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Development of an Innovative Market Approach for AVL Racing

Diploma Thesis

Mechanical Engineering and Economic Science

Transportation Technology

Graz University of Technology

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STATUTORY DECLERATION

I declare that I have authored this thesis independently, that I have not used other than the declared sources / resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

Graz, …… ……

(Signature)

Acknowledgement

“Ein Weg entsteht dadurch, dass man ihn geht!” (Franz Kafka)

As Franz Kafka says ways are being formed by walking them.

I am happy that I have had many people joining me on this way as tutors and friends, helping me to accomplish this thesis.

I would like to thank Mr. DI Gerhard Schagerl and Mr. DI Guillermo Pezzetto, who gave me the opportunity to work on such an interesting topic as the title of this thesis implies. Moreover, I want to emphasize the great working atmosphere and the professional and target oriented mentoring that you provided to me.

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Since the accomplishment of this thesis represents the biggest milestone of my academic career so far, I’d like to thank my entire family and my fellow friends. Thank you, Mama, Papa, Peter, Omi, Oma, Opa, Lisi, Werner and Martina, for being the best backing I can imagine.

Abstract

AVL Racing is a department of AVL List GmbH and provides vehicle dynamic software solutions (VSM and DRIVE) for the teams of top international motorsports leagues. Its main business is selling licenses of VSM and engineering services.

Because of the very high degree of complexity in terms of modeling and system costs, in the past this kind of software was reserved to teams in the top racing categories. Recent market observations by AVL Racing show that smaller teams in emerging leagues started to use these tools as well. In order to become a main player in those categories, AVL Racing commissioned this diploma thesis in cooperation with the Institute of Industrial Management and Innovation Research, a member of Graz University of Technology. Obviously, these smaller teams have to be approached in a different way than the big teams which are already served in the current target markets.

In the course of this thesis, several market research methods were applied to gain detailed information about the new customers' desires and requirements. As a result of the market research, it became obvious that AVL Racing is recognized by only one third of the involved race teams. Furthermore, it provided information about the current expenses on vehicle dynamic simulation software and how the software is used in those markets.

By combining the internal strengths of the department and the opportunities offered by these new markets (validated by the market research data), a new business model was derived. This model provides a new product family and a recommended course of action of how to implement it.

The core elements of this new model are the extensive reorganization of the features of the existing simulation tool and the shift from service and support intensive tailor-made product solutions, towards low involvement, off the shelf products, which can be sold to a competitive price due to a lean cost structure. This business model contains a pricing strategy to unlock these high potential markets. This differs from the current license based model.

This market approach provides the basis to conquer the new markets and can be seen as a holistic proposal of a strategic framework, tailored to the requirements of the new target markets.

Kurzfassung

AVL Racing, eine Abteilung der AVL List GmbH, ist ein weltweit agierender Partner von Rennteams in den Top-Ligen des Motorsports und ist spezialisiert auf dem Sektor der Fahrzeugsimulation.

Einerseits durch die hohen Systemkosten und andererseits durch den hohen Komplexitätsgrad im Bereich Datenbeschaffung und Datenanalyse, war Fahrzeugsimulation bis vor kurzem lediglich den großen Teams im Spitzenmotorsport zugänglich. Neueste, von AVL Racing beobachtete, Entwicklungen zeigen jedoch, dass sich nunmehr auch Teams von den kleineren, aufstrebenden Rennserien weltweit diesem Trend anschließen. Um in diesen Märkten schon von Anfang an präsent zu sein, hat die Abteilung AVL Racing diese Diplomarbeit in Zusammenarbeit mit dem Institut für Industriebetriebslehre und Innovationsforschung der Technischen Universität Graz in Auftrag gegeben.

Dieser neue Markt muss jedoch sehr unterschiedlich von dem derzeitigen Zielmarkt, den großen Teams in den Top-Ligen des Motorsports, bedient werden.

Dazu liefert diese Diplomarbeit, durch angewandte Marktforschungsmethoden, detaillierte Informationen über Kundenverhalten und Kundenwünsche in diesen bisher weitgehend unerschlossenen Marktregionen. Im Zuge dieser Marktforschung wurde unter anderem festgestellt dass die Tätigkeiten und Produkte von AVL Racing in diesen Rennserien weitgehend unbekannt sind. Außerdem konnten die Hauptanwendungsgebiete sowie das marktübliche Budget für Simulationsprodukte dieser Art eruiert werden.

