescopic bearing)). The central unit is locked and unlocked using small electro motors (see section A-A). The white block in this view is shifted up to lock shifted down to unlock the rear unit.
  In the top view the thick dotted black line shows that the suspension modules are only partly connected to the central unit. This was necessary because it had to fit around the B-post of the body-work.

- Drawing 7D : 3/4 front view.
  This drawing was made using the colours and drawing style which match with the general character of the design. The blue-green and red-brown are two nature colours, but also give the

ecologic an unconventional look. The drawing style is sober to accentuate the integrity of the design. Finally chromium covers give the design is exclusive retro-look.
The design is build up combining modern and classic style elements.
The circles (and ellipses) are repeated a number of times.

- Drawing 7E : 3/4 rear view.
  Compared with the 3/4 front view, in which the dynamic appeal of the design is accentuated, the 3/4 rear view is (I think) more a combination of frivolity and friendliness.
  Not drawn, but nice is the possibility to use the lower part of the bumper as standard for example bicycles by pulling it backwards.
  On the rear side the opening is located for fuel and loading the batteries.

- Drawing 7F : 2D-presentation exterior (standard version).
  This drawing shows the some details like the methods for opening the doors. It also shows the possibility for opening the roof.

- Drawing 7G : 2D-presentation exterior (long version).
  This drawing shows how the ecologic can be transformed from the standard to the long version. I chose for the user friendly electrical way. It could of course also be done by hand, but that would disappointments for the user (it is a upperclass car and has to be equipped in conformity with this). The central processor is used to give online instructions. After the rear unit is pushed out and locked, the coverparts have to be mounted. I have chosen for hard plastic cover parts that are normally stored in a garage. Carry the parts standard would lead to extra weight. Further I expect that the transformation from standard to long version (or back) can easily be planned, because mostly, before leafing home, you know which version is needed.
  The drawing also shows the transformation of the rear seat. Both rear seats can be transformed separately, or fold up if more luggage room is needed.

- Drawing 7H : Interior view (general layout).
  As mentioned in phase 5, the interior design was postponed to this final phase. This was not a good idea, because it caused me a number of problems before coming to a satisfying design. The design of the interior refers to the circles in the exterior design. The circles used for the dashboard unit and the storage unit have the same dimensions and are therefore interchangeable (for left-driving countries). For the same reason the central dashboard unit (in retro-style) is symmetric. On top of the central dashboard the central processor is located. This processor works as navigation system and supports with online help. By using the navigation system the rotary engine can automatically be switched on when leaving the city area combined with a low battery level.

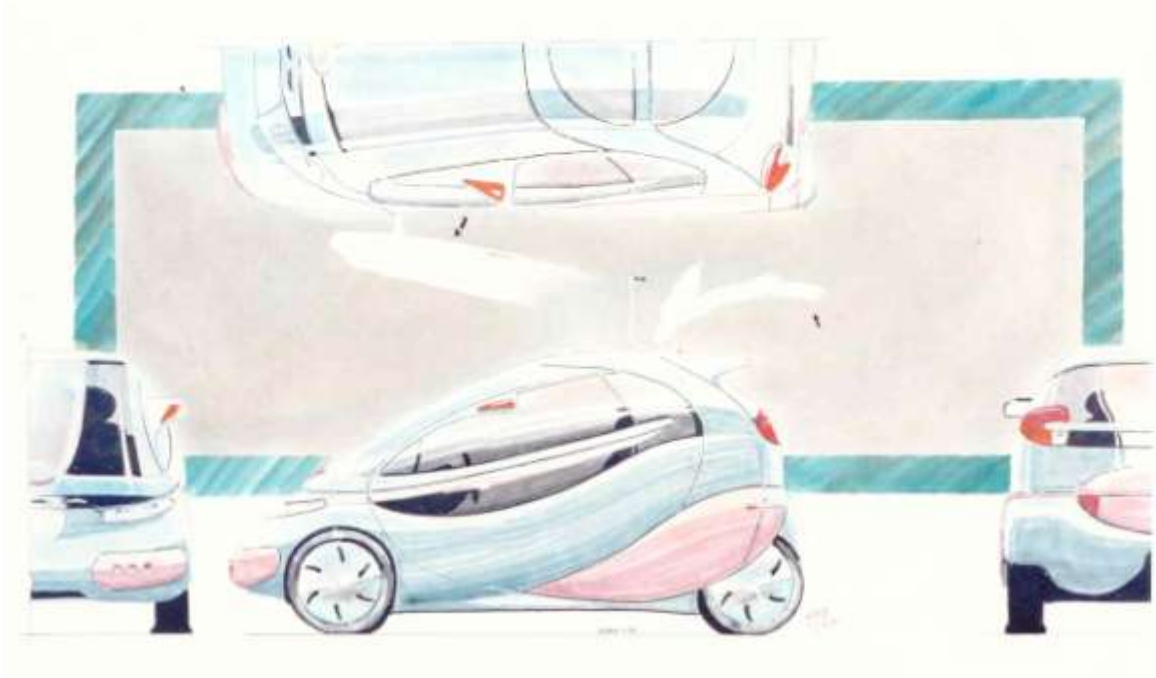
- Drawing 7I : Interior view (details).
  For drawing the interior, the second drawing was made using softer colours (because I was not really satisfied about the first one). Because I had not yet designed the details of the interior, I was lucky to be able to make this drawing afterall (work abroad took less time than expected). It shows that on each side of the steering wheel a wing-like handle is used instead of classical handles. The left handle is used to switch the lights, the right one for the windscreen wiper(s). The upper and lower button on top of each wing can be turned also. The display is semi-analogue. I tried to keep the dashboard simple. As a result of this I choose to give a speed indication by speed/10. So 50 km/h is indicated as 5. However to be able to read the 'exact' speed, a analogue display is added consisting of 10 partitions of 1 km/h. Because of the presence of a navigation system it is also possible to get information about the maximum or advised speed. Two red lights will light up you are driving faster than the maximum speed. The same lights blink if you are driving faster than the advised speed.
  In the dashboard three main colours are used: yellow for the digital speed display, green for the analogue part if the display, and red for warnings.
  The other colours are orange/brown (blue for maximum light).

