

Branding and design propositions for HED transmission systems for heavy construction equipment

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ABSTRACT

EM Center is a recent business unit of BAE Systems Hägglunds with the aim to adapt the electric hybrid drive line solutions developed for their military SEP vehicle to the civil market. The target customer group are Original Equipment Manufacturers of heavy vehicles operating under conditions where the hybrid drive characteristics are particularly beneficial and can be utilized in a more optimal way. This thesis tries to answer the question: *how can EM Centers products be presented to the target customer group in a attractive and selling way that clearly reflects the company and its brand identity profile and through this contributes in creating a sustainable market position and competitive advantages?* and results in a brand identity suggestion for EM Center as well as a product design communicating the chosen values. In order to do this, branding options with varying degree of differentiation from BAE Systems identity are examined as well as visual product design shape personalities.

Keywords: Visual Brand identity, Product design, Hybrid Electric Vehicle

PREFACE

Since I initiated my university studies in 2003 I've had the chance to, among other things, spend some time in Milan as an exchange student, finish a bachelors degree in economics and now finally my engineering studies at Chalmers. This master thesis, where I'm trying to highlight the importance of a relevant design regardless of product type, is hence the final part to many years of studies. It should cover the main things I've learned within the programmes Industrial Design and my specialization Automotive Industrial Design Engineering.

The work has been extremely inspiring and very educative. I've had a wonderful time in Örnköldsvik and at BAE Systems- where I'm very happy to currently be working within my favorite field marketing and communications.

Basically I would like to thank all new people I've met that have helped me adjust to this new town and company. I do however have to send a special thank you to Göran Westman, Pontus Karlsson and Ralf Rosenberg. Thanks to Göran I got the chance to come here in the first place (which I'm more grateful for every day that passes), Pontus, that has been following my everyday work at BAE Systems, has provided me with more feedback than I possibly could have hoped for, and Ralf has kept me focused on producing a work that actually represents what I should be able to achieve based on my study experience.

I also want to thank all colleagues at EM Center as well as Marina Bonn that, to a great extent, was the reason my work actually has been put into practice and further developed.

Lastly I want to thank my family and especially my father. His arguments and reasoning has definitely improved the outcome of this thesis, and knowing that he thinks I've done a good job means the world to me.

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ABBREVIATIONS

B2B	Business to business
B2C	Business to customer
BAE Systems	The company name emerged from the union of British Aerospace (BAe) and Marconi Electronic Systems (MES)
G	Generator
HED	Hybrid Electric Drive
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
OEM	Original Equipment Manufacturer
PC	Power Converter
SEP	Splitterkyddad Enhets Plattform

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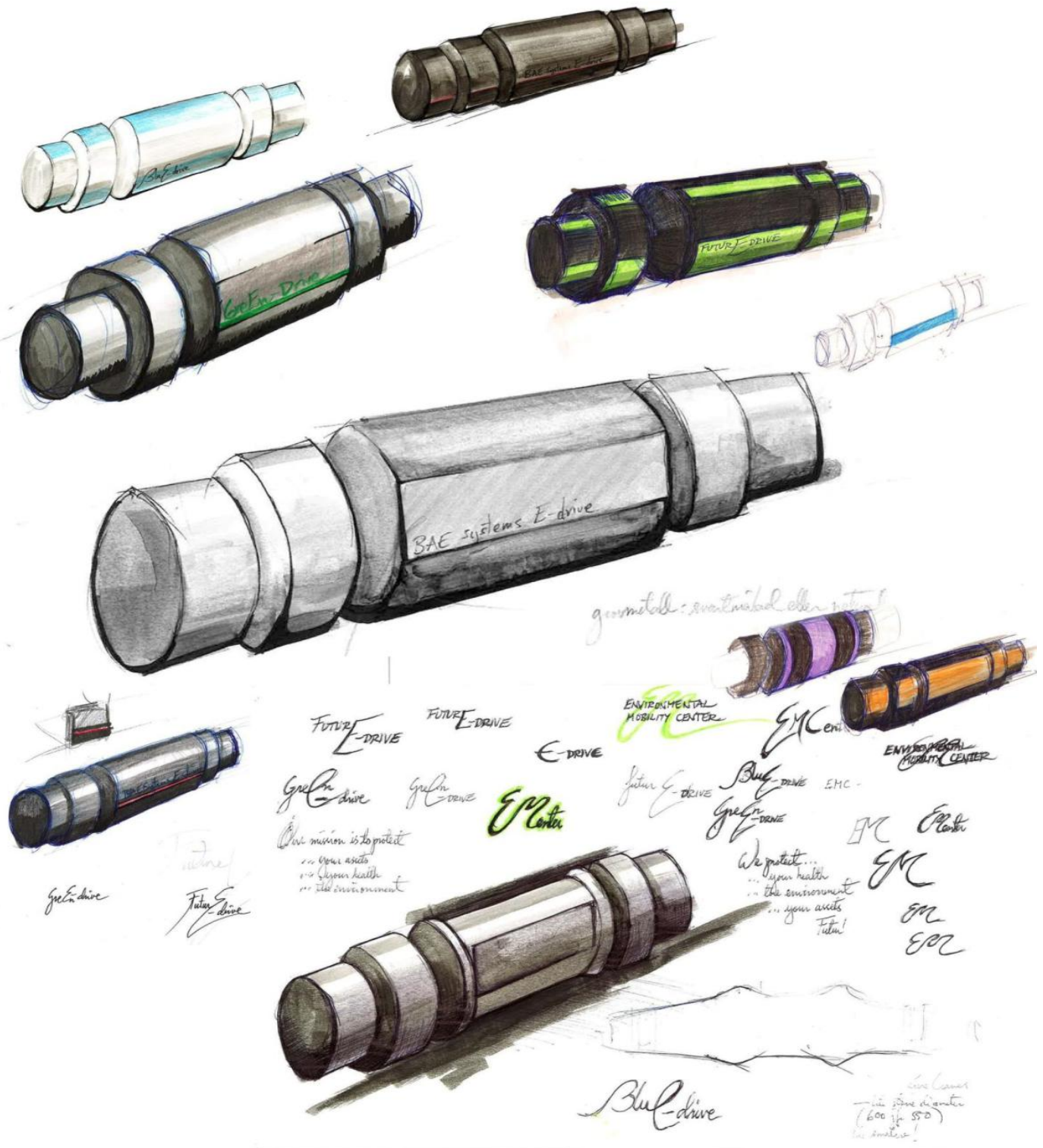
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Conceptual scetches of the E- drive axle



1. INTRODUCTION

1.1. BACKGROUND

The predecessor to BAE Systems Hägglunds was called AB Hägglund & Söner and founded 1899 in Örnsköldsvik. Through the years the business has varied between everything from woodwork to furniture to aircraft and in 1957 they first initiated the production of military devices starting with top turrets and continuing towards the armoured and infantry fighting vehicles area. The company was later branched into different business areas that today are parts of Hägglunds Drives, Cargotec and BAE Systems. BAE systems is a global defense and security company with about 107 000 employees worldwide. They provide products and services for air, land and naval forces as well as advanced electronics, information technology solutions and customer support. There are three business units in Sweden: Bofors, C-ITS and Hägglunds. Hägglunds today manufacture primarily infantry fighting vehicles (like the CV90), armored all-terrain vehicles (like BvS10) and turret systems.

Environmental Mobility Center, EM Center, is a business area of BAE Systems Hägglunds founded in 2009 with the aim to adapt the hybrid transmission technology developed for the SEP program (short for Standardiserad Enhets Plattform) to the civil market. Analyses of the market have identified a suitable target customer group among Original Equipment Manufacturers, OEMs, of heavy construction equipment vehicles and heavy special vehicles. The majority of companies providing Hybrid Electric Drive, HED, solutions today are targeting OEMs of lighter vehicles like busses or trucks. At the same time the demand for HED solutions among OEMs of heavy vehicles are increasing. The benefits in e.g. fuel savings and increased productivity enabled by HED solutions for this vehicle group are substantial. Although some of the biggest companies are developing hybrid transmissions of their own, far from every OEM have neither the money nor the time nor the knowledge to do so. EM Center's vision is to become *"the leading global provider of hybrid electric drive systems for medium and heavy special vehicles"*. EM Center's task is hence to manage every aspect of the core product; from business development, marketing and sales to deliveries and participations in national development programs. Further EM Center will provide *"in-house engineering"*, which gives OEM companies the possibility to benefit from EM Center's engineering knowledge and get help with e.g. testing and manufacturing.

The concept is internally called E-drive and is a complete solution that offers customers a simple way to, partly or entirely, implement hybrid drive lines to the vehicles. Hybrid

systems can basically either be built up in parallel with the energy storing technology simply as a supplement to the traditional drive line, or, which is technically more challenging, in series where the traditional propulsion system is replaced by electric transmission, comprising generator, power electronics, electrical machines, energy storage and a hybrid control unit. In order to fully grasp the technology and be able to offer ultimate solutions EM Center is focusing on developing the series hybrid configuration although they are wholly capable of offering also parallel and complex systems. The system is module based, which makes it possible to implement into a vehicle in a volume-weight optimizing way and to modify according to the customers/vehicles demands on, for example torque and power. The most differentiating aspects with Hägglunds product from competitors is that the electrical engine is mounted axially which, due to the need of no bevel gear, even further reduces space demands.

The reason the E-drive configuration is a success is because of the electric motor characteristics in combination with the series coupling. Electric motors are characterized by high torque from standstill opposed to conventional combustion engines connected to torque converters and automatic transmissions. This enables increased productivity and reduced fuel consumption by allowing the Internal Combustion Engine, ICE, to work in a more optimal way. The series hybrid configuration, with energy storage, is especially favorable for vehicles with frequent accelerate-decelerate operating conditions since it is possible to recover maximum regenerative energy from breaking. Further, there's no need for mechanical coupling between the ICE and wheels which, in combination with the overall modular architecture makes the system very flexible and hence adaptable to the majority of vehicle geometries.

1.2. PURPOSE AND AIM

The strategy planning of this civil investment is rather far advanced but a lot is still undone at the same time as the market conditions continuously change. To be able to get a strong market position and share it is important to create a consistent, clear and transparent product identity/ platform to work from. This in turn helps in creating a strong brand awareness among customers which is a prerequisite to succeed. The purpose of this paper is to present and examine different branding propositions for EM Center and E-drive based on, for example, market studies (strategies among competitors), and degrees of differentiation from BAE Systems brand standards as company as well as to examine the product design possibilities and limitations. The aim is to present a final brand strategy suggestion for the business unit as well as a product design language communicating the selected values and strategy through shape elements and implemented design cues.

This paper can also be read as a description of how design work can be done at a big, technical- utility producing, international Business to Business (B2B) company; where problems can emerge and compromises are needed.

1.3. PROBLEM DEFINITION

This Master thesis will try to find an answer to the following question: how can the product be presented to the target customer group in a attractive and selling way that clearly reflects the company and its brand identity profile and through this contributes in creating a sustainable market position and competitive advantage?

1.4. DELIMITATIONS

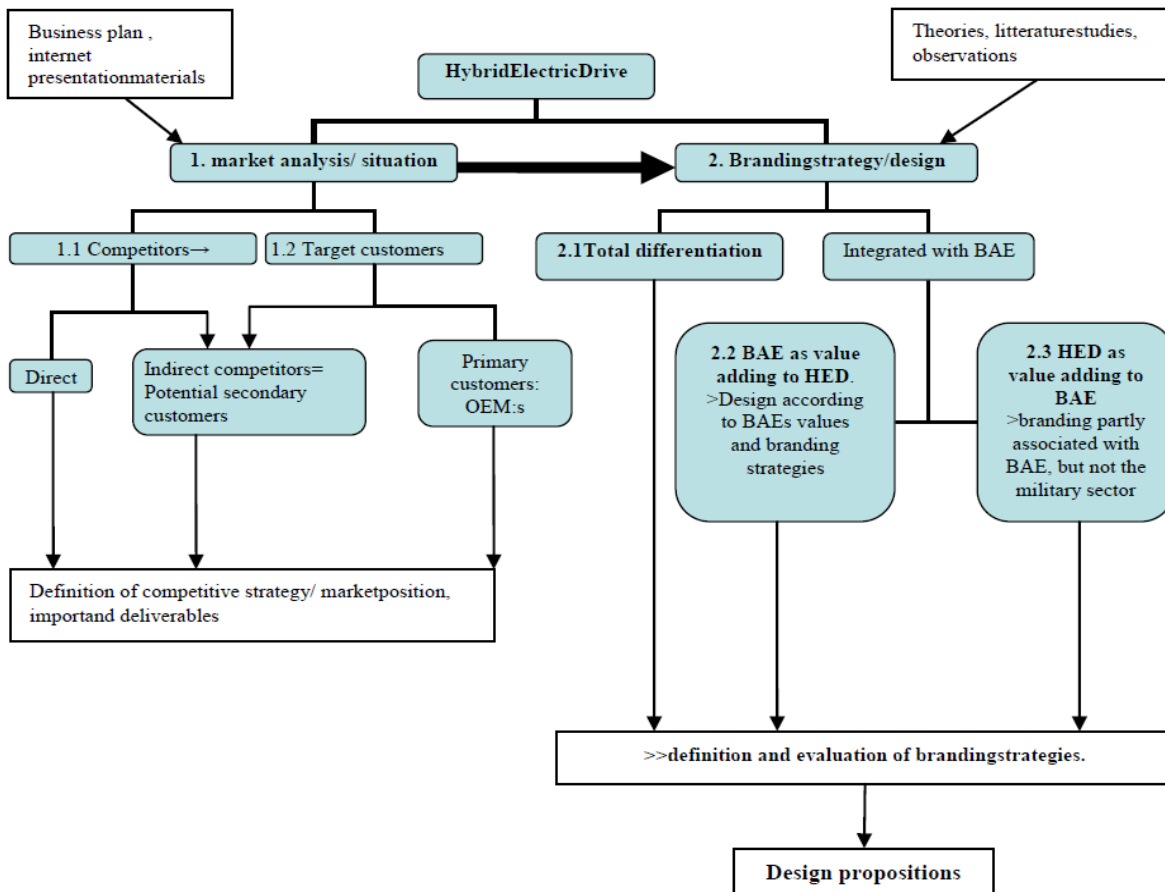
According to the first (preliminary) business plan the HED investment should be *”organized in a separate, wholly owned, legal entity”* to show strong commitment towards the civil sector, it’s demands and culture. The entity should further share resources and results with BAE Systems whenever feasible in order to avoid sub-optimizations. Furthermore BAE Systems has a strong organization with extensive defined brand standards. These definitions will not be seen as delimitations in this thesis, but pros and cons for concepts of different degrees of differentiation from BAE Systems will be analyzed as freely as possible.

The evaluation of the concepts presented are focusing on and considering only the visual design and branding aspects. The relationship between BAE Systems Hägglunds and EM Center, (legal aspects, how technological knowledge and resources are exchanged and shared etc.) will of course greatly affect the evaluation results. These practical factors are not the focus of this thesis though, and they will hence be neglected although they, in reality, are important to consider before making final branding decisions.

The names EM Center and E-drive are used throughout this thesis to facilitate the reading. These are not final denominations and in the final concepts some other suggestions are presented.

1.5. METHOD

This thesis has been written during autumn and winter 2010-11 at BAE Systems Hägglunds Örnköldsvik. Basically the work consists of four major parts; Theory studies and market analysis (no1 in picture 1), shape design and characteristics (the prerequisites for E-drive), Brand strategy analysis (no2 in picture1) and final branding and design suggestions. An



overview of some areas examined in this thesis is seen below (Picture 1).

Picture 1: Some areas examined in this thesis

The first part covers basic knowledge and theories needed in order to be able to understand the business situation and its prerequisites. It consists of a technological overview as well as a market analysis as extensive as possible (different hybrid techniques, BAE Systems brand strategy, the E-drive product, description of customers, competitors, their branding and their production). The information is a mix of primary and secondary data gathered from literature studies, EM Centers internal documents, discussions with people working at EM Center and BAE Systems Hägglunds, as well as from internet websites, magazines and

observations. The information is used as benchmark material and constitutes the basis for brand building and profile work for EM Center and E-drive and hence contributes in creating the brand and product identity.