Des Weiteren wird ein neues Geschäftsmodell, maßgeschneidert auf diesen Markt, vorgeschlagen. Um ein solches Modell tatsächlich und erfolgreich umsetzen zu können, wird zudem näher auf die Ist-Situation der Abteilung AVL Racing eingegangen.

Als Kernelemente des neuen Geschäftsmodells dienen unter anderem die komplette Umstrukturierung und Neuorganisation des derzeitigen Simulationstools sowie der Wandel von einem service- und supportintensiven Produkt, hin zu einer Produktfamilie, die in sich geschlossen ist, und ohne diese kostenintensiven Faktoren (Service und Support) auskommt. Des Weiteren beinhaltet es eine alternative Leistungsabrechnung welche sich erheblich von der derzeit benutzten Lizenzierung unterscheidet.

Durch diese Diplomarbeit konnte eine Möglichkeit eines neuen Grundgerüsts für die strategische Eroberung dieser aufstrebenden Märkte gefunden werden, indem es auf die Anforderungen der potentiellen Kunden maßgeschneidert ist.

Table of Contents

1 Introduction

This chapter provides an overview of the company AVL List GmbH, the department for which this work is performed, and the approach used to meeting the requirements of this diploma thesis.

1.1 AVL List GmbH

Founded in 1948, AVL represents the world's largest privately owned, independent company for the development of powertrain systems with internal combustion engines, instrumentation and test systems.[1]

AVL acts in several fields of business:[2]

- Developing and improving powertrain systems and components for the automotive industry;
- Providing the leading technology of instrumentations and test systems for engines and vehicle testing;
- Advanced simulation technologies for the design and all phases of the development process of powertrain systems.

AVL employs 5250 people in total, 2500 in Graz and another 2750 worldwide. The company has 45 affiliates all over the world. It is notable that 96% of AVL's business is exported with only 4% domestically used. The annual spending in R&D (Research and development) is approximately 12.5% of the total turnover which in 2011 reached € 830 million.[3]

[1] Cf. AVL List GmbH (2012)
[2] ibidem
[3] ibidem

1.2 AVL Racing Department

AVL is divided into three main divisions:

1) Powertrain engineering (PTE)
    a. Vehicle area
        i. AVL Racing department
2) Instrumentation & test systems (ITS)
3) Advanced simulation technologies (AST)

These divisions focus on the research of AVL Racing department in the Vehicle area of powertrain engineering (PTE). This department consists of 20 people dedicated to develop a vehicle dynamic simulation software called VSM (Vehicle Simulation Module) and a data post processing (analysis) tool named DRIVE.

Figure 1: Business scope of AVL Racing[4]

As illustrated in Figure 1, AVL Racing is a global player and is involved in the top motorsports categories by providing simulation software and engineering expertise to tune, adjust and enhance performance of race cars. To reflect the environment in which the department is embedded, Table 1 lists the most important facts of AVL List GmbH.

[4] Cf. AVL Intranet (2012)

AVL List GmbH Key Facts	
Annual turnover	€ 830,000,000
Employees	5250 worldwide
R&D quota	12.5%
Export quota	96%

Table 1: AVL List GmbH key facts (2011)[5]

1.3 Conceptual Formulation and Objectives

AVL Racing is recognized as one of the leading vehicle dynamics simulation software providers in top motorsports leagues.

The top racing markets are very competitive with a high level of rivalry and strong customers. In the past years, tools like VSM were only used in those top leagues, but (according to AVL Racing's market observations) recent developments show that the awareness for simulation tools in lower categories is increasing rapidly.

AVL Racing wants to be the preferred partner for these smaller race teams and therefore needs to evaluate the demand and the requirements to meet the customers' expectations.

To do so, it is absolutely necessary to execute an extensive status analysis of AVL Racing's current internal business model including sales, pricing strategy and EBIT (Earnings Before Interest and Taxes) calculation. Based on this analysis, the new target markets are evaluated. This market research provides information about market size, market share, demand, customer requirements, and possible distribution channels. The results of this study yields input parameters for further proceedings.