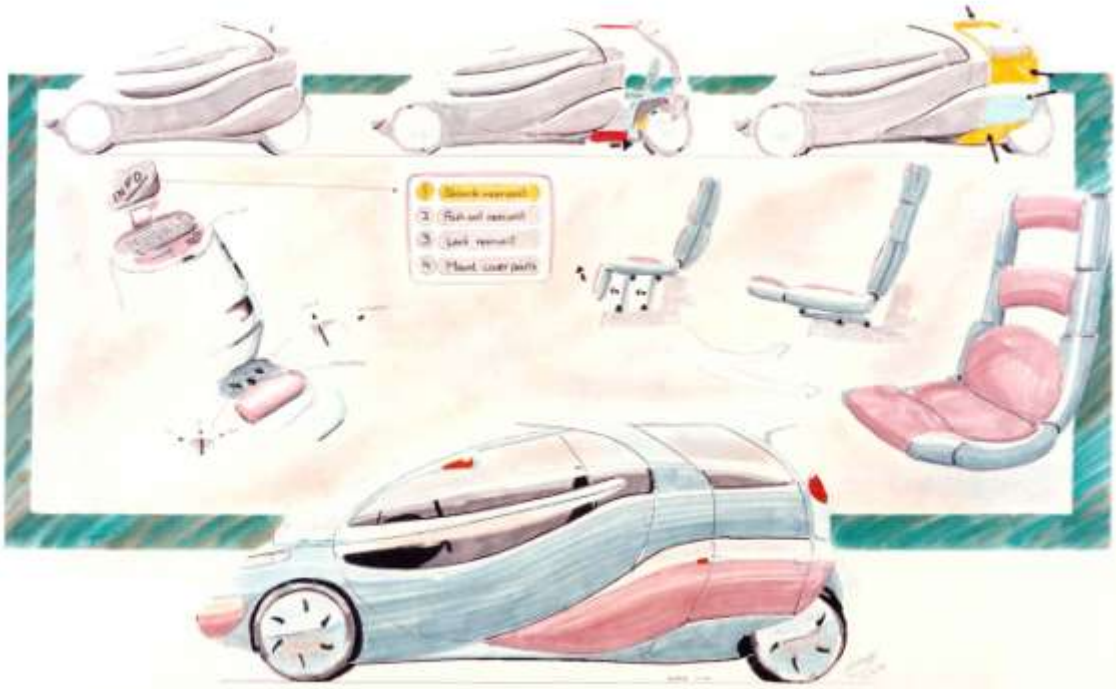
Four analogue displays indicate the fuel level, the battery-capacity level, the rotational speed of the rotary engine and its temperature. The central of these four display lights up red to warn the driver.
If the central warning sign lights up, the user has to listen to the 'voice' and read additional instructions on the online help system. The speaker of the voice is places on the left side of the speed display symmetric to the distance display.
The ecologic is switched on/of using the same remote control as for (un)locking the doors.
When opening the storage unit cups and pencils can be hold in the holes.