The second part focuses on the product characteristics and design possibilities for E-drive. Different shape alternatives are examined and evaluated through a comparative survey. The survey is conducted among 20 people in order to determine differences in perception of 10 shapes. The respondents are kept unaware of the technical aspects in order to get as reliable answers as possible considering only the shape personalities, and results uninfluenced by factors as manufacturability or function.

Thirdly three branding concepts with different degrees of differentiation from BAE Systems brand strategy are described and evaluated through SWOT analysis and workshop discussions with the employee group at the moment working with EM Centers brand identity. The concepts classification is made in order to cover the whole scale from identical identity with BAE Systems to total differentiation. Furthermore basic product designs are presented for each concept. The concepts have served internally in the company as a basis for discussions around the branding of EM Center in order to find the optimal branding strategy. BAE Systems Hägglunds branding work for EM Center has run in parallel with the work with this thesis and will continue throughout spring 2011. Hence the final branding strategy presented in this thesis is a proposition independent from BAE Systems Hägglunds final decisions.

The final branding proposition in this thesis is made primarily in order to determine directions for the product design work and to be able to use the results from the second part in a relevant and successful way. Final product design propositions communicating the chosen identity are made. The designs are individually evaluated through surveys among 20 respondents in order to evaluate how successfully the design transmits the chosen values and characteristics to the observer.

2. THEORETICAL FRAMEWORK

This chapter contains useful knowledge for the understanding of the subjects discussed in this thesis: a short description of hybrid technology, the fundamentals of branding and its purpose and how BAE Systems is reasoning around the subject, as well as a description of the present market situation.

2.1. HYBRID TECHNOLOGY

In order to understand EM Centers' business area and product offering a basic knowledge of Hybrid Electric Drive, HED, technology is required. The E-drive system of today, more closely described in chapter 2.4, is a series hybrid configuration due to the system benefits in general and the target customer group requirements in particular. However, EM Center can just as easily provide parallel or complex hybrid solutions thanks to the knowledge acquired through the extensive development process of the SEP vehicle and the complexity of the E-drive solution.

There are several benefits to using hybrid transmissions among which reducing fuel consumption and dependency naturally is a major one. By succeeding in doing so you don't just achieve cost and emission reductions, which leads to a better working environment, but also get a significant advantage compared to competitors using conventional fuels when it comes to political emission regulations which tend to get increasingly strict. The reason hybrid configurations allow for fuel reductions is that the combustion engine (primary power source), is complemented by electric motor(s) (secondary power source) and usually some kind of energy storage. This makes it possible to decrease the size of the ICE while at the same time allowing it to operate as close as possible to its optimal RPM- torque interval (in which the fuel consumption is minimized). A combustion engine's torque is minimal at low RPMs and hence a large engine is necessary for acceleration from standstill. The amount of power that engine can provide is at the same time far more than needed for steady speed cruising. Opposed to this the electric motor delivers maximum torque at standstill and is hence well-suited to complement the ICEs torque deficiency at low RPMs which, depending on the hybrid architecture, allows the combustion engine to operate in the intervals it was designed for. (Chan, 2002)

Hybrids also allow recuperation of regenerative energy while braking (if energy storage unit exists) which is especially useful for vehicles operating in cycles of frequent acceleration/deceleration. The accumulated energy can later be used, for example, to drive limited distances with zero-emissions or for launching the vehicle from stand still.

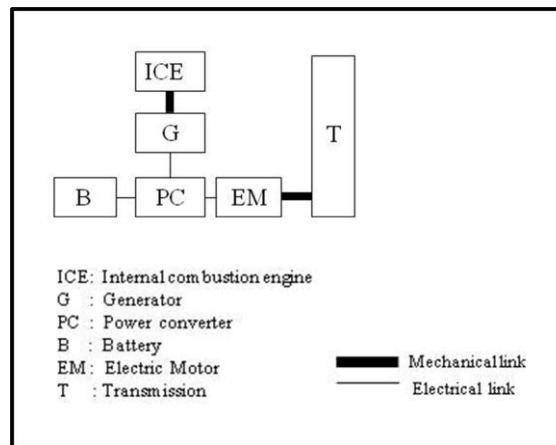
There are different classifications of hybrids. One is to divide them into groups depending on the hybridization rate (HR), (Picture 2), that is a quantification of the relation between power available from secondary source and total power available in the drive train. (Liao, 2004)

Picture 2 the equation to calculate the Hybridization Rate of a vehicle

Depending on the HR the vehicles are divided into (micro), mild ($HR < 23$), semi ($23 < HR < 28$) and full ($HR > 38$) hybrids: Mild-hybrid vehicles only feature start-stop and regenerative braking functions, semi- hybrids furthermore use the available electric power to accelerate and boost the vehicle. Full hybrid further has enough electric power to drive purely electrically for a limited distance. (The micro hybrid has a smart energy management (Koot, 2006) for powering onboard auxiliaries through a generator but features break energy recovery very limitedly.)

The most common way is tough to divide them into parallel-, series, parallel- series and complex (power-split) hybrids depending on the function/ construction of the drive line.

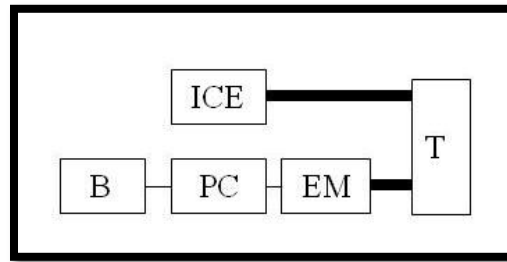
Series hybrids are preferable in a lot of ways. The ICE mechanical output is directly converted into electric energy via a generator and used to propel the vehicle via the electric motor (Picture 3). Hence they do neither require a mechanical coupling between the ICE and the wheels, nor an energy storing device. This makes the layout very flexible when it comes to the placing of components and it's further possible to reduce the amount compared to parallel drive line solutions. The ICE can operate on rather constant RPMs which makes the emission configuration rather fix and hence easy to filter efficiently. The electrical engine can also be used as a generator to recover regenerative energy from braking and for vehicles with operating circles with, for example, frequent acceleration/deceleration this configuration is optimal. The operation control of the ICE constitute a big challenge for this layout though, especially if without energy storage.(Chan, 2002)



Picture 3: Series Hybrid Typology

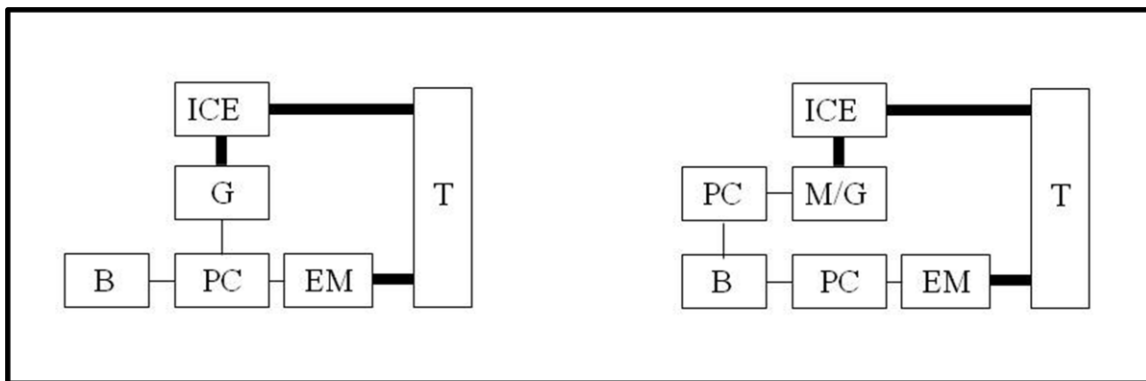
Parallel hybrids gets their names from the fact that the ICE and the electric motor are, simply, coupled in parallel which makes it possible for each power source to either work independently or to assist each other in propelling the vehicle. This is the most common hybrid system frequently occurring today in busses etc (an example is BAE System U.S. that have developed this hybrid system for city busses). The layout (sometimes) makes it easier to incorporate parallel hybrid transmissions into vehicles than the series layouts, since it is a complement to already existing drive trains and normally only small alternations are needed. Since there are

two ways to guide the mechanical energy, as well as few transformation steps, the losses are minimized (Picture 4). The electric engine can work as a generator and transmit power from the ICE to the energy storage when the power output is bigger than required to drive the wheels. It can also recuperate regenerative energy from braking, but only to some extent: this layout often gives the electric engine lower power output than the ICE, and hence it prevents maximum recuperation. Further the system requires both an energy storing device as well as a mechanical coupling between ICE and wheels, which makes the layout less flexible than the series hybrid. (Chan, 2002)



Picture 4: *Parallel Hybrid typology*

Complex hybrids are a combination of the two above and hence they possess both the negative and positive characteristics of both series and parallel hybrids. The ICE can work on optimal RPMs at the same time as the fuel consumption can be minimized. The system does though require both a mechanical coupling between ICE and wheels as well as an extra generator (compared to the parallel configuration) which makes the installation less flexible and the system more complicated and costly- for civil customers this price- level is substantial. There are different variants of this configuration among which two are shown here below (Picture 5). The main difference between them is the unidirectional power flow of the generator in the series-parallel configuration as opposed to the bi-directional power flow of the electric motor in the complex configuration. This allows for versatile operation modes like for example “three propulsion power” (ICE+ two electric motors) (Chan, 2002)



Picture 5: *Series-parallel typology versus Complex Hybrid typology*

2.2. VISUAL BRAND IDENTITY, PRODUCT DESIGN AND INTERPRETATION

When developing a business plan, choosing target market and positioning strategy towards competitors it's hardly ever enough just to identify an unmet need, or to have a superior product, but the design, branding, communication and marketing towards this specific group has to be done in the right way. Competition is huge in almost every business area these days and in order to attract the customer interest and attention you have to stand out from the masses. To cite Fortune magazine: *"In the 21th century branding will be the only unique differentiation between companies"*.

The profile, channels and attitudes chosen when communicating with the customers shapes their perception and mental positioning of the brand or product. It's a combination of consequently used parity and differentiating points from competitors on all levels that affect how strong and competitive market position that is attained. It is hence not just direct design or technical attributes that decide how products/brands will be perceived, but the quality of communication between sender and receiver, that is, to what extent the brand is capable of consequently communicating the message in a way that is understood by the customer.

Since all the company activities send signals to the customers it is important that the transmitted message is unambiguous and relevant in order to create strong brand equity (Kapferer, 2001). Brand equity is most easily defined as the "added value" in the brand definition:

Brand= physical product+ package + added valued.

This immaterial value consists of the parts Name Awareness, Brand Loyalty, Perceived Quality and Brand Associations, that summed up can be equivalent the difference between success and failure.

In design work it's usual to talk about Brand identity. Identity is a complex concept that can be analyzed at two levels:

- Tangible level. Identification of brand belonging through visual resemblance/ diversity with competitors, consistent use of design elements etc.
- intangible level, that describes different corporate processes, values, mission, vision, mental emotional factors and heritage

Monö (1997) describes four ways through which this identity is communicated: the product (form design, function), visual communication (e.g. advertising, brochures, visit cards etc), verbal and social communication (representation, customer relations, corporate culture), and environment (location of business operations). It's important that these four communicate a consistent identity message. Design management is an area that works interdisciplinary with all corporate units in order to achieve this unified design language according to brand vision and business idea. Corporate internal guidelines often called Brand Standards are defined in order to facilitate this. They describe the corporate identity (vision, mission, values, personality), in detail how the company presentation material should be designed with rules for logo use, fonts, colours, pictures etc, how the layout of stationary should look, signs, etc. All with the purpose of creating a unified corporate profile, internal and external.

2.2.1. THE PRODUCT IDENTITY

It's just as important for the product to have a strong brand as it is for the brand to have strong products. This is most easily achieved by letting the product identity be part of the brand identity (Karjalainen, 2004). According to Kapferer (2001) the product is the first source for brand identity recognition for companies and hence the design should mirror the brand's core value, corporate culture and philosophy. Besides communicating brand belonging the product form design should further clearly express the product's characteristics and the aim of the product, or to cite Monö (1997) "In contrast [to art], things which are designed to be useful, must be understood to be useable" e.g. what is the product, how does it work, who is supposed to use it and how is it supposed to be used. Hence product design has a communicative function as it is an important part in transmitting the defined brand identity.

The relationship between the understanding of design and the core values can be described as a semantic transformation (Karjalainen, 2004). Product semantics is an area that studies the psychological relation between the customers' perception of the design and its function/meaning, e.g. the meaning of product signs and how they are interpreted. Semantics can be seen as a way of trying to create logic in the design work (Krippendorf, 1989) and explain how it affects the creation of product identity (Monö, 1997; Warell 2001).

In conclusion the product identity is defined by the company and answers the questions; What is the product, how is it and what values does it transmit (what is the brand "soul"?). It describes how the company wants the brand/product to be perceived by the public. Brand/product image, on the other hand, answers how it in reality is perceived and unsuccessful identity communication can result in fatal deviations between identity and image. (Warell, 2001; Mårtensson, 2009) The product identity is supposed to give meaning and create substance to and understanding for the product. The identity expression completely loses its meaning if the link between message and the customers' perception of it doesn't coincide but even if you succeed in keeping a consequent design language though the whole branding process it's no guarantee that you succeed in transmitting this to the customer.

The Visual Product Identity, VPI, consists of, and is experienced through three intertwined modes:

1. *Recognition* of product type and/or brand through iconic signs that can be described as portraits: diagrams, metaphors or "paintings" of the reality. Recognition is instantaneous and works internationally since it is based on physical congruence or visual similarities between product types or brands (for example explicit or implicit design cues). This is the safest way to create identification, as long as it is done clearly and with consistency, since it's not based on individual interpretation. This method for recognition creation is frequently adapted by designers through consistent use of characteristic visual elements (for example front grills in the automotive industry) in order to create coherence throughout a product/brand portfolio.
2. *Comprehension* relates to the identification of the product characteristics (it's quality, nature, how it works and is supposed to be used) by visual references. The area of semantics has here contributed a lot to the understanding of design. This identification happens in two ways:
 - a. Through indexical signs: a physical tangible connection or a causal relation between the signifier and the object. One example is trails in the snow: an index of that someone/ something has walked there. Another is design quality: "nice" tolerances

- and surface finish are an expected outcome from high precision manufacturing processes. Hence there's a causal relation between process and outcome.
- b. Completely arbitrarily or subjectively and habit related through symbolic signs. Symbolic signs are an "agreement" between symbol and interpreter, e.g. the meaning of the symbol has to be learned. Examples are letters and languages, traffic signs, logotypes. These symbolic interpretations may hence vary greatly from one region or country to another
3. *Associations* are created through the company's strategic brand messages and communication of core values. This is an utterly subjective (culturally dependent), visual interpretation of symbolic signs, which means you have to be aware of the possible misinterpretations between sender and receiver (company and client). This is, understandably, very difficult to predict and control but through a well planned and clear marketing process the possibility to reach the target customer group with the right associations increases (Chandler, 1994)

The product identity is hence communicated through the design and experienced through these three signs and modes combined. But how this exactly is done, through which references or how the results can be evaluated is an area that to great extent still is unexplored. To start with the interpretation of signs is highly individual and dependent on the interpreters' knowledge, experience and preferences as well as what context (or syntax) the sign is in. Furthermore design is not a precise science with models and methods that makes it possible to rationally reason around results in a quantitative matter. There are some general guidelines, for example the known fact that people find symmetry attractive and have less fate in products with a clearly modular look (Papanek, 1984; Strompff, 2003), but these "guidelines" are too vague to be able to draw absolute conclusions from or predict design results based on.