Based on this research, a new business model is proposed, which allows AVL Racing to tackle these new markets with a product portfolio tailored to their special requirements.

1.4 Approach

Figure 2 indicates the performed actions to accomplish the tasks given by AVL Racing in correspondence to the required time schedule.

[5] Cf. AVL Intranet (2012)

Step one involved the required extensive literature review to research and summarize strategic innovation management. This first step provided foundational support for recommended improvements for AVL Racing.

Step two involved a status analysis including current strategy, SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis, sales and marketing, and EBIT calculation.

Step three involved primary research with a field study. For a business model to be successful, information about the customers and the market is crucial. Data collected from interviews and questionnaires was analyzed to verify information from secondary research sources which included marked share, size and volume. The primary research also confirmed the need for a new AVL Racing business model.

Step four involved designing a business model which recommends innovative strategies to create a leaner cost structure, increase profits, and improve access to new markets.

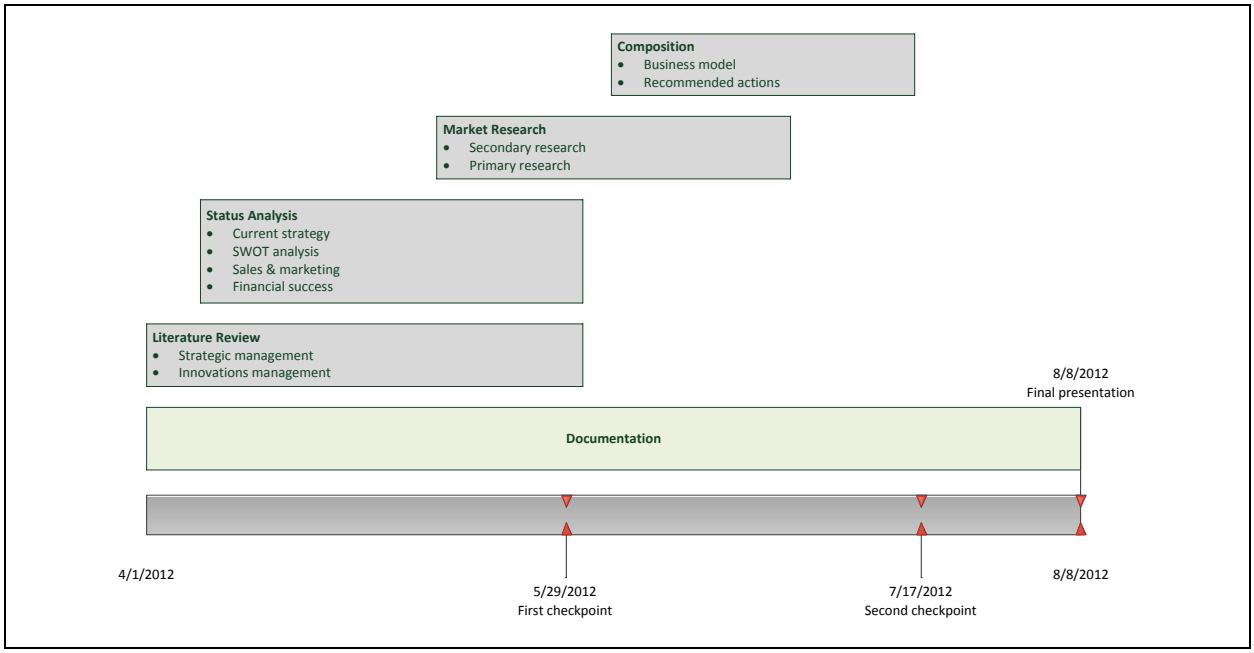

Figure 2: Completed tasks in coherence with the project timescale[6]

This business model will be presented to AVL top management and provide a suggestion about the further product and business strategy.

[6] Own illustration

2 Strategic Management

This section provides the background information for recommended proposals to restructure AVL Racing's product portfolio.