- Drawing 7J : Ghost view.

In the ghost view all aspects of the design are combined. The drawing shows, the suspension system, the power unit in front and the batteries and fuel tanks in the rear end and the passengers compartment. The seats are included in this drawing too (I only drew the two seats on the left side). Each seat has it's individual integrated seatbelt. The two front seats have airbags for the rear seats.
Further has to be mentioned that the windows (only the upper part) can be opened (electrically) in a conventional way by moving along the inside of lower part.

3.10 Drawings Ecologic

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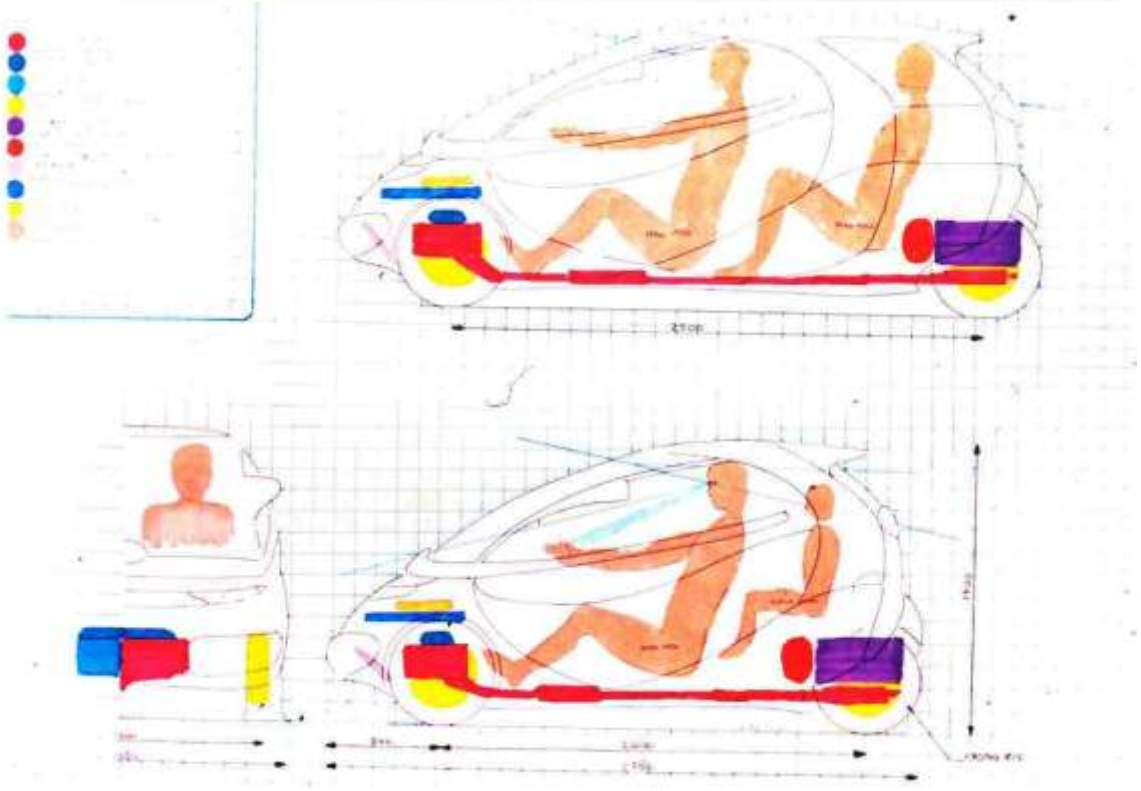