Design Format Analysis is one method developed in an effort to be able to concretize and describe characteristic form elements and cues in a way that makes them understandable not only for the designer but for the whole corporate organization. Even though this method, that basically analyses and weighs similarities and differences between a company's existing products and portfolios to identify brand characteristics, is "better than nothing" the answers/results are far from objective truths. (Warell, 2006, Nåbo).

As a designer there are no unambiguous guidelines or rules to follow in order to guarantee success. Especially when it comes to innovative "radical" design you can never be completely sure of how the message will be perceived or if the aim with the design will be reached. Long-range planning and consistency in communication and design language is a first step, but to really minimize the risk of misinterpretation an understanding for the customer situation, his preferences and his image of the brand and its products is crucial. At the same time as it is important to understand the customers it's equally important never to forget that it may be difficult, or even impossible, for them to explicitly explain what they want, or to come up with alternative solutions. In the product development process one should never base all decisions upon customer surveys. Instead the work should be a long-term interaction between manufacturer and customer. The challenge as a designer is hence, not only to be able to communicate brand values and identity consistently and clearly through the product design from the corporate point of view, but at the same time to be sensible to market changes and customers demands and to find ways to merge the two sides.

2.3. BAE SYSTEMS BRAND IDENTITY

BAE Systems vision is: *“To be the premium global defense, security and aerospace company”*

BAE Systems Hägglunds’ vision: *“To be the partner of choice providing vehicle systems ready for demanding missions through life”*

In order to achieve their vision their mission is: *“To deliver sustainable growth in shareholder value through commitment to Total Performance for all our customers”*.

“Total Performance” is the company culture which involves every aspect of how business is done: Customer focus, financial performance, program execution and responsible behavior. To achieve the desired culture everyone is to behave consistently with the three core values:

- *Trusted*: We deliver on our commitments, we are honest and take responsibility, we can be relied upon, everyone matters,
- *Innovative*: We create leading-edge solutions, we value imagination and experience, we empower teams, working together we turn our ideas and technologies into solutions
- *Bold*: We constructively challenge and take the initiative, we operate with tenacity and resolve, we accept challenges and manage risk, we set stretching goals

BAE Systems has a much defined brand identity that is communicated through the entire organization. There are templates and guides for graphic elements for all presentation material and these are publicly available at the homepage. They have not, however, implemented the identity into the shape and visual design of the products so, independently of differentiation strategy, there are margins from a shape point of view. The lack of defined design cues depends on the diversified product portfolio character as well as the fact that the aim with the product design is primarily function, not aesthetics. According to Fredrik Burholm, industrial designer at BAE Systems Hägglunds, some artificial design cues are used as consistently as possible in order to create visual brand recognition, but it mostly concerns the interior of the vehicles produced by Hägglunds and there is no requirement from BAE Systems for using them. Examples are white colour on “passive” surfaces and the typical BAE red stripe on black seats.

BAE Systems also own companies that are not branded as BAE Systems brands. An example is Safariland (Picture 6) - a producer of law enforcement and security products acquired by BAE Systems in 2007. The brand standards are not available but from the home page it is clear that the branding has no connection to BAE Systems whatsoever. (Safariland, 2011)



Picture 6: *The safariland logo type*

2.4. EM CENTER AND E-DRIVE

EM Centers brand identity is yet not defined but the core business is to produce and offer hybrid propulsion systems and solutions. E-drive is one of their product offerings. The modular characteristics of the system, with some scalable and some fix components, makes it adaptable to customers’ needs and offers the possibility to optimize performance and vehicle packing

while keeping a relatively low cost for individual vehicle applications. The following section describes different E- drive components, their functions and basic requirements.

2.4.1 SYSTEM, COMPONENTS AND FUNCTION

- *Control system (system management)*

The control system and signal interface consist of configurable hardware and software that allows integration with existing vehicle control systems. The parameters are tailor made for each vehicle application, but since they are both reusable and adaptable the system development cost of each vehicle can be kept rather low. The system manages system activation and deactivation, power management (between ICE and electric engine, considering auxiliary loads.), fault management and diagnostics.

- *Power generation*

Since E-drive is a series hybrid system the power generation is done by an ICE coupled to an electric machine. EM Center will, at least to start with, not offer ICEs since most customers already have relationships with engine manufacturers. They will though be responsible for the dynamic behavior of the combustion engine- drive system combination

The generator, that simply converts the ICE kinetic energy to electric energy, is either directly coupled to the engine crankshaft or connected via a gear arrangement in the case of hydraulics. The dimensions used by E-drive are based on different electric machine frame sizes selected to suit certain standard diesel engine bell housing dimensions.

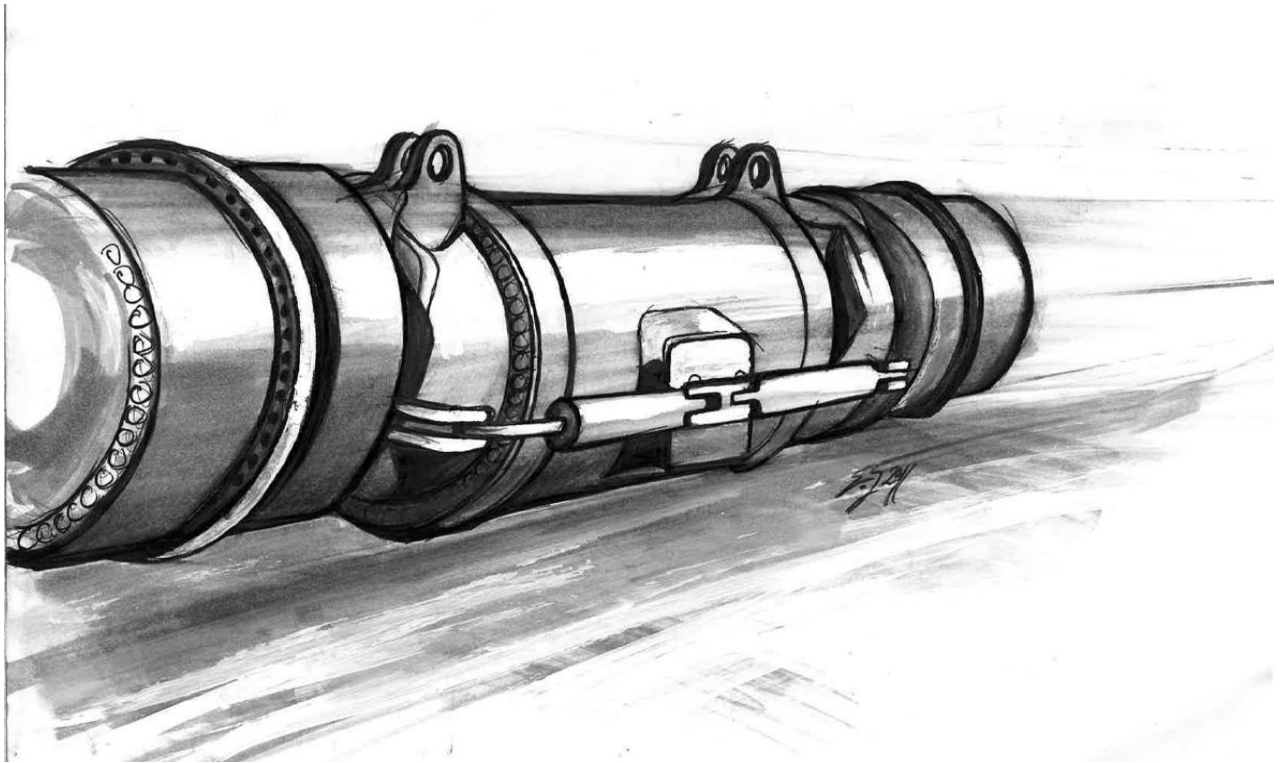
The power converters are power electric components connected to and controlling the electric machines. They are standard components that convert the generator produced AC to DC on the DC-link, and DC to AC at the consumer, according to controlled voltage and frequency.

- *Energy storage*

There are four ways to store energy: chemically (batteries), with electric charge (capacitors), hydro dynamically (accumulator) or mechanically (flywheel, spring). All of these are possible solutions, but, although the development progress is rapid, there is at the moment no "perfect" energy storage (Life-time, price, size are limiting factors) In vehicles today batteries are most common and most promising today are Li-Ion batteries. For E-drive different solutions are considered

- *The E-axle*

The E-axle is an electrically driven equivalent to the rigid beam axle of a normal heavy vehicle. It replaces automatic gearbox, transfer gearboxes and drive shaft (Picture 7). It consists of five main components: The load carrying structure (motor housing), the electric motor, gear reduction and differential arrangement, cooling and lubrication system and hub reductions. The load carrying structure consists of a cylindrical shell that protects the components inside (electric motor, gears, lubrication system) from the bending forces an axle experiences. It also serves as the interface for the hub reductions.



Picture 7: *The E-axle*

Inside the E-axle a reduction gear with differential function is located. The internal gear reduction consists of planetary gear trains linked together to also serve as a differential. The electric motor is connected to the gear arrangement and these two are mounted as a complete unit inside the load bearing shell. External loads are not transmitted to the sub assembly but it is subject to axial loads acting on the input shaft when steered hub reductions are connected.

A number of different electric motor frame sizes will be used to fit the different vehicle requirements (medium, heavy, extra heavy...) The power required for the different applications is hence determining diameter or stack length of the housing. (Since and part of the energy losses increase with increased , the torque is wanted to keep as high as possible. The torque is directly proportional to the radii, through $Torque = F \cdot r$, and F is determined by the strength of the magnetic field, the current and the stack length (leader length).)

Inside the main structure there's an oil reservoir for lubrication and cooling oil. It is circulated by a common pump and the flow is controlled by valves that lubricate the gears and cool the electric machine.

Hub reduction and brakes are “of the shelf” bought components to suit customer needs (gear ratio, load carrying capacity)

The electric machine may also be used for auxiliary power loads (e.g. loads not used for vehicle movement). It will in the future be possible to produce both mechanical (to drive an AC-compressor, a hydraulic pump, a fan...) and electrical (DC/DC converters to power the vehicle or DC/AC inverters to provide power for equipment normally connected to the power grid) auxiliary power.

2.5. THE MARKET SITUATION

The total market for heavy construction equipment is large and, according to a study made by GIA (Global Industry Analysis, 2010), expected to grow extensively over the years to come especially in developing countries. In 2008 the top 50 manufacturers had a combined turnover of USD 168 billion.

Although the benefits from Hybrid Electric Vehicle, HEV, solutions are far greater for construction vehicles than for passenger cars, busses and trucks, the development hasn't been as fast as for the latter group. This is because volumes are lower, the development of HEV solutions for vehicles operating under extreme condition is difficult and customers want tried out solutions. Over the last years there has been a clear change and OEMs are now pushing hard to be able to offer their customers hybrid solutions. Not only does the technology increase productivity, but in a world where the lack of crude oil, environmental protection and energy conservation are growing concerns the development of EV technology has taken on an accelerated pace. This section will give an overview of the current competitor and target customer situation

2.5.1. COMPETITORS

Since this, presently, is a rapidly evolving business area it is very difficult to keep track of the competition situation and how far companies have gotten development wise. This is hardly difficult to understand since no company gives away their ideas for no reason. This section of the thesis is, hence, not complete, but it still gives an overview of the identified competitors, what brand strategies they are adapting, what HEV products they are offering/planning to offer, and what information they want to keep publically available. The competitors can be divided into two groups depending on their business strategy: direct competitors and indirect competitors.

2.5.1.1. Direct competitors

Direct competitors are companies that are manufacturing, or planning to manufacture, electric hybrid drive lines for construction vehicle OEMs. Based on material gathered from homepages, brochures etc, some characteristics these have in common can be summed in:

- The majority are targeting their products towards lighter vehicles than EM Centers target group.
- The majority are providing parallel electric or hydraulic hybrids, although serial hybrids are planned and to some extent offered as well.
- They are mainly focusing on their national market, with the biggest competitors coming from and acting in Germany and the USA.
- The companies are big and established (most are founded around 1900).
- For the majority hybrid transmissions are neither their only, nor their biggest products.
- The hybrid transmission development process is often executed in co-operations with other companies.
- No separate brand platform for the hybrid drive line products is adapted. Instead the branding and product identity of the HEDs is defined and conducted in line with the companies' over all brand standards.

- Non of the competitors are using identifiable design cues in order to create brand recognition besides, to some extent, colour and logotype.

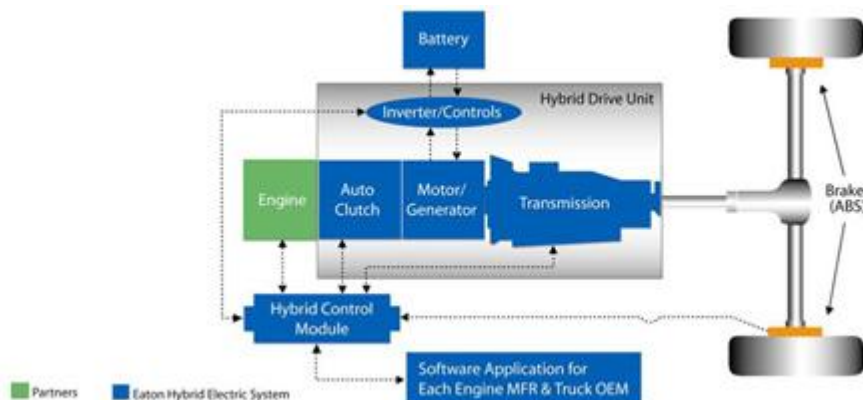
The largest construction equipment manufacturers providing HEV solutions are Eaton, Dana Corporation, Deutz, Allison, ISE Corp, ZF and Bosch.



Eaton is an American company founded in 1911 that describes itself as “a global technology leader in electrical components and systems for power quality, distribution and control; hydraulics components, systems and services for industrial and mobile equipment; aerospace fuel, hydraulics and pneumatic systems for commercial and military use; and truck and automotive drive train and power train systems for performance, fuel economy and safety.”

They provide 2 types of hybrid transmissions:

- Parallel hybrid electric (HEV) systems, with customers like FedEx , UPS and Coca Cola (Picture 8)
- Hydraulic hybrid (HHV) transmissions, with a parallel version called Hydraulic Launch assist, HLA® as well as a series hydraulic hybrid. These are mostly used in refuse trucks, busses and trucks. (for example used in Mercedes BlueTec® Atego Hybrid)



Picture 8: Eatons' parallel electric hybrid configuration

In cooperation with Peterbilt Motors c/o and Kenworth they are today one of the worlds' biggest manufacturers of hybrid drive lines, with American truck OEMs as their main customer group. The Brand Standards are not publically available, but it's easy to get a coherent idea about their overall identity through the home page, which for example contains the following short description:

The company culture is summed in “*Superior Performance*” and the core values are defined as:

- *Make our customers the focus of everything we do.*
- *Recognize our people as our greatest asset.*
- *Treat each other with respect.*

- *Be fair, honest and open.*
- *Be considerate of the environment and our communities.*
- *Keep our commitments.*
- *Strive for excellence*

At present no available information indicates that Eaton has plans on developing HEV solutions for the heavy construction equipment market.

(Eaton, 2010)



Founded in 1904 Dana Corporation is a “*world leader in the supply of axles; drive shafts; off-highway transmissions; sealing and thermal-management products; and genuine service parts*”.

According to press release articles at the home page they offer an electric parallel hybrid drive train technology, called Spicer TE-15HX, specifically engineered for off-highway vehicles, but at the time of writing this thesis it was difficult to find reliable information about this project and according to some articles the project is still in a conceptual phase.