2.1 Historic Background

The term "Strategic Management" was first mentioned in 1979, in the conference proceedings of a meeting at the University of Pittsburgh under the title, "Business Policy and Planning; The State-of-the-Art." The contributions from this conference were published in a collected edition titled, "Strategic Management: A New View of Business Policy and Planning".[7] Figure 3 illustrates the development phases of strategic thinking.

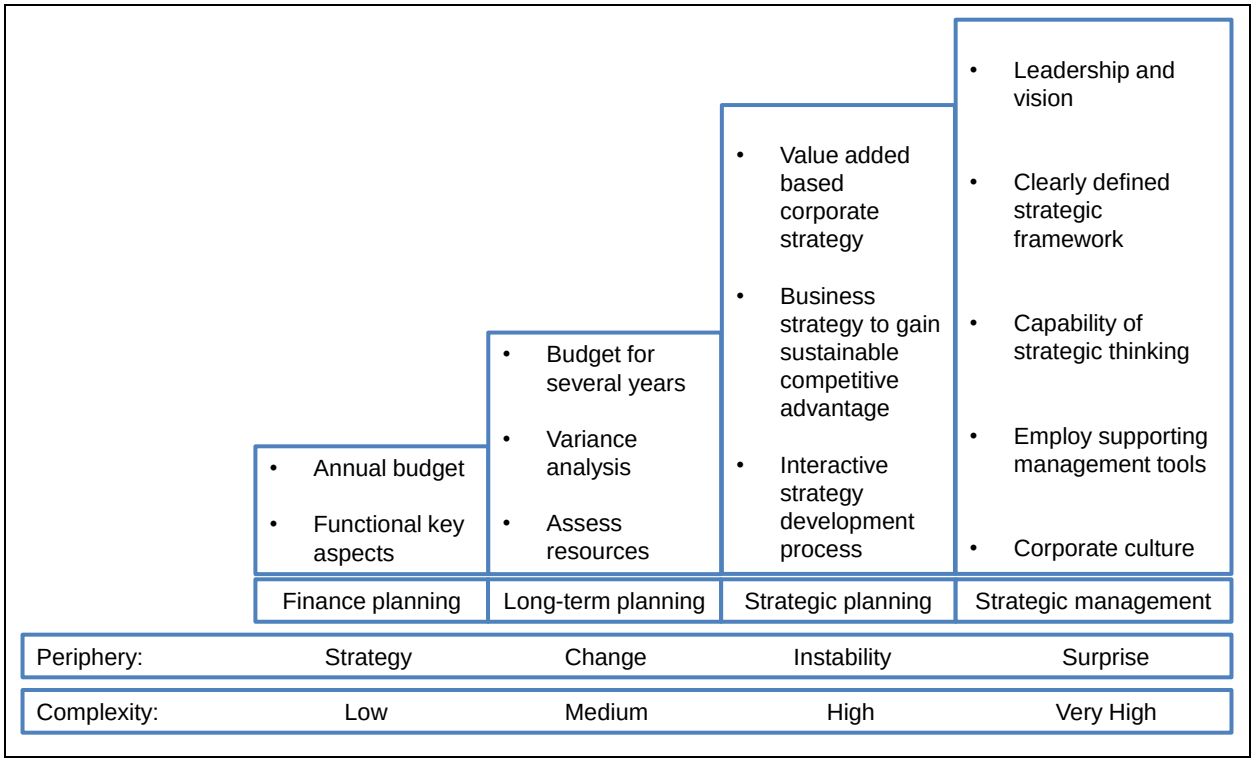

Figure 3: Development phases of strategic thinking[8]

[7] Cf. Welge (2003), p. 8; cf. Schendel/Hofer (1979)
[8] Cf. Gluck et al. (1980), p. 4

In this illustration finance planning, long term planning and strategic planning can be seen as pre-stages and bricks to achieve a broad understanding of strategic management.[9]

Strategic planning on its own delivers a detailed road map but it lacks of several important aspects of the practical implementation. The following problems can be identified:[10]

- Strategic planning concentrates on the formulation of the strategy and neglects its' implementation.
- Delegation of strategy works to the planning department results in a low level of acceptance for the strategy.
- Strategic and operative planning are executed separately.
- Strategic planning neglects the internal monitoring of structures and activities of a company.
- Resources required for the implementation are not considered.