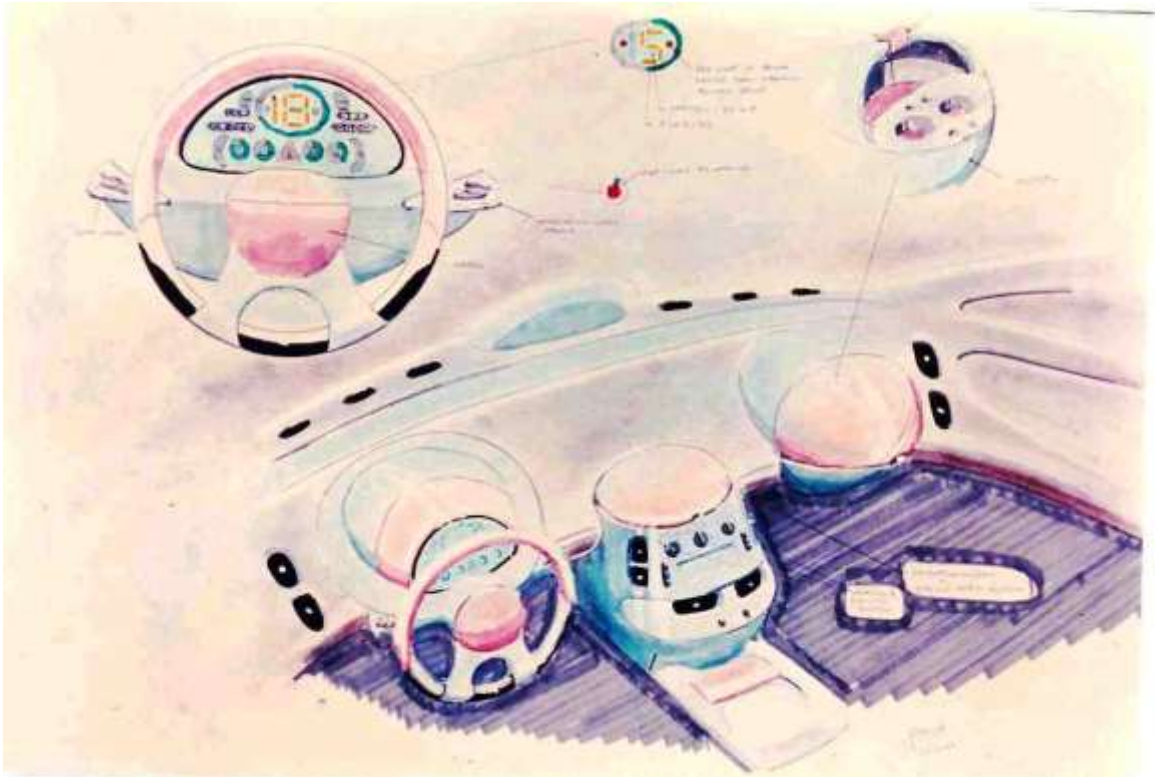

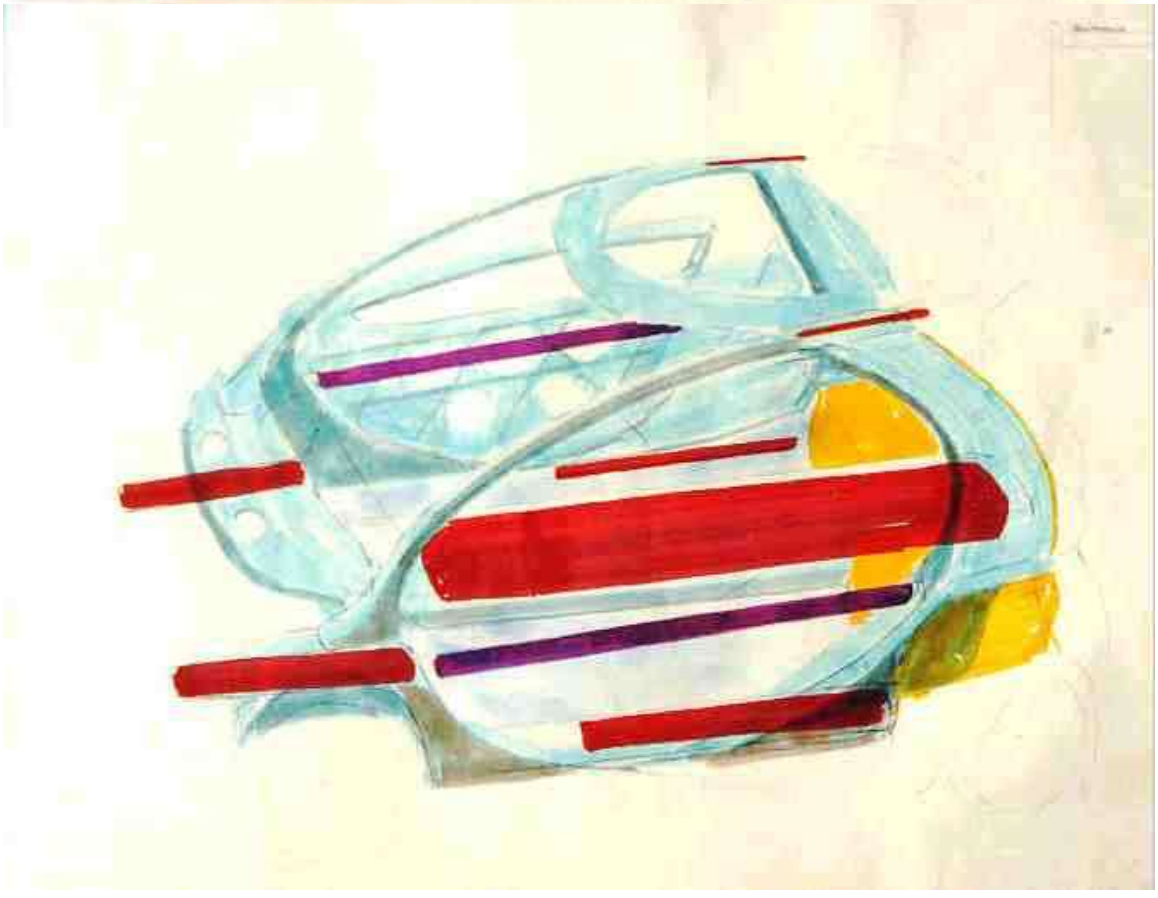

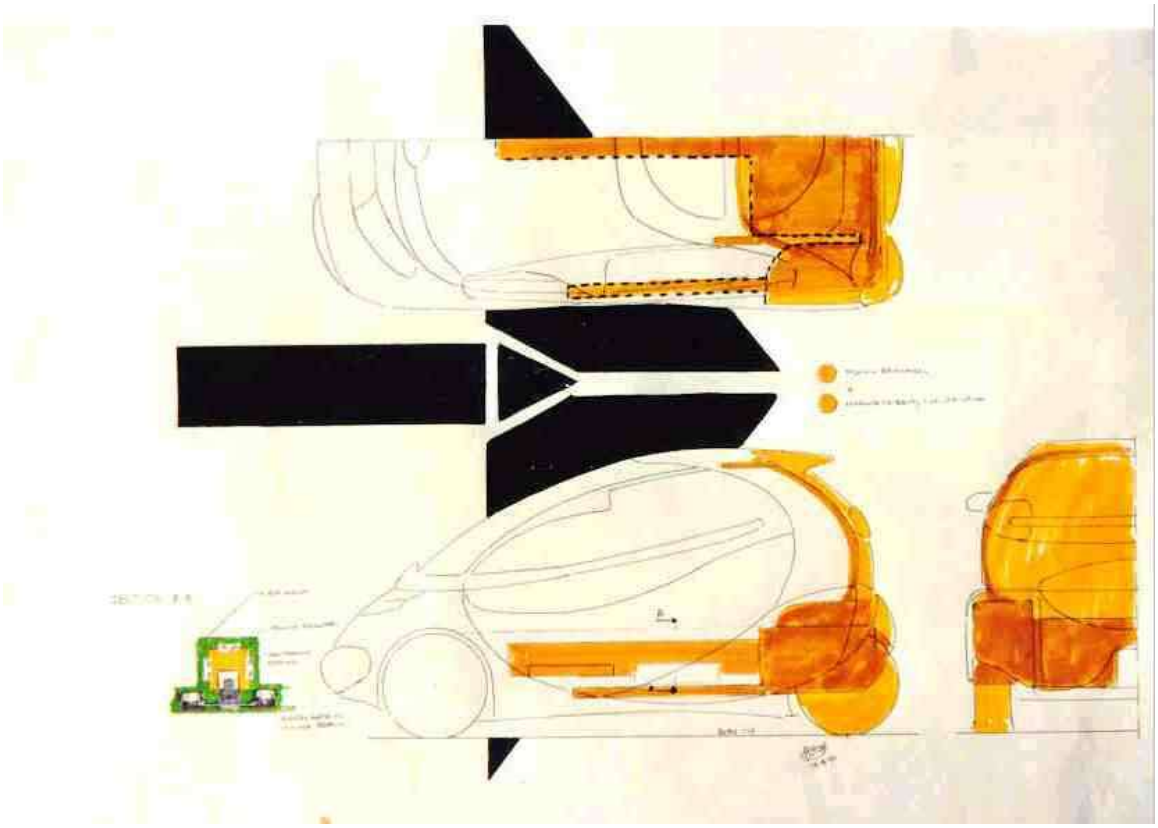

4 PROJECT INVOLVING A CHOICE: BICYCLE

4.1 Introduction

As mentioned earlier in the introduction of Chapter 2, the bicycle points to the same group of users as the ecologic. It has to share ecologic's character and fulfil the mobility demands together with the ecologic. It is again a rational choice to user either the car or the bicycle. Maybe even more than for the ecologic the bicycle is build up around my own ideas about cycling. It is the first time I designed a bicycle. Nevertheless the basic idea was settled in less than one hour. It was worked out further in the presentation drawings.

The bicycle is based on the ergonomics of the so-called hybrid-bike. This bicycle is a mix of a racing-bike and an ATB. It can be used for functional and recreative cycling. Special demands were the ability for using it for (my favourite) cycling vacancies.

The project consisted of only two phases, the initial design phase and the presentation phase.

4.2 Initial design

This was simple; I took my measuring-tape, went to my bicycle and registered its dimensions. Two days later, at my parents place on a beautiful Sunday morning, I made some sketches to see what would come. Already the fifth profile sketch showed a good idea (see drawing 8A). A few hours later I made a 3D sketch

(drawing 8B) and was also satisfied about this. Only for the idea of course. All the details had to be worked out later.

4.3 Presentation drawings

- Drawing 9A : Profile during daily use.