The Brand standards, (covering the hybrid project), are extensively described and available at the homepage (<http://identity.dana.com>). They define their corporate philosophy in “*One Dana*” which consists of:

Foundational values:

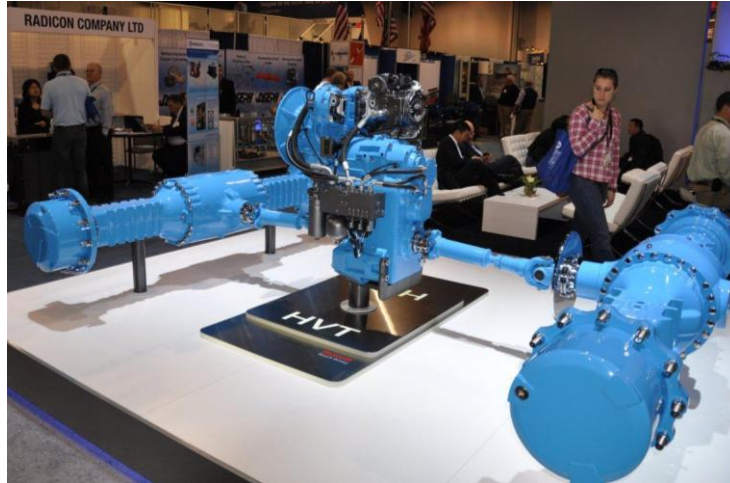
- Honesty & integrity
- Good corporate citizen
- Open communication
- Continuous improvement

Key deliverables:

- Customer satisfaction
- Innovation & Technology
- Quality
- Strong Suppliers

At expositions they are, at the moment, using a blue colour on their axles, which is the only identifiable visible brand differentiator. (Picture 9)

(Dana, 2010)



Picture 9 Dana axles and the blue colour used on expos



Deutz was founded in Germany in 1864 and is one of the worlds' oldest engine companies.

In cooperation with Weyhausen and Heinzmann they are developing parallel mild hybrid systems (Picture 10) for off-road construction vehicles. The development progress of this project was, at the time, very difficult to find information about.



Picture 10. Deutz Hybrid Drive

The Brand Standards are not available through the home page but their vision is summed in “we set standards and shape the future”. They describe themselves as

- *Independent manufacturer of diesel engines*
- *Complete product range from 25 to 560 kW*
- *Engines for all areas of application*
- *Cooling systems: air, oil, and water*
- *Engines tailor-made to customers' needs*
- *Economy: life-cycle cost advantages*
- *Service-orientated*
- *Global reach with subsidiaries and strategic partners*

- *Internal abilities: quick, flexible, and innovative*
- *Reliable supplier.*

The homepage was redesigned by a marketing agency called Cube design, in order to better communicate their identity. (Deutz, 2010)



This American company was founded in 1915 and is, according to their homepage, “*the premier global provider of commercial duty automatic transmissions and hybrid propulsion systems*”

They have been producing parallel electric hybrid drive lines since 2001 (mainly for busses) under the names Allison Hybrid H 40 EP™ and H 50 EP™. The benefits from the system are named HyValue™, which features HyGain™, HyIdle™ and HyTraction™ (Picture 11). Allison is definitely the company with most branded hybrid products among the competitors when it comes to marketing and presentation materials- on the actual product no identifiable design cues are used. Information about the HEVs is easy to find and get a basic functional overview of.



Picture 11: Allison HyGain features and Hybrid logo

Brand standards and identity was renewed and defined together with the marketing agency Pauley Creative in order to adapt the company profile to the international market. The colours silver and red are frequently used. The brand standards are not publically available though. Further their internet sites differ a lot between countries: The American is far more “designed” and colourful than the European one. They also produce products for the military market and that profiling is completely different from the profiling towards the civil market.

Their vision towards the civil market is to

“ Be the world leader in commercial-duty transmissions, hybrid-propulsion systems, and related parts and services for on-highway vehicles, military vehicles, and off-highway

equipment. We will earn our Customers' enthusiasm through continuous improvement driven by the integrity, teamwork, and innovation of Allison people”

and the brand promise is

“the automatic experience with an unrivaled combination of Quality, reliability, durability, vocational value and Customer service.”

Towards the military market their mission and vision is summed in below (Picture 12)

★★★★★★★★★

OUR MISSION: ALLISON TRANSMISSION DESIGNS AND MANUFACTURES THE WORLD'S BEST POWER TRANSMISSION PRODUCTS FOR MILITARY VEHICLES. OUR PRODUCTS AND SERVICE ARE SUPERIOR – CONSISTENTLY PROVIDING THE HIGHEST QUALITY, RELIABILITY, DURABILITY AND VALUE TO OUR CUSTOMERS AND THE **WARFIGHTER**.

★★★★★★★★★

OUR VISION: ALLISON TRANSMISSION WILL BE THE GLOBAL LEADER OF MILITARY VEHICLE POWER TRANSMISSION PRODUCTS. THROUGH THE DEDICATION, INTEGRITY, AGILITY AND INNOVATION OF OUR PEOPLE, WE WILL CONSISTENTLY EARN THE RESPECT OF OUR CUSTOMERS AND THE **WARFIGHTERS** WE SUPPORT BY PROVIDING THE HIGHEST QUALITY PRODUCTS IN THE WORLD.



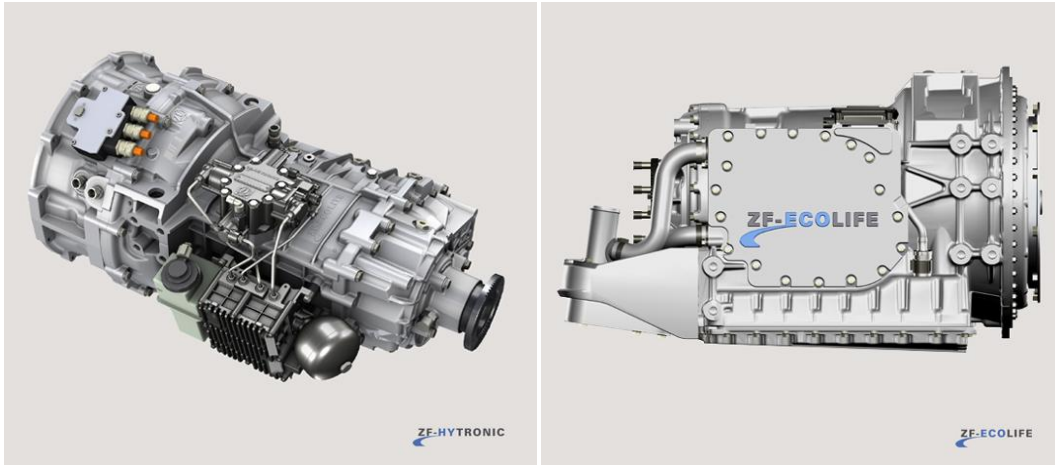
Picture 12 Allisons vision and mission towards the military market

(Allison, 2010)



ZF was founded in Germany and is “a leading worldwide automotive supplier for Drive line and Chassis Technology with approx.60000 employees at 119 locations in 25 countries. In order to continue to be successful with innovative products, ZF annually invests at least five percent of its sales (2007: more than €694 million of €12.6 billion) in Research and Development.”

They offer a parallel hybrid system for CVs, like city busses and distributor trucks, under the name HyTronic lite, (Picture 13) (which is a hybrid version of their product ASTronic lite) as well as a series hybrid solution called AVE 130 electrical portal axle for city busses (which, for example, is used in Mercedes Citaro BlueTec). They also plan to develop hybrid systems for heavier CVs with a release date in 2014 (Drive 2, 2010) The hybrids are thoroughly described and easily found on the home page. Furthermore ZF is planning to release hybrid transmission systems for their military market which they today offer traditional transmission systems to. Contrary to Allison they adapt the same branding and profiling both towards the civil and military sector.



Picture 13: ZF- Hytronic and ZF- EcoLife

The brand standards are not publically available, but after contacting the marketing department it was possible to receive a copy. They use very conceptual and artistic ways to describe colour choices and combinations, page layouts and the corporate feeling. ZF is the company among studied competitors that has the most thought through brand standards but they still cover the whole company brand portfolio including the hybrid solutions. They describe their Brand profile as a triangle with eight Corporate Attributes constituting the basis for all their actions and the characteristics that need to be fulfilled in order to perform and succeed on the following two levels: Product and Performance Profile and Total Expertise.

They frequently use a matte silver colour on their products and much thought is put on detail. The logotype is also consequently casted into the products (Picture 14) (ZF, 2010)



Picture14: ZF axle with casted logotype



Bosch-Rexroth is *“one of the world’s leading specialists in the field of drive and control technologies... As The Drive & Control Company, Bosch Rexroth develops, produces and sells components and systems in more than 80 countries in the technology fields Electric Drives and Controls, Industrial Hydraulics, Mobile Hydraulics , Linear Technology, Assembly Technology and Pneumatics”*

They are producing Hydrostatic Regenerative Braking (HRB) parallel hydraulic hybrid systems for refuse trucks, but during the data collection period info was very hard to find on a home page that is rather impossible to navigate.

Branding material is not available besides for their core values:

- Future and profit orientation
- Responsibility
- Initiative and consequence
- Openness and trustfulness
- Fairness
- Reliability, credibility and legality
- Cultural diversity

Whether **Bosch Rexroth Group** is aiming towards the HCV market and has plans on offering products similar to EM Centers is though unknown and difficult to predict.

(Rexroth Bosch Group, 2010)



Founded in America 1995 ISE Corp is a *“leading developer, manufacturer and distributor of heavy-duty hybrid-electric drive systems based on a core set of proprietary technologies focused on three critical subsystems: energy storage, controls software and power electronics.”*

ISE specializes in series hybrid-electric as well as all-electric/zero-emission technologies. They offer energy storage systems and hybrid system components aimed primarily at busses, trucks and vans. As the name suggests ISE are focusing only on innovative energy solutions and hence the branding is focused around these. No brand standards are publically available though and for a young company like this it is difficult to predict towards which market sector thgeir future business strategy will be aimed. (ISE Corp, 2010)

Other manufacturers of hybrid transmissions found on the market are

- Azure (USA): Balance™ parallel hybrid electric and LEEP™: low emission electric power.
- Enova (USA): parallel hybrid electric drive trains
- Permo Drive (Australia): parallel hydraulic hybrid systems. RDS™ Regenerative Drive System

These are all targeting light vehicles like busses and trucks.

To conclude none of the major direct competitors (besides ISE) have separate branding or profiling strategies for their hybrid offerings. They are all manufacturers of conventional drive trains and the hybrid alternatives are seen as value adding investments to broaden the product portfolio and to be able to compete continuously, both innovation and product wise in the future. The companies producing products both for the military and civil sector have chosen very different branding strategies towards these different markets, still keeping the same corporate name. Visual shape design features, cues, are not used on the physical products and hence the design is purely functional. Colours (especially on expositions) and casted logotypes are the elements used to create visual brand recognition and differentiation.

2.5.1.2 Indirect competitors (= potential secondary customers)

Indirect competitors are OEMs that manufacture and develop hybrid drive lines for their own vehicles e.g. not offering their transmission solutions as a product to other OEMs. Hence they are not targeting EM Centers direct customer group but they are reducing the total market size. At the same time they can turn into both potential customers, if their development programs fail, and direct competitors, if their business strategy changes.

These are in general the largest OEM companies in the market and include (information from the existing business plan):

- *Caterpillar*- The biggest manufacturer at the market (approx. 19% of the total market share). Launched a hybrid electric 25t earth mover, D7E, in 2010.



- *Komatsu*. Next biggest at the market(~11% market share) Launched a PC20-8 hybrid hydraulic excavator already in 2008 .



- *Volvo Construction Equipment, VCE*, - plans to release a L220F wheel mounted loader.



- *Liebherr*. Has produced the largest diesel electric mining truck on the market, T282B launched in 2008.



- *Hitachi*. Has launched a huge development program for hybrid drive mining equipment.



- *Kobelco*. Light- medium (~8t) electric hybrid excavator, SK80H.



- *Doosan*. Plans to launch a hybrid excavator in 2012.



- John Deere. Plans to launch hybrid solutions for construction and forestry applications.



2.5.2. END USER REQUIREMENTS

The end users are dominantly functioning in mining, construction, infrastructure or cargo handling businesses. According to the existing business plan their 1st criteria when selecting construction equipment, is normally productivity, product life cycle cost and safety. The 2nd is robustness and reliability, and the 3rd direct cost of equipment. The equipment life time is expected to be about 20000-30000 hours (5-10 years), with major service requirements no more frequently than every 10000th hour. To be interesting for the OEMs it is hence important to deliver products that at least fulfil these standards.

2.5.3. CUSTOMER CHARACTERISTICS, OEMS AND MARKET SEGMENTATION

The direct target customer group consists of the OEM construction equipment market that, according to the existing business plan, can be characterized by:

- Substantial end user market growth (up until 2008).
- Gross margin on products in average 35-40% including maintenance/spare parts. Gross margin on equipment approximately 30%.

- New technology is bought in from suppliers. Internal R&D spending is low.
- Product life time is long, 10-15 years.
- Low to medium size volumes (100-1000/model/ year).
- Vehicles are normally not standardized but differentiated to be optimized for their use scenario.
- Instead for the end user to buy the vehicle leasing is growing steadily.
- Target ROI to end users 3-4 years.

Of all the OEMs fulfilling these criteria E-drives is primarily targeting OEMs that:

- Produce CVs heavier than 20000 tonnes, for mining, construction, infrastructure and cargo handling.
- Have no internal development of electric hybrid drive lines or known partnership with suppliers of such drive lines.
- Produce more than 200 vehicles/year.
- The vehicles are supposed to operate in cycled use scenarios with high power take-out and/or frequent breaking and/or frequent lifting/ lowering of load.

This is a market where competition is small and the series hybrid characteristics can be utilized in an optimal way. Through this market segmentation around 20 potential customers are identified, among which some are Kone Cranes, Atlas Copco, Kalmar, Sandvik Mining, Bell Equipment, Ljungby trucks etc.

Conclusion

As the competitor and customer analysis show EM Center and E-drive have all the prerequisites and possibilities to succeed. The OEMs are asking for HEV solutions and competitors on the heavy duty market are few especially in EM Centers target market segment. No competitor (identified) is focusing only at HEV solutions at the same time as targeting the heavy duty construction vehicle customer group, as is the strategy of EM Center. Furthermore none of the competitors is working with the product shape and design in order to create brand recognition and hence EM Center could easily create brand uniqueness by doing so. Visually the differentiation possibilities are limitless since competitors are designing purely functional products without brand specific design features. Finally EM Center is well in advance technology and development wise compared to competitors. "Used in a correct way" these factors can give EM Center a big competitive advantage and help in creating a stable market position. EM Center can focus completely and whole heartedly on the development of their specific technology - which among other actors on the market only is developed as an extension of their current product portfolio. This shows a commitment towards the customers and acts as a reassurance for them that EM Center sincerely believe in the technology and its future benefits for the target customers.

3. CONCEPT GENERATION AND EVALUATION

This chapter describes the prerequisites of the product design and the three branding concepts are defined according to degree of differentiation from BAE Systems brand standards. Only design and branding aspects are considered. The concepts constitute alternative bases for further brand platform development and product design. SWOT analyses (see appendix XX) are made in order to evaluate the concepts and conceptual design propositions are made for each concept to give a hint of how the design could look. No design evaluations are made at this stage. Finally one branding concept is chosen and further developed.