A more specific look on strategic management provided by Ansoff shows that it comprises strategic planning as well as leadership and a monitoring of the implementation of the strategy.

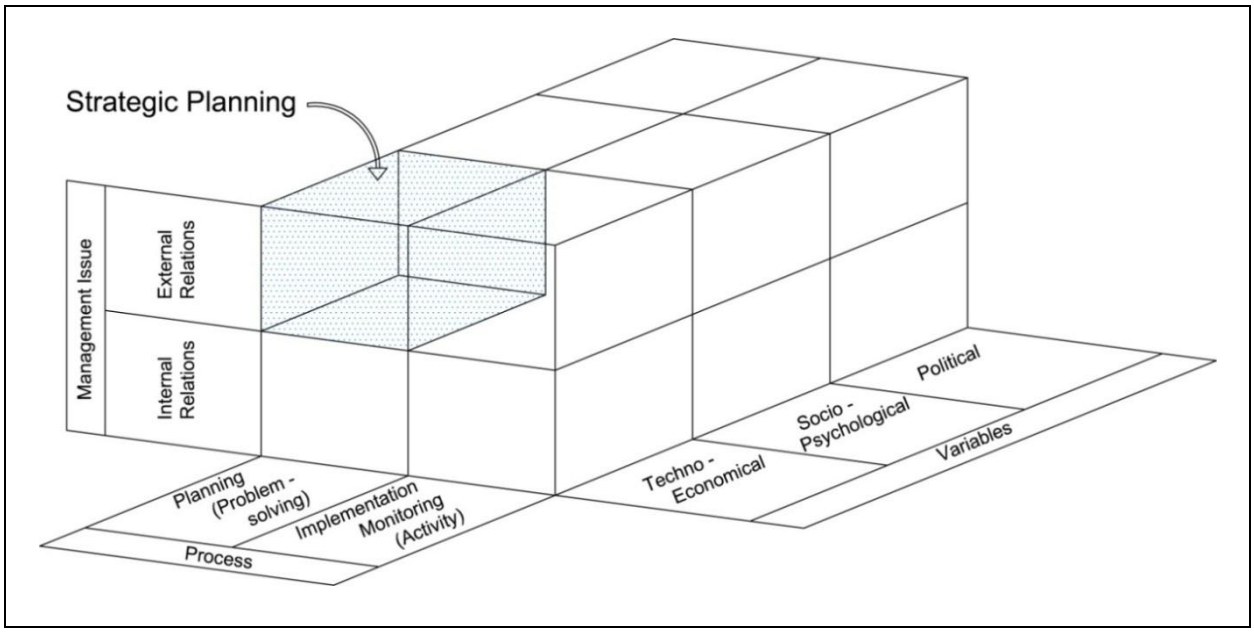

Figure 4: Strategic planning as a part of strategic management[11]

[9] Cf. Welge (2003), pp. 8 - 10
[10] Cf. Wilson (1994), p. 13
[11] Cf. Ansoff et al. (1976), p. 2

Figure 4 clarifies the input of peripheral parameters like technology, economy, politics and the changing values of the society.

2.2 Classic Theory of Strategy

According to the classic theory, is defined as a planned package of measures to meet long term goals of a company. This implies that strategy is the result of formal, rational planning.[12] The following characteristics describe this classic understanding of strategy:[13]

- Strategies consist of a sequence of single decisions.
- Strategies are hierarchical constructs.
- Strategies give statements about the positioning of a company.
- Strategies give statements about the calculation of resources.

Barney demonstrates this hierarchical system in the illustration below, which puts strategy in the third level as a package of measures to achieve the corporate mission and objectives. Goals and mission are defined by the top management.

Figure 5: Strategies as a hierarchical construct[14]

[12] Cf. Welge (2003), p. 13
[13] Cf. Hungenberg (2001), p. 4; cf. Barney (2002), p. 10; cf. Macharazina (1993), p. 204
[14] Cf. Barney (1997), p. 11

Summing up, Figure 5 clarifies that strategy is a rational package of measure, which is defined by a mission statement and specific performance targets installed by a firm's top management.[15]

2.3 School of Mintzberg

As a counter position to the classic theory of strategy, the school of Mintzberg implies that strategy is not a result of rational and formal planning.[16]

Mintzberg specifies five different understandings of strategy:[17]

- Strategy as a plan
- Strategy as a ploy
- Strategy as pattern
- Strategy as position
- Strategy as perspective

Those five ideas of strategy can be summed up in a basic pattern of strategies as indicated in Figure 6.