  The bicycle has a frame made of lightweight material, probably aluminium or a composite material. The frame is characterised by two crossing lines. One from the saddle to the front axle and one from just above the front wheel to the crank-shaft-unit. The frame is build up from three parts:
  . From top front wheel to crank shaft unit (part 1).
  . From saddle to the crossing with part 1 (part 2).
  . The rear suspension connected to part 1 and 2 (part 3).
  The parts are mounted together (see detail 2 on drawing 9A).
  The 'drive-line' is conventional (derailleur). Both front and rear wheel brake using drum-brakes. The dynamo is built in the front wheel axle next to the drum-brake. The front suspension is rather unconventional because I choose to use the vertical part for the vertical strength and the horizontal part for the horizontal strength. The steer is detailed too. It includes a integrated front light with a battery (loaded by the dynamo). This enables to be seen also if you are not cycling. The light is switched on using a button on top of the steer. Of course a cycle computer is integrated in the steer. For the safety the steer has no sharp edges. It is covered by cork because of its good isolating and damping capacities. The gear is selected using the red balls. Also for the safety the steer has no traditional brake-handles but a brake-cable that can be used over the full 'length' of the steer.
  Because a luggage carrier is not always used, this design has a carrier that can be folded up if it is not needed.
  Even if it looks like that, the steer and the saddle have no spring in between them and the frame.