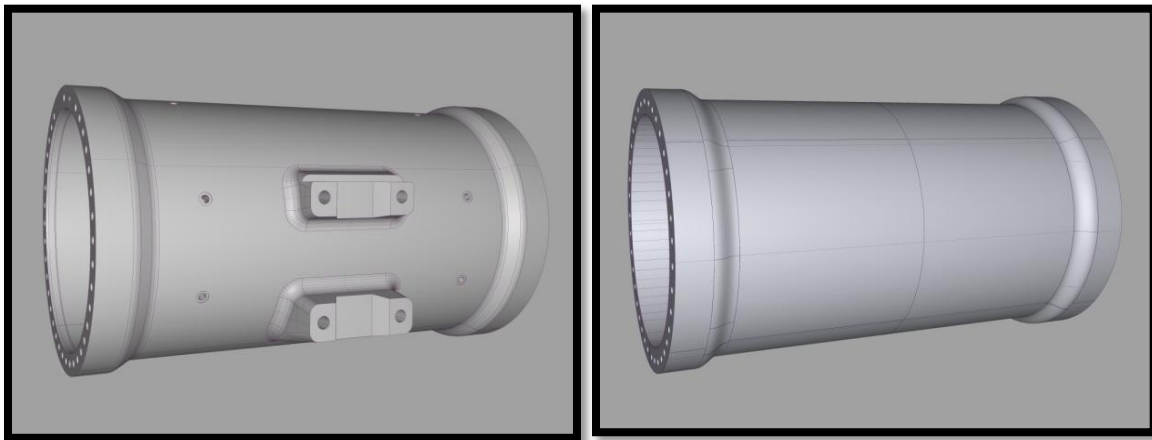
3.1. THE PRODUCT DESIGN

To transmit brand identity through product design is far easier for visible utility articles than for purely functional products. The car industry is a model example of where the use of design cues has been refined and implemented in a successful way. Everyone recognizes a BMW through, not only explicit cues, like the grill and logo type, but for example through the body accents and the characteristic Hofmeister Kink (Picture 15). The products of EM Center, on the other hand, are technical assemblies with limited design options shape wise. Possible shape modifications should ideally be based on technical research and in order to strongly motivate them they should result in improved performance. Manufacturing costs are important to keep low and as one of the key benefits with this system is its flexibility and space optimizing characteristics, this naturally means that the size of the components should be kept as small as possible. Almost all components are bought from different contractors and although design alternations may be possible the factors above mentioned are number one priority, especially since the components are hardly visible when installed. It's very important to remember that design elements never should affect functional, technical or usability aspects negatively in this kind of product where technical performance always will be the strongest sales argument.



Picture 15: The BMW characteristic hofmeister Kink indicating rear wheel drive.

EM Centers' core business is to produce and provide hybrid propulsion systems for the target customer group. The E- axel system layout described in chapter 2.4 is hence not the only possible variant. Hub motors or conventional drive trains are, for example, possible solutions as well. The E- axle configuration is, though, one of EM Centers' product offerings at present time and the electric machine housing is further one part that, at least for the moment, is manufactured by BAE Systems Hägglunds. The fact that the electric machine housing is mounted axially is a unique differentiating factor from competitors. Furthermore the housing is, at least if installed as a rear axle, partly visible. The geometry and shape is within limits possible to modify since it simply is a load carrying and protecting structure. Furthermore, as seen from the market and competitor analysis, no one puts much focus on the visual product design and hence it's possible to create a strong differentiation point by doing so. To be unique is a powerful and efficient way to create brand recognition and awareness which, as mentioned in chapter XXXX, is crucial in order to attract customers. This component is hence, for this particular product configuration, suitable for design and branding purposes. The axle can furthermore be either fix or steerable, which changes the look of it rather drastically as shown here below (Picture 16). The housing for the steerable variant is obviously less visible than the fix variant, but still visible to some extent.



Picture 16 *The Electric machine housing of the E-axle. The steerable variant versus the fix.*

This is clearly not a product that is purchased because of its aesthetics and hence, engineering solutions should be the basis for dimensions and shape. Although the visual branding of the products might be secondary to the function it's still important to transmit a look of functionality and quality in order to be trustworthy. The purpose of the visual design is obviously not just to create uniqueness but to communicate the technical characteristics of the product. The challenge is to identify the combination of design features best communicating and transmitting the desired values. How to do this is far from obvious but it is possible to, even with small means, drastically change the product appearance. It can be as simple as working with proportions between surfaces and radii, split- lines or colour combinations. This is demonstrated in chapter 3.1.1 where a survey is made in order to identify connections

between design features and values communicated. In general a successful product design should succeed in communicating:

- What it is, the characteristics and sales arguments- As defined by EM Center: a hi- tech productivity increasing, cost-reducing and environmental friendly transmission system for heavy construction vehicles in demanding fields of application.
- The desired product characteristics: (for example: powerful, durable, sustainable, innovative, continuously developed and improved. Easily installed and adaptable to customer wishes and vehicle geometries.
- Brand identity and belonging through the communication of the selected core values and brand messages, in order for the customer/viewer to identify, remember and understand the product.

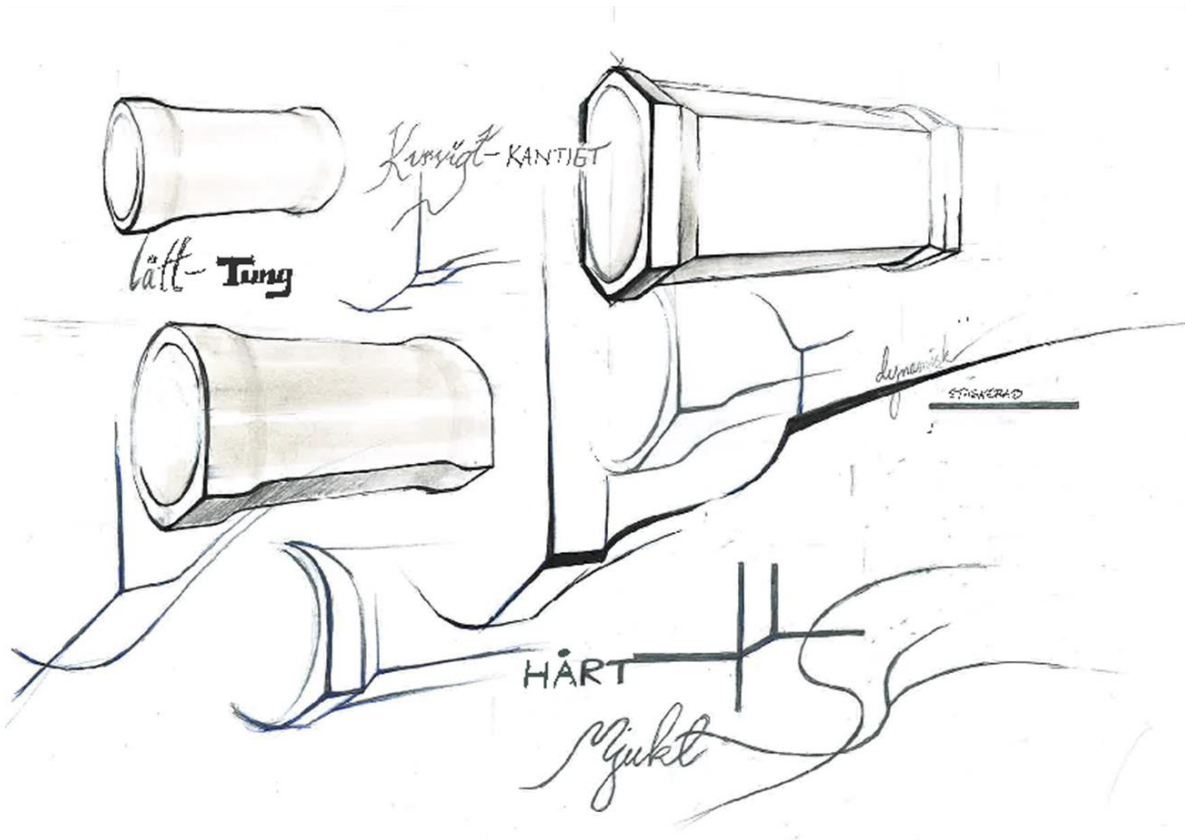
In this case, with a new product directed towards a completely new market, there aren't, unfortunately, any concrete models or methods to help backup design choices. There are no guidelines as to how the customer group interprets different design features; for example Design Format Analysis, mentioned in chapter 2, isn't useable since there are no previous products to compare with. When making choices the designer simply has to be as explicit as possible in explaining the reasons and the motives behind them.

In an attempt to transmit desired characteristics through the design the following decisions were made:

- Non visible components, e.g. components from contractors, will not be branded as EM Center products but according to their original brand belonging. This allows for greater flexibility when choosing suppliers and furthermore there is no identified benefit for branding them differently, as long as the contractor choices are well justified, e.g. it should be clear who has produced what part and why this contractor is chosen. EM Center will be responsible for the quality of the system in total, but a faulty component is still traceable to the original manufacturer. If there is a wish for a more unitary design to create a product entity feeling as opposed to "a puzzle of components, this can partly be done by colouring or by branding certain passive (protective) parts, like for example converter boxes, through the chosen design cues. Because of the component characteristics, requirements and placing the engine housing is most suitable to be brand carrying, and design focus is hence put on this part.
- Some kind of artificial design cue (s) should be implemented into the design and used consistently through future products (lines) in order to create brand and product recognition. This cue will serve as a strong differentiator and contribute in creating a design language emphasizing quality, accuracy and overall product characteristics.
- The design should be kept as simple as possible. No- functional visual design elements are always cost increasing. In order to justify form modifications on the cylindrical engine house these have to contribute highly to the desired product appearance and communication of brand/product identity. Ideally an introduced design feature should be a result of a function and hence result in a patent. Furthermore the geographical production location is in northern Sweden and a way to associate to this is by using "typical Scandinavian simplicity".

3.1.1 THE SHAPE AND PERSONALITY

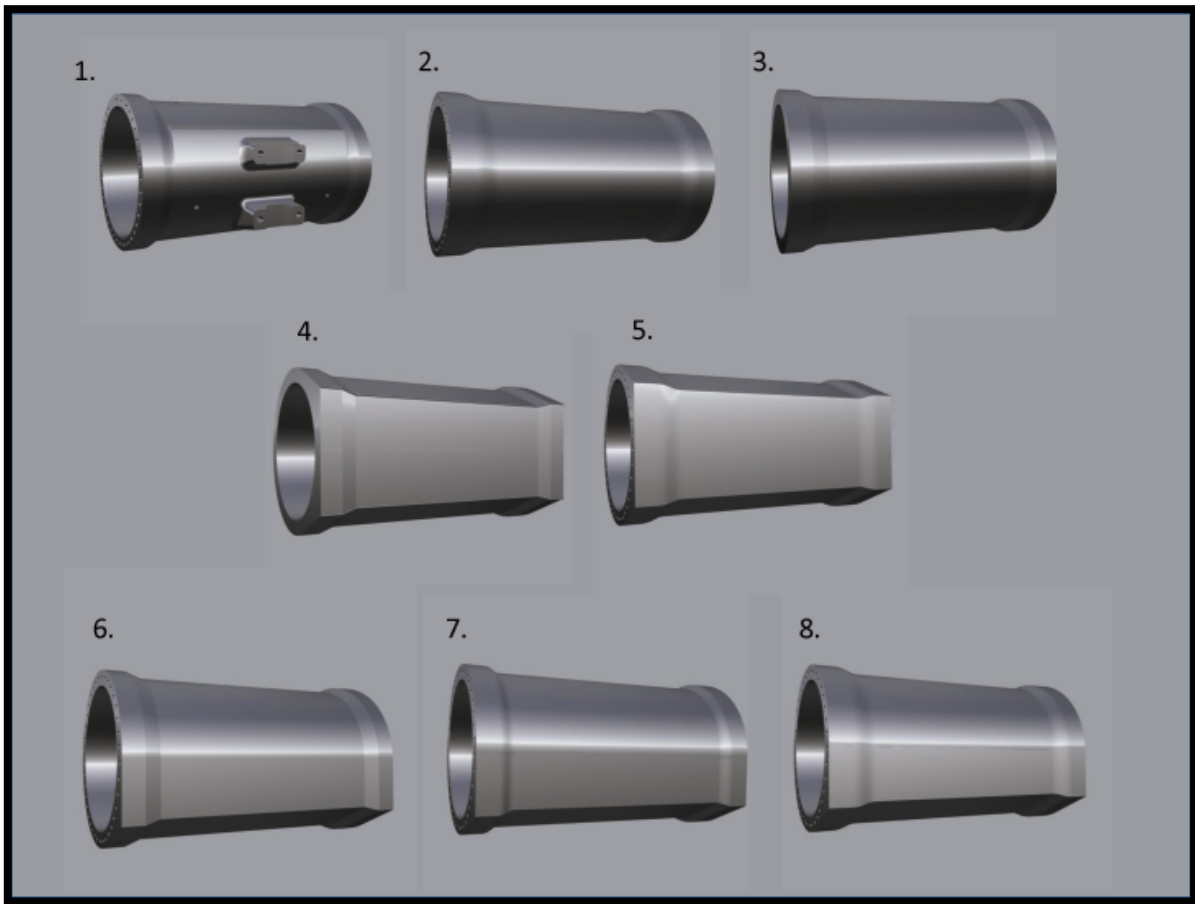
The limiting dimensional factors of the housing are the diameter and stack length of the cylindrical electrical machine, as well as the connected differential gear arrangement. The ratio of the stack length and diameter determine the power output and since the power required is varying for different vehicle applications these two vary accordingly. The basic shape is cylindrical, which automatically communicates the characteristic shape of the electrical machine. Shape alternations are possible but will automatically lead to increased material requirements, added weight and cost as well as increased space/ volume requirements. The alternations should hence be as subtle as possible. Some basic sketches are shown below (Picture 17). Different combinations of radii and accents are experimented with in order to play with contrasts: soft-hard, light-heavy, dynamic-stagnated etc.



Picture 17: Basic shape studies

In order to be able to motivate and make decisions concerning what shape and design features to use a survey was made examining how well and to what degree different shapes communicate which values. The final product identity is yet not determined though and hence no final conclusions or decisions can be made solely on the survey results at this stage. 20 respondents were selected of varying background and aged between 23 and 41. Eight shapes (Picture 18) were compared between each other and rated according to 10 attributes considered as more or less desirable by EM Center. The evaluated attributes were the results from discussions with people working at EM Center and their perception of what a successful product identity could comprise for this type of product; Useable, Functional,

Technically advanced, Caring, Innovative, Sustainable, Professional, Efficient, Powerful and Adaptable. These attributes are, depending on final brand identity strategy, representing more or less desired and important product characteristics (in chapter 3.2 different brand identity options are described through 3 concepts). The product identity should be part of the brand identity, and hence the design best communicating the final brand identity values is most suitable to use. The results will later serve as a help in order to justify shape choices and to be able to motivate why one shape is better than another for the particular final chosen identity.



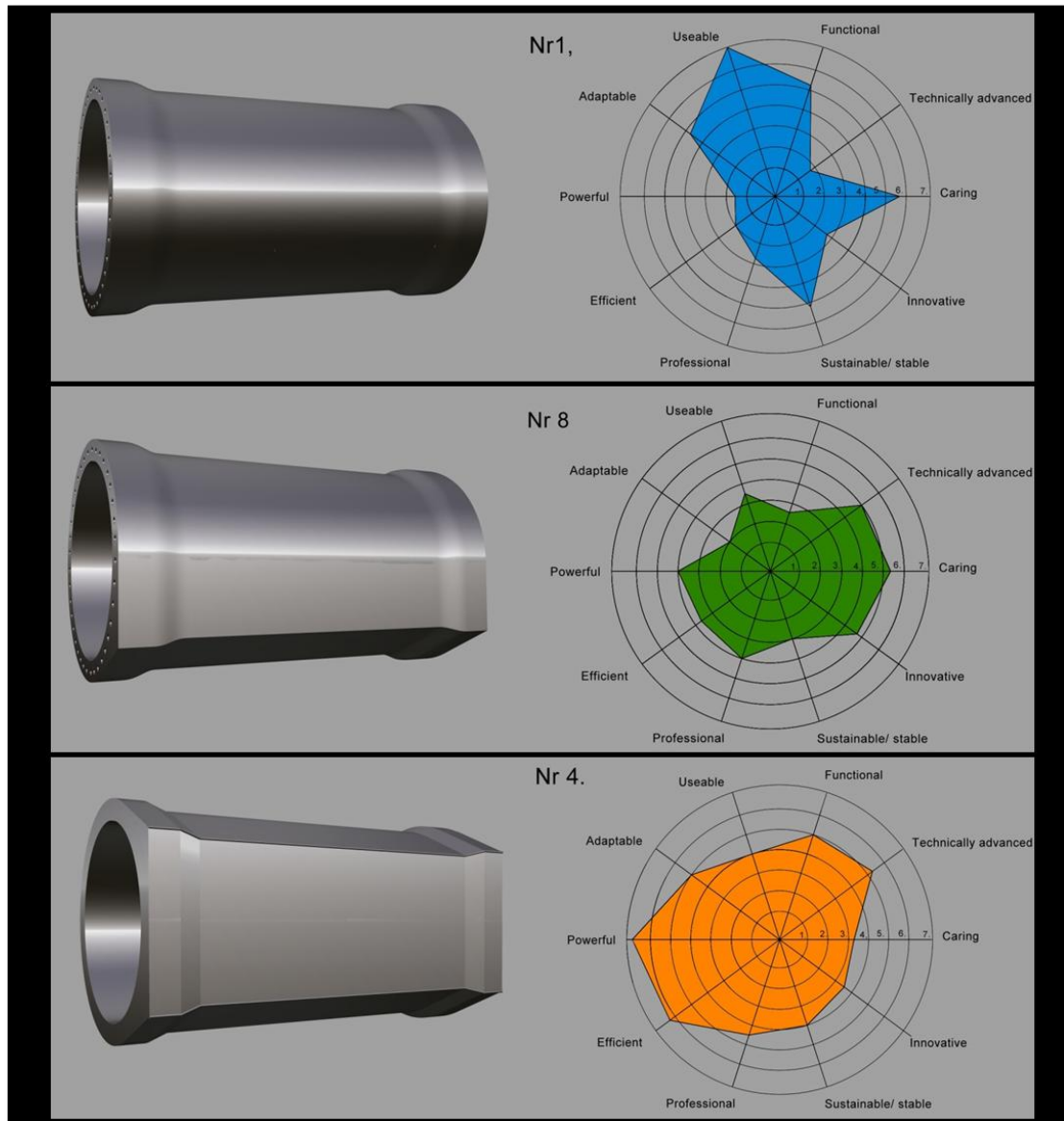
Picture 18: *The shapes evaluated*

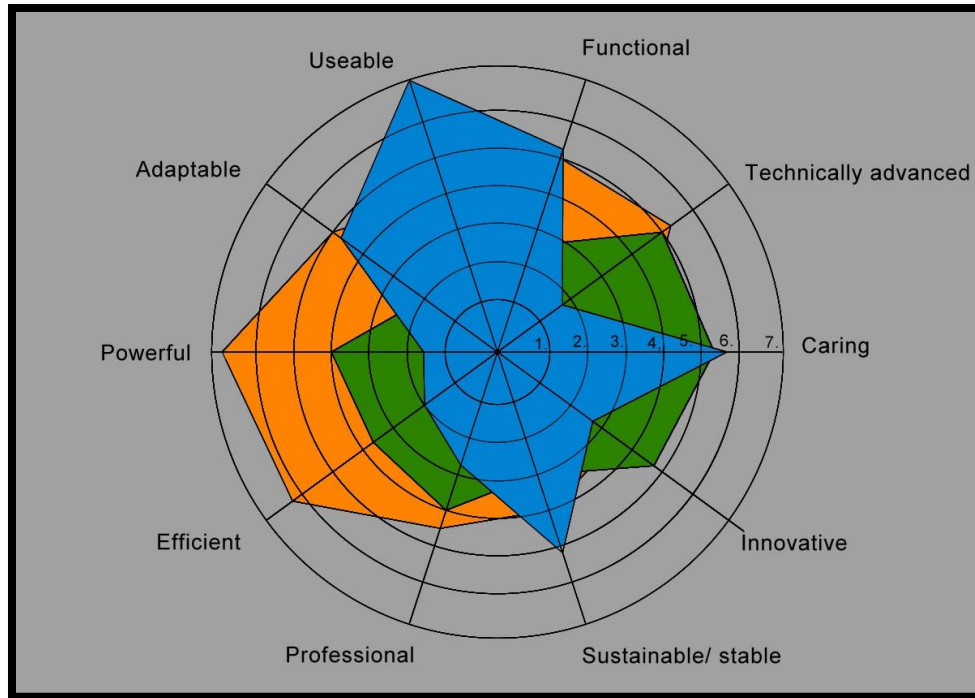
The ratings were made in order to purely evaluate the visual form language. No consideration of manufacturability, weight or cost is taken. Hence the respondents chosen were kept unaware of the technical function and product use. People working with the product would more or less consciously consider practical aspects (what is easiest to manufacture, what is best suitable for the customer group etc.) and that was not the purpose for this particular survey. Due to the fact that the respondents didn't understand the functionality of the product many of them didn't understand the purpose of the "arms" for the steerable axle variant (no 1, Picture 18) and that model was hence finally removed from the survey results. The different shape alternatives could still easily be used for that

configuration as well although the extra components needed makes the housing less visible, and hence the design less important.

The designs evaluated can be divided into 3 groups: a simple cylindrical shape, a one edge shape and a two edge shape. Different curvature and angel variations are evaluated for each group. Some of the results are shown here below (Picture 19) and afterwards compared (Picture 20). For complete results [see Appendix XX.](#)

Picture 19: Study results: Shape personalities



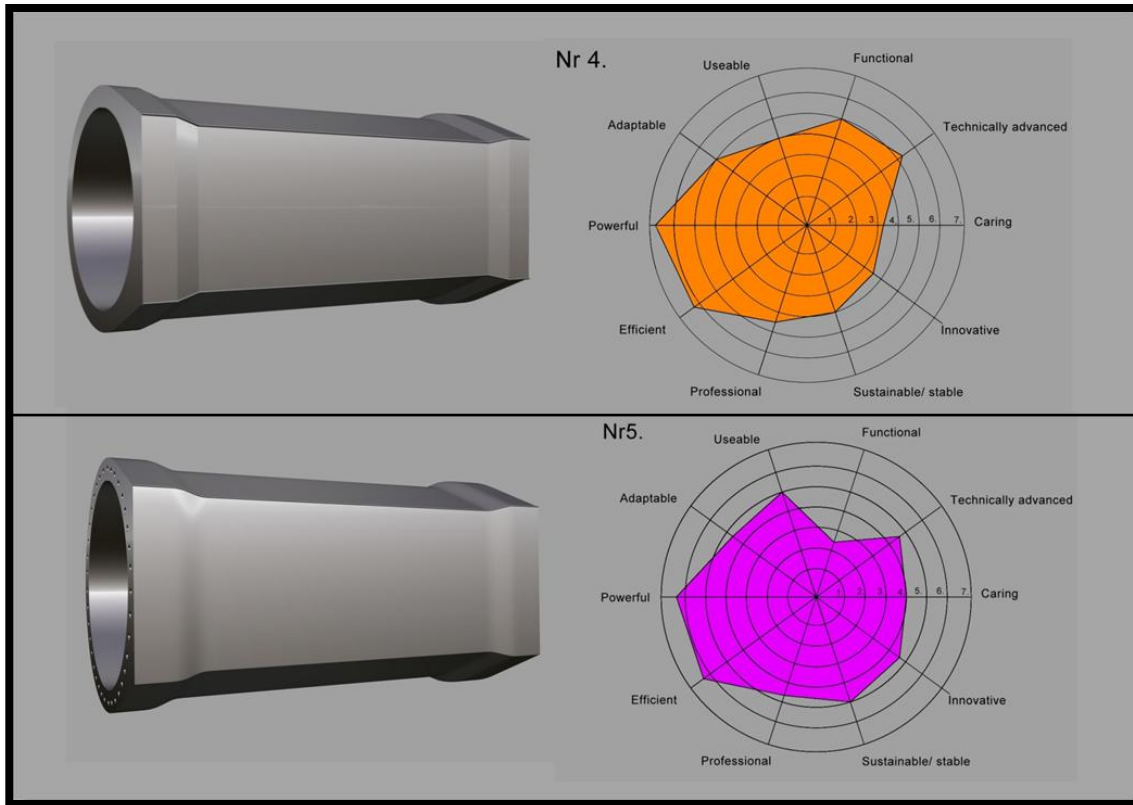


Picture 20: Comparison of the shapes in picture 8

The major results from the survey can be summed in:

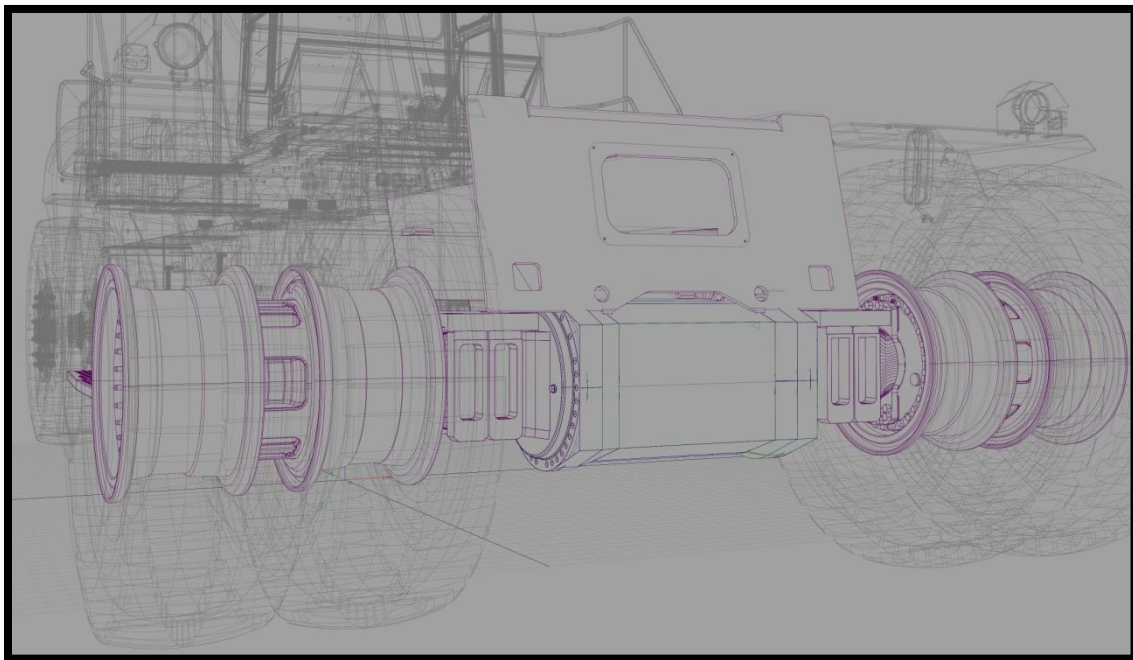
- The simple cylindrical shape is consistently rated high and low. For soft values like useable, caring and adaptable the shape often gets the highest rating but for “hard” values like powerful, technically advanced or innovative the shape consistently gets the lowest scores. If it is desired to emphasize the technical productivity increasing character of the product this shape should hence not be used.
- The two-edge shape consistently scores very high for powerful and efficient, and is rated the highest on 5 of 10 attributes (efficient, powerful, technically advanced, professional, and adaptable). If all 10 values are chosen to be important this shape is hence the best to use as the total average score is the highest.
- The one-edge shape is overall rated moderately but has the least spread between soft and hard values. It scores much higher for technically advanced, innovative, powerful, efficient and professional than the simple cylinder shape, but is still rated considerably lower than the two edged shape.
- The small differences between the shapes in the 3 groups, e.g. radii and curvature variations do affect the expression and the survey results to some extent. The results don’t vary greatly between for example, the two variants of the two edged shape, but the personality differences are nonetheless visible with the greatest differences being usability and functionality (Picture 21).

3. Concept generation and evaluation



Picture 21 Differences in characteristics depending on radii variations

In the picture below you see how shape 4 would look installed in a vehicle (Picture 22):



Picture 22 Shape 4 installed in a vehicle

To conclude the simple cylindrical shape should be chosen if soft values are considered most important, the two-edged shape should be chosen if hard values are considered most important, and

finally the one-edged shape is to be chosen if a combination of soft and hard values is desired. In the next chapter different branding strategies will be described and evaluated and based upon those results a final shape choice can be made.

3.2 THE BRANDING CONCEPTS

Before being able to continue the design work and make decisions concerning what characteristics to give priority to or what shape or colours to choose in order to transmit the correct values, a brand identity has to be specified. To be able to communicate an identity through the design, a prerequisite is simply that an identity exists. As mentioned in chapter 2.3 there are no limitations shape and design wise indifferently of chosen differentiation and branding strategy, but the identity still has to be defined in order to be able to make correlating design decisions. As described in chapter 2.2, the best results are achieved when brand and product identity coincide. The branding work at EM Center has been started but is yet far from finished. Hence alternative branding strategies had to be developed and evaluated before being able to make decisions concerning the product design. It's impossible to recommend a consistent design language without anything to be consistent with. The branding aspects for this kind of B2B company are just as important as for consumer goods and B2C marketing. The mere aesthetic visual branding of the products may not always be seen as priority number one, but the branding of the company is utterly important: what values and identity that is to be communicated and the ability to transmit the desired message in a correct way to the customers. In this section three alternative strategies with different degree of differentiation from BAE Systems brand identity are described and evaluated. The concepts are chosen in order to cover the whole scale from BAE Systems brand identity to total differentiation.

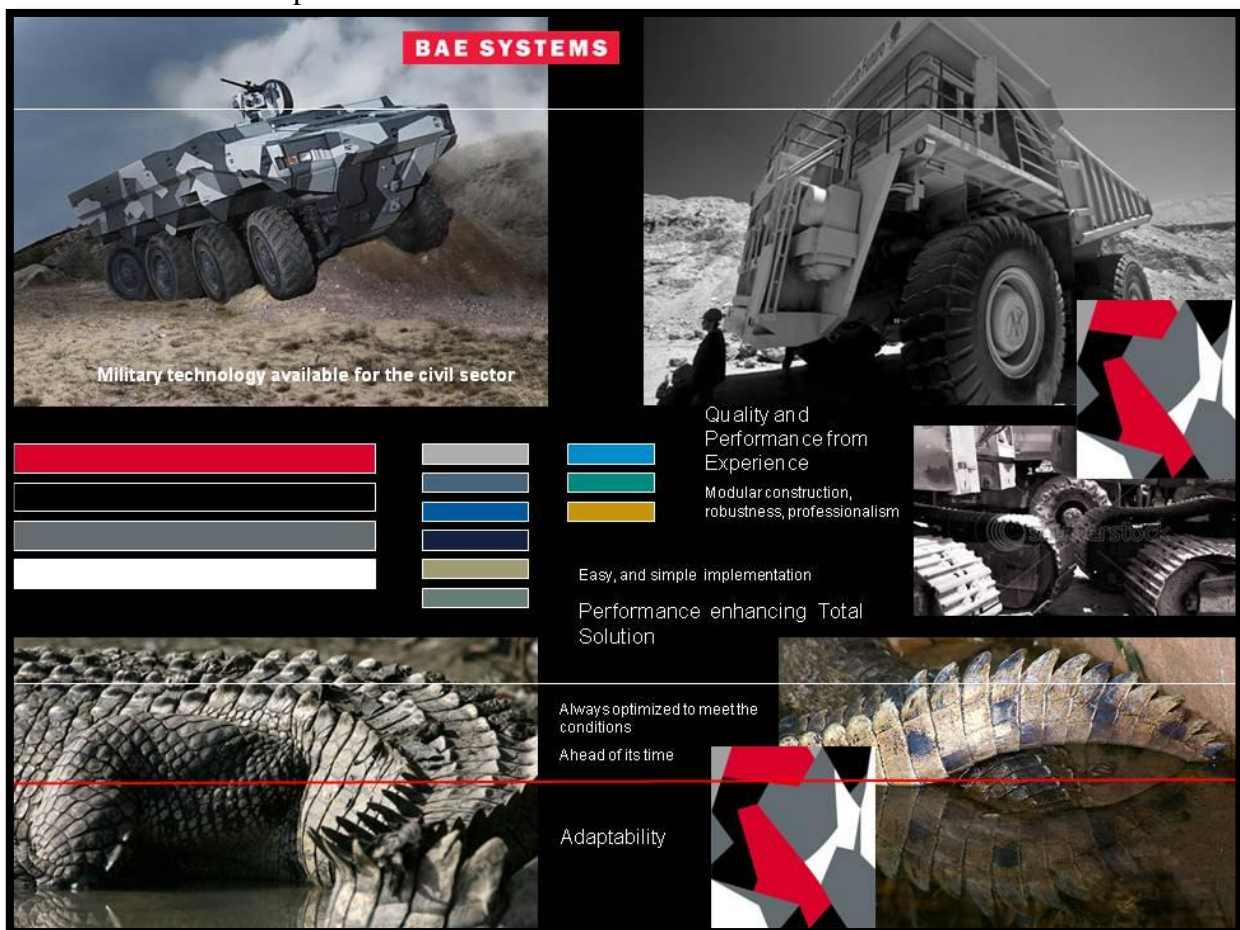
3.2.1 CONCEPT A: E-DRIVE ASSOCIATED WITH BAE SYSTEMS

In this concept E-drive is presented with a strong connection to BAE Systems and everything the company stands for with their long history of high-tech military products (Picture 22). Thanks to BAEs experience, knowledge and previous accomplishments the drive line is expected to keep a high quality and hence BAE Systems creates added value to the drive line. The drive line will function as a strategic brand through adding an additional new business area and customer group to the company portfolio. In this case it is crucial for the drive line to pay off since it doesn't create any added value to the BAE Systems brand. The branding is done in line with BAE Systems brand standards (core values, layouts, colours etc.) .