  The lock is integrated in the frame (just under the carrier).

  The round grey coverparts not only have a aesthetic function (keep technic out of sight) but also helps to prevent dirt from getting in.

- Drawing 9B : Profile during cycling vacancies.
  Since my first cycling vacancy, when I was 9 years old, it is my favourite way of spending my holidays. This summer I was in the south of France enjoying the variety of the landscape and the joy of cycling up hills, down hills and in between hills. The cycling vacancy-outfit if the bicycle is therefore based on these experiences.

  In general all bags are made of the traditional material, but sealed on a very light plastic frame (grey-coloured in the drawing). This frame makes it not only easier to mount the bags on the frame of the bicycle, but also keeps them in shape if these are not completely filled. I designed three bags: one for the front wheel (on both sides of course), one for the steer and one at the rear.
  All bags can easily be mounted by screwing. Special attention is payed to the functionality of the bag at the rear. This bag has two parts. The top part can be removed if not needed. Other details are the grooves on the top for better grip for a bottle with water and the tent. In case of rain a rain shield can be fastened using the special rings. On the lower part extra strong binder rings are placed to hold the luggage on top. When visiting cities or shopping it is not possible to take off all luggage. To solve this problem, the integrated special sack can be used to carry a handbag.

  The zip-fasteners are used to close all bags.

4.4 Drawings Ecocycle