There are several benefits to being associated with BAE Systems. To start with it is an established, huge company with high brand awareness, at least within some market sectors, all over the world. This eases access when entering new markets and marketing expenses can be heavily reduced compared with new brands. The branding work is already done and hence sub- optimization can be minimized. Through the history the organization has acquired a huge internal knowledge and technological and economical resources. The fact that BAE is a military company can further create an added value and uniqueness to the EM Center and E- drive image and act as a differentiating factor usable in the branding work. "Advanced military technology developed through years finally available for you".

Basically the military aspect is used as a differentiating factor that provides the customer with a kind of automatic quality control.

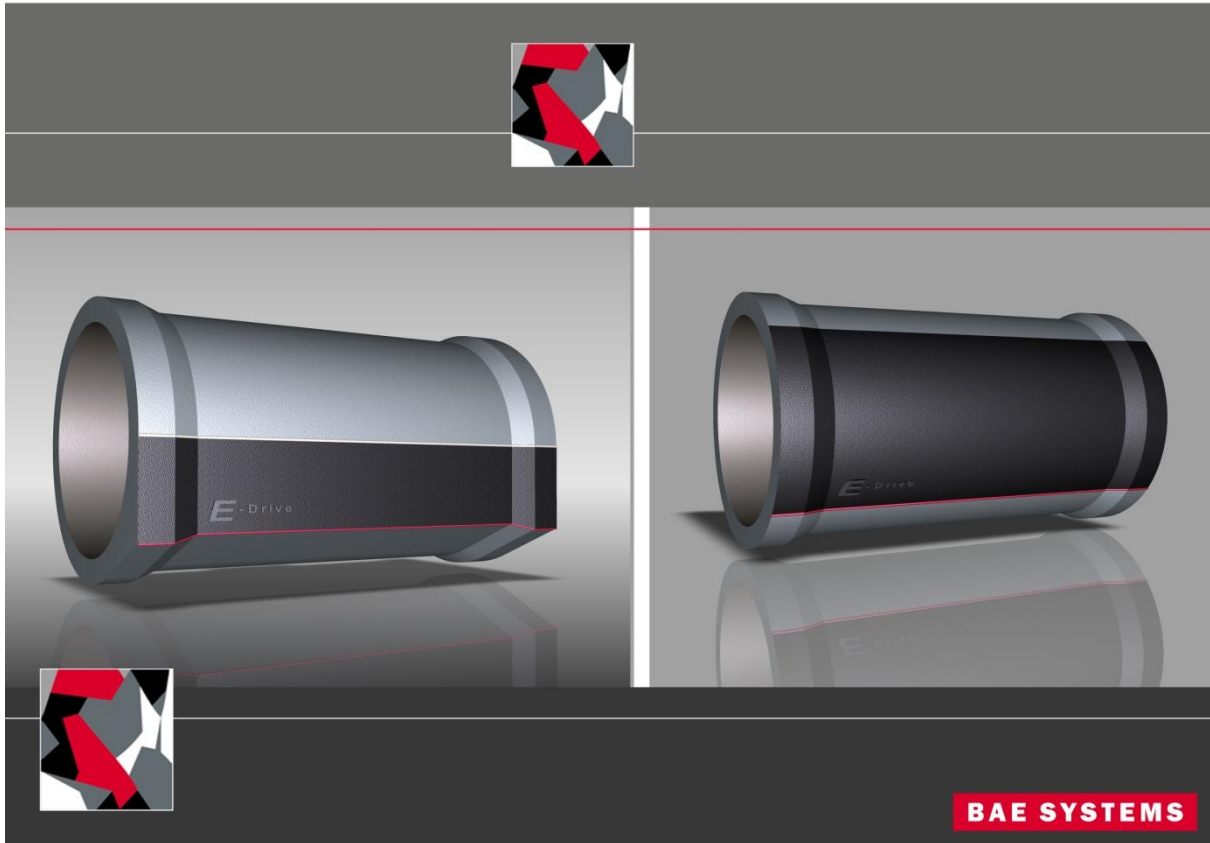
However the down sides are substantial. It is important to show a strong commitment towards the civil sector, its demands and needs in order for the customers to take the production seriously and to succeed. With branding and presentation materials completely in line with BAEs standards it might be difficult to differentiate EM Center from the military sector and above all to identify the unit as a serious civil investment. The BAE Systems brand has some bad associations and far from a perfect reputation among the public. Examples are “Big And Expensive”, not good enough quality as well as bribe scandals and branding E-drive as a BAE product automatically projects the BAE associations and image on EM Center as well. Furthermore the military market may be controversial. Customers may have both personal and professional reasons not to choose contractors associated with a military company selling and delivering weapons and infantry fighting vehicles all over the world. It is an ethical question which values and factors the OEMs in turn want to present to their end customers and be associated with.



Picture 22: Inspiration board Concept A

Conceptual design propositions

The design propositions for this concept (picture 23) are directly derived from BAE Systems brand standards and colours. The design is simply one of many possible solutions and no evaluation is made in this stage. It's simply an example of how it could look. The design communicates stability and power in a discrete subtle way that well correspond to the core value Trusted. Innovative and Bold are more associated with the system as an entity, but is visible in the design through it being well differentiated from competitors. This concept is developed to show an extreme example of how branding could be done and communicated but, as mentioned, the negative aspects originating from this branding strategy are substantial and these designs are hence not developed any further.



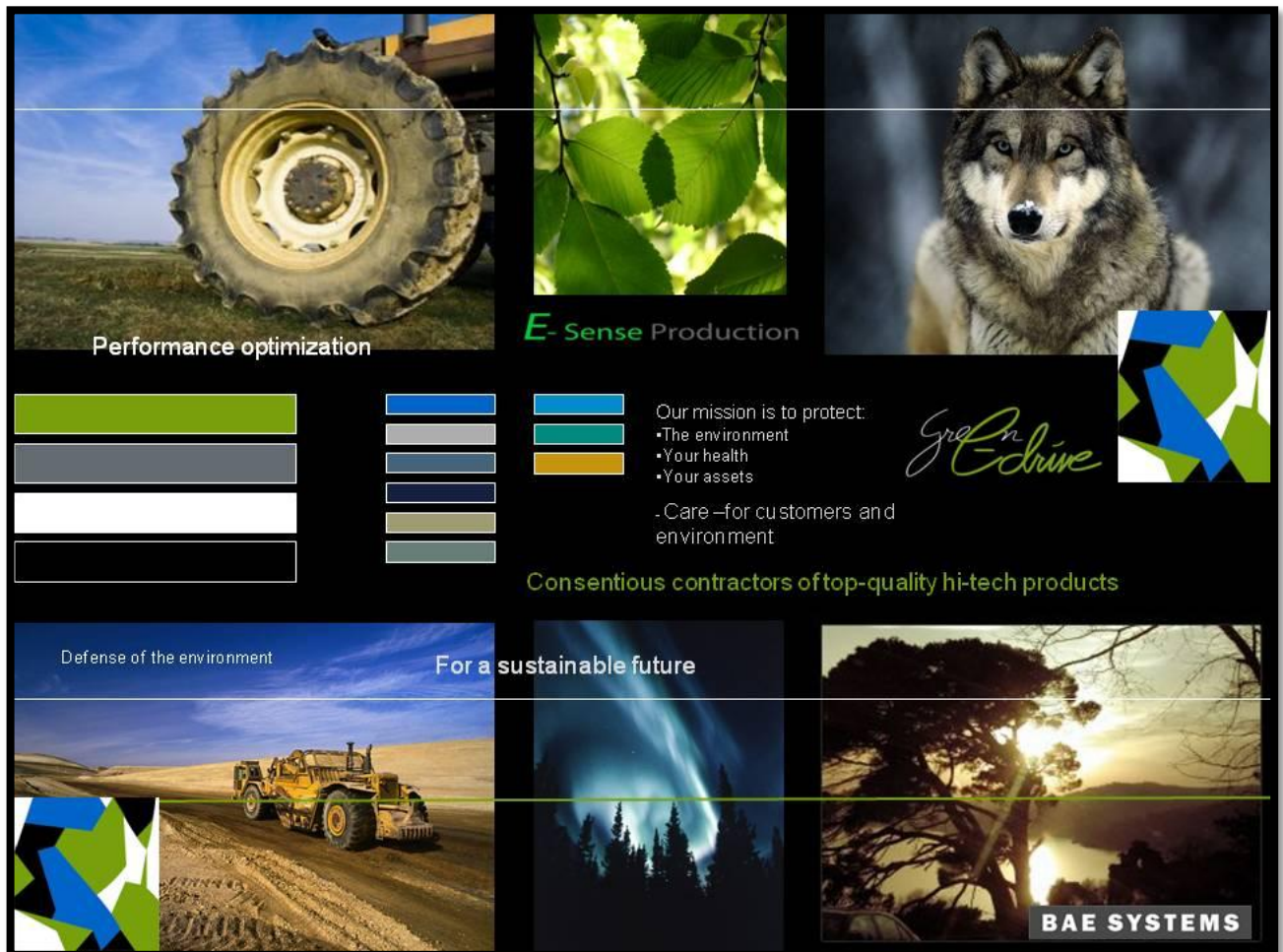
Picture 23: *Design propositions Concept A*

3.2.2. CONCEPT 2: BAE ASSOCIATED WITH EM CENTER AND E-DRIVE

The main difference with Concept B, compared to Concept A, is that EM Center here adds immaterial value to the BAE image by creating positive associations to the brand (Picture 24). This is done through adapting a softer approach and a more humane identity. EM Center is marketed and branded as conscientious contractors of top-quality high-tech products for the public sector. A company caring for the customers and the environment. The products are highly competitive alternatives whilst taking responsibility and caring for the environment, the customers and future sustainability. EM Center benefits from, and is associated with, all the in concept 1 mentioned, positive aspects of the BAE Systems brand, without being associated with the military industry. Depending on how strong the link between BAE Systems and EM

3. Concept generation and evaluation

Center is chosen to be they will affect each others' image to different degree. If, for example, BAE System Hägglunds loose future business deals this might affect the public image negatively and hence EM Center simultaneously. It's important to carefully evaluate and set



standards to keep the relationship on an optimal and stable level. BAE Systems brand standards can partly be used but it's important to create a branding strategy clearly directed towards the civil sector (with separate homepage, brochures etc.) The drive line gets a silver bullet or flagship position, and as one it's not equally important for it to pay off as for Concept A, since the products will affect the BAE Systems brand image in a highly positive way.

Picture 24: Inspiration board Concept B

Design propositions

As in the branding the design is softer in this concept (Picture 25). The product name Sphere is used which refers the ideal shape of the sphere to the product characteristics, as components perfectly functioning in an ideal assembly perfectly adaptable to any customer needs. Sphere is associated with the shape of the earth and the characteristics are communicated through an environmental friendly, soft and calm design. The shape is left as a cylinder related to the perfect circle. Since different power variants of the product are planned the white, lighter one could be used for lighter vehicles and the black for heavier. The design communicates environmental friendliness and harmony and as mentioned in chapter 3.1.1, the cylindrical

shape automatically communicates the cylindrical shape of the electrical machine. One imaginable problem with this design is that it may look too calm and anonymous. No bright colours and a very discrete design might make the product less attention attracting and possibly



perceived as boring.

Picture 25: Design propositions Concept B

3.2.3 CONCEPT C: TOTAL DIFFERENTIATION

Total differentiation in this aspect means no connection to the BAE brand whatsoever (Picture 26). The main benefit to this is that the brand identity can be independently defined according to EM Centers visions and goals and there is no risk for BAE Systems to affect the EM Center image negatively. Focus is put on technique, innovation, knowledge and future visions. Total differentiation can be done by creating a completely new brand and product platform but by doing so the advantages from a strong brand awareness are lost. Furthermore the lack of a link between the companies may be seen as false marketing since EM Center in reality is a part of BAE Systems Hägglunds. A solution to these two problems is to associate EM Center to Hägglunds and hence benefit from their successful history and heritage at the same time as



maintaining an "invisible" link to BAE. A possible problem to this is branding conflicts with Hägglunds Drives that nowadays is completely independent from BAE Systems Hägglunds.

Picture 26: *Inspiration board Concept C*

Design proposition

This design tries to capture power, performance and futuristic characteristics (Picture 27). Clearly visible colours are used and environmental friendly factors are ignored in order to emphasize functionality. The focus is advanced technology from contractors that invent, improve and always deliver. A negative aspect to these designs is the orange colour. Many OEMs use yellow/orange on their vehicles (for example CAT) and hence, though the colour nicely would blend in, the use of it highly would reduce the differentiating factors that are important to enable instant brand recognition.

Picture 27: *Design propositions concept C*

4. RESULTS: BRANDING AND DESIGN SUGGESTIONS

This chapter presents the final branding suggestion and a corresponding product design, based on the survey results described in chapter 3.1.1, communicating the chosen brand values.

4.1 THE BRAND STRATEGY

Based on the SWOT analysis and after evaluating the branding concepts together with people from the company a branding strategy mix between concept B and C is chosen (Picture 28). The benefits from not being too closely associated with BAE are substantial and hence a differentiated strategy is desired although there always should be some kind of link between the companies. The potential customers are, through the chosen business strategy, rather few and contacts have already been established and co-operations initiated. Hence the need to emphasize the relationship and market EM Center through BAE Systems does not seem crucial. The OEM customers on the market are to a great extent aware of the existence of the different contractors. Hence marketing in this business is not as much about the creation of brand awareness through advertising as about the quality and consistency of representation, personal relations and presentation materials.

The vision: *"to be the global provider of performance optimizing drive line solutions for medium to heavy special vehicles, through consistent development of innovative resources and efficient technologies* is suggested instead of the existing vision to be: *"the leading global provider of hybrid electric drive systems for medium and heavy special vehicles"*. The suggested vision is less limiting since it doesn't specify a certain technology; although HED are the focus of today, different, more optimal solutions may be available in the future. Furthermore the vision covers EM Centers' important function as a research center.

After discussions the attributes *Versatile, Powerful, Reliable, Efficient* are chosen from the ones evaluated in 3.1.1 to be the most important and hence suggested as core values for the brand. They cover both the product and organization characteristics and should hence be communicated through the product.



Picture 28: Imageboard final branding

4.2 THE PRODUCT STRATEGY

The values chosen can all to different extent be interpreted as both soft and strong characteristics.

Versatile refers to one of the main benefits with the system with its flexible properties both when it comes to the content of the system and the placing of the components. Versatile is also applicable for EM centers organization thanks to the diverse range of high competence among the personnel as well as the possibility and will to develop and adapt the products according to the customer wishes.

Powerful is the strongest of the values referring directly to the increased power performance achieved through the product use, as well as the internal competence of EM Center as an organization. This value is also the resultant for EM Center from the link between EM Center and BAE Systems: power is one strength, or benefit, that follows from being backed up by the worlds' second largest defense and security companies.

Reliable is soft in the sense that it tells the customers that EM Center cares about relations and agreements and can be trusted to deliver as promised at the same time as it refers to the product being functional, well proven and operating according to plan.

Efficient refers to both EM Center and their product utilizing assets in an efficient way and hence caring for and optimizing both the customer economy and the environmental impact. At the same time it's associated with increased productivity.

The fact is that this is a product that improves both soft and hard factors; E-drive is not only productivity and efficiency increasing, but the environment situation through reduced fuel consumption compared to traditional non-hybrid vehicles is improved. Hence there is no reason to hide this as long as the hi-tech, innovative and serious feeling isn't lost and it is clear to the customers that the environmental friendliness is a positive bi-factor and nothing they are paying extra for. There has to be a balance between softness and edgy hi-tech to communicate all the product characteristics. Technical details should never be over shadowed. This is a functional product and nothing contradicts that more than non functional presentation materials. This can be done by using contrasts: mixing colours, edgy and calm shapes, emotional pictures with strong to-the-point technical etc, always transmitting the same message and identity as to avoid contradictions. A colour palette containing primarily green, orange, blue and different shades of grey is used in marketing and presentation materials.

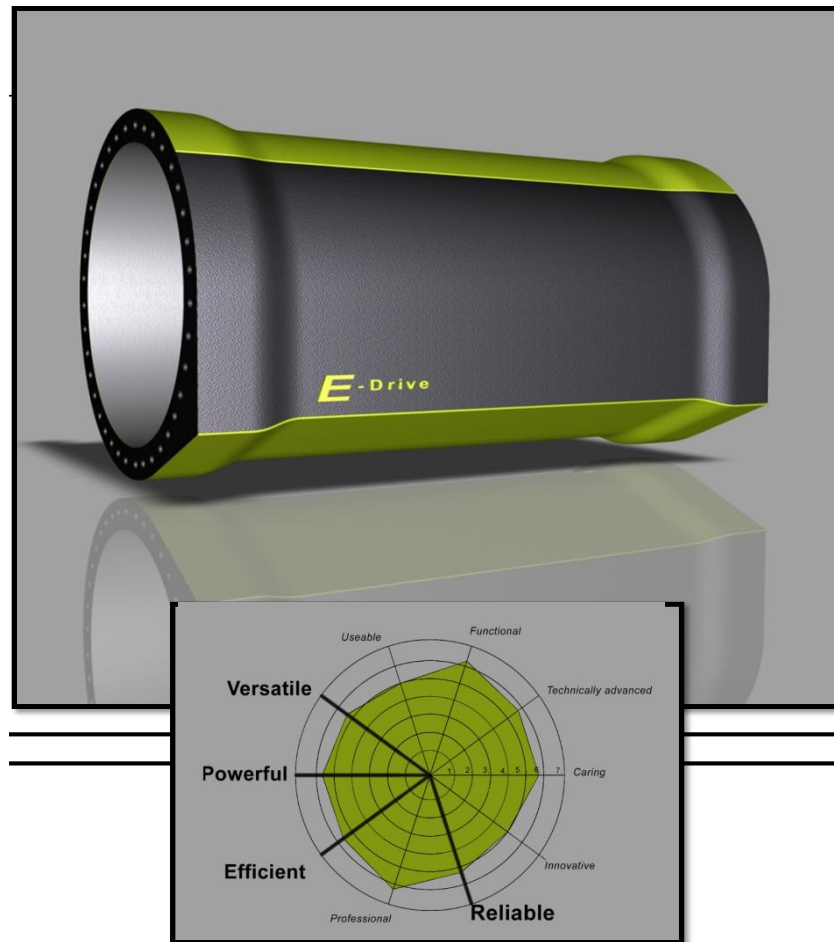
4.3. THE PRODUCT DESIGN

After discussions within EM Center the shape chosen is the one-edged variant because of its ability to transmit both soft and strong values as shown in chapter 3.1.1 (Picture 19). Although the two-edged shape rated highest overall it is not chosen for practical reasons: the manufacturing process would be more complicated, the final product heavier and more expensive. The higher ratings are not seen as substantial enough to justify for these factors. A soft radii is kept to emphasize the design look. To toughen up the expression and create contrast between the soft colour and shape the edge, or accent, is added (Picture 29). This equals an increase of ~7% weight and 700-1000kr/ housing which, is considered a negligible cost for this kind of product. The lower vertical edge is important both from a branding and functional point of view since it enables the brand name or logo type to be more visible than on the cylindrical version of today. Furthermore it strengthens the construction and makes it less sensible to bending forces. A large logotype is casted into the shape in order to enable brand recognition whether or not the OEMs later decide to paint the housing in their own colours.

The colours green and black are chosen for the product. While competitors might use green in their marketing materials no one (found) use it on their actual product. Furthermore green in general doesn't indicate a specific brand belonging in contrast to, for example, Ferrari or Coca Cola red. Green is strongly associated with environmental friendliness and hence it automatically communicates one of the product characteristics. To maintain the hi-tech innovative feeling the overall look shouldn't be too soft. This can be achieved by combining sharp shapes and soft colours or vice versa. To avoid a too calm and anonymous feeling a brighter nuance of green than in the design propositions for Concept B (Picture 25) is chosen and combined with a rigid black. The OEMs could further be offered to choose no or other colours for an extra charge.

In order to evaluate how well the chosen design communicates the selected core values described in chapter 4.2, a similar survey as in chapter 3.1.1 is made. This time the shape is

evaluated on its own in order to get more valid results concerning this particular design without comparison to others. To get results as uninfluenced as possible by differences in respondent characteristics a respondent group as similar as possible to the one used in the previous study is chosen: 20 respondent, 3/4 male, aged between 23 and 41. The results from this survey are very positive indicating that the proposed design to a great extent communicates the desired core values. On a scale of 7 *Versatile* is in average rated at 5.3, *Powerful* at 5.7, *Reliable* at 5.2 and *Efficient* at 5.8. The results are illustrated here below (Picture29).



Picture 29: Final design proposition

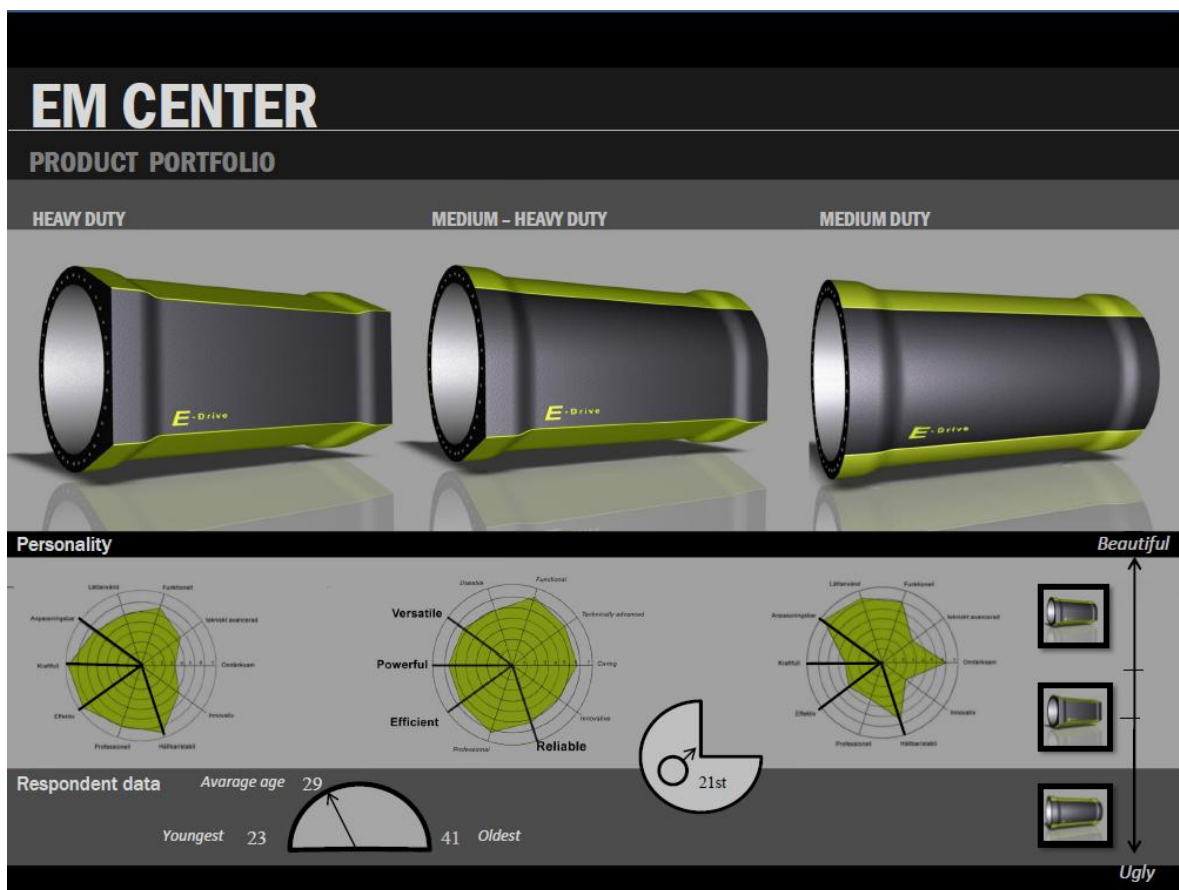
The introduced design cues that are to be used consistently through the future product portfolio can hence be summed up in:

- The horizontal line
- The radii of the edge
- The vertical surface with casted logotype (Note! Not the E-drive logo at the picture)
- The colours: two per product (Note! The exact nuances are not specified)

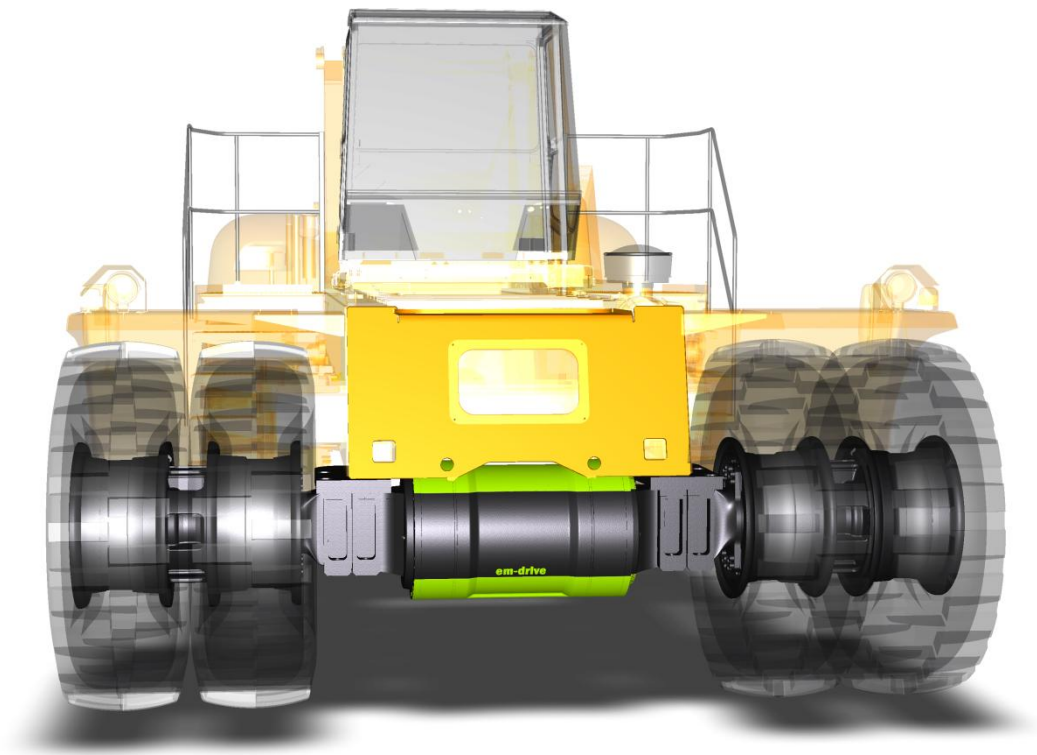
This is a design language that, at least according to the conducted survey, well communicates the desired characteristics. The presented design could, of course, be used for all different customer vehicles that EM Center is targeting, but my personal opinion is to ignore the extra manufacturing costs and the complications it conveys and to offer

4. Results: Branding and design propositions

different shape variants for different areas of use. My suggestion is to offer three alternative designs depending on vehicle power class: for *heavy duty* applications the sharper two-edge model communicating efficiency, power and non-nonsense functionality could be suitable. (Creating these two edges, or accents, would of course, results in the double price and weight increase compared to suggestion one). For *medium-heavy* applications the above presented "one-edge" design would be offered, while for medium duty vehicles the simple, soft, cylindrical shape could be used. The shape is light and easy, naturally communicating the function of the electrical machine directly through the shape (Picture 30). The three shapes efficiently communicate their personality differences and could hence form a functioning product portfolio. In this case it is very important though to use the same radii and curvature, as well as colour, to create a consistent and recognizable design language.



Picture 30: Evaluation results and product family proposition



5. DISCUSSION AND FURTHER RECOMMENDATIONS

This chapter discusses issues and thoughts around the work process, methods and results. It also describes areas of interest for further deeper studies into the field.

As mentioned the brand identity of EM Center is yet to be defined and this area is crucial to examine and specify in order to be able to continue the design work in a relevant way. To communicate brand belonging and product identity through the product design the values to communicate have to be specified. Hence the focus of this thesis is, to a great extent, on the visual branding aspects as well as visual product design, and it would be interesting to continue the work considering the technical prerequisites to a greater extent. Really smart design propositions for a technical product like this shouldn't just visually communicate the brand identity and core values, but preferably also construction wise optimize the function and performance. In the future it would hence be interesting to dig deeper into the technical aspects and create a consistent design language not only visually but functionally.

Technical details of E-drive may naturally not be described, but this shouldn't affect the results of this thesis much since it is focusing on visual design elements. Critical technical dimensions do of course constitute a basis for the design work of the product, but are not seen as absolute limitations.

Furthermore the validity and reliability of the surveys conducted is questionable. In order to identify reliable trends and be able to seriously base decisions upon the results 20 respondents are not enough, but the results can still serve as guidelines. A more thorough study among customers would also be nice to do, both for branding and product design suggestions, since their perception of a design may differ from the general public's'.

Construction wise the real future challenge is to invent and design an easily adaptable mounting solution for the E- axle. In order to reduce production costs it is necessary to create a modular way to implement it into different vehicles frameworks and geometries. As it is today the mounting method of every axle prototype is individually dimensioned and designed to fit so a modular solution to this would increase the efficiency enormously.

Although it, to start with, is crucial to decide what degree of differentiation from BAE Systems to adapt, how to brand this civil investment and what form design cues to implement in order to transmit the general identity, future branding/ design concepts could be derived from different criteria. For example to analyze the different market sectors (mining, bulk handling etc.) to adapt branding, presentation and product characteristics to their possible special needs and wishes and hence create a consistent product portfolio.

Considering the market analysis, with especially customer and competitor facts, these can never be 100% reliable or complete. The market situation is changing rapidly, and development progress or failure is impossible to predict. Part of the material presented in this thesis comes from the existing business plan and part is my own research. The

development state of competing products is, of course, impossible to get technical details about since a lot is classified, but even material one would think should be official, like brand standards, has been difficult to get hold of. Only three of seven contacted companies have sent materials and then explicitly explained that the documents are classified and only to be used for my thesis.

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7. APPENDICES