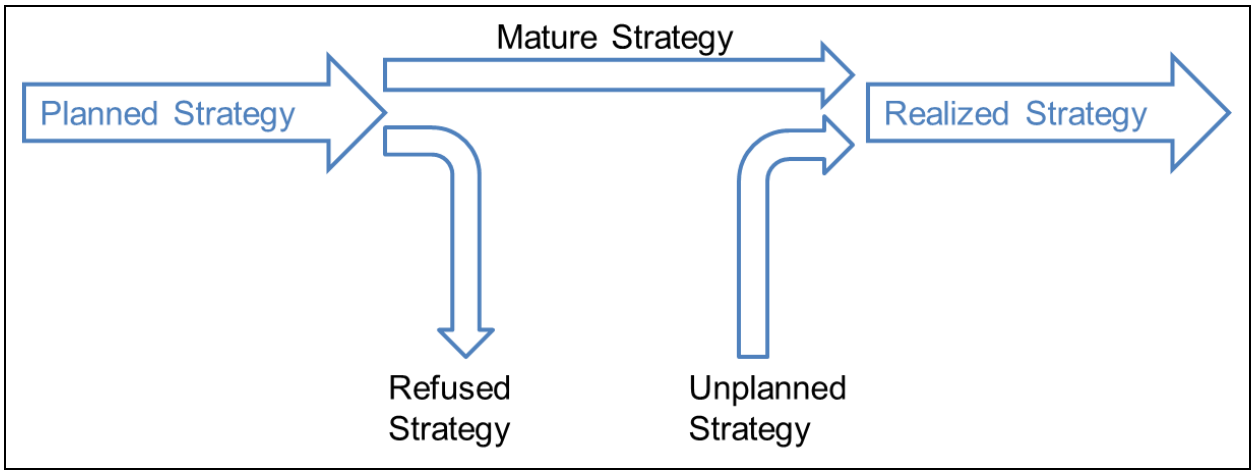

Figure 6: Basic pattern of empiric monitored strategies[18]

Mintzberg's ideas are directly related to the real life in companies in which he tries to identify common patterns. He does not create a fixed formula, but models for further

[15] Cf. Welge (2003), p. 15
[16] Cf. Welge (2003), p. 16
[17] Cf. Mintzberg (1978), pp. 934 - 948
[18] Cf. Mintzberg (1978), p. 945

discussions for real corporate life. This reflects his negative attitude toward pre-defined planning models.[19]

Taking both approaches into consideration (the school of Mintzberg and the classic theory of strategy), strategic management in general, is a process of formulating and implementing strategies into corporate environments.[20]

2.4 Strategic Management Models

The following models help to understand the rational decision-making process and to better understand how strategies are implemented.

2.4.1 Ansoff's Approach

This model can be understood as a classic example for a formal, rational, decision oriented strategic management approach.[21]

As shown in Figure 7, the model systematizes the decision making process in the areas in which the planning of growth and diversification strategies are taking place.

His model systemizes the required tasks which have to be considered by planning a growth or a diversification strategy. Since there are so many influential variables to take care of, it becomes difficult to choose the best strategic option. The top management has to consider the interactive dynamics of every aspect to find a solution for the "make or buy" issue. In Figure 7, the dashed lines indicate the scope of a decision. The decision making process starts first starts with a diversification decision ("Stop 1"), and passes through three more phases ("Stop 2 – 4"), in which the level of information steadily increases and ends with a final diversification decision in ("Stop 5"). As a result a strategic plan is derived, which consists of strategic targets and the strategic budget. The "Review Trigger" indicates the step of strategic monitoring.[22]

[19] Cf. Eschenbach et al. (2008), pp. 222 - 223
[20] Cf. Welge (2003), p. 19
[21] Cf. Welge (2003), p. 24
[22] ibidem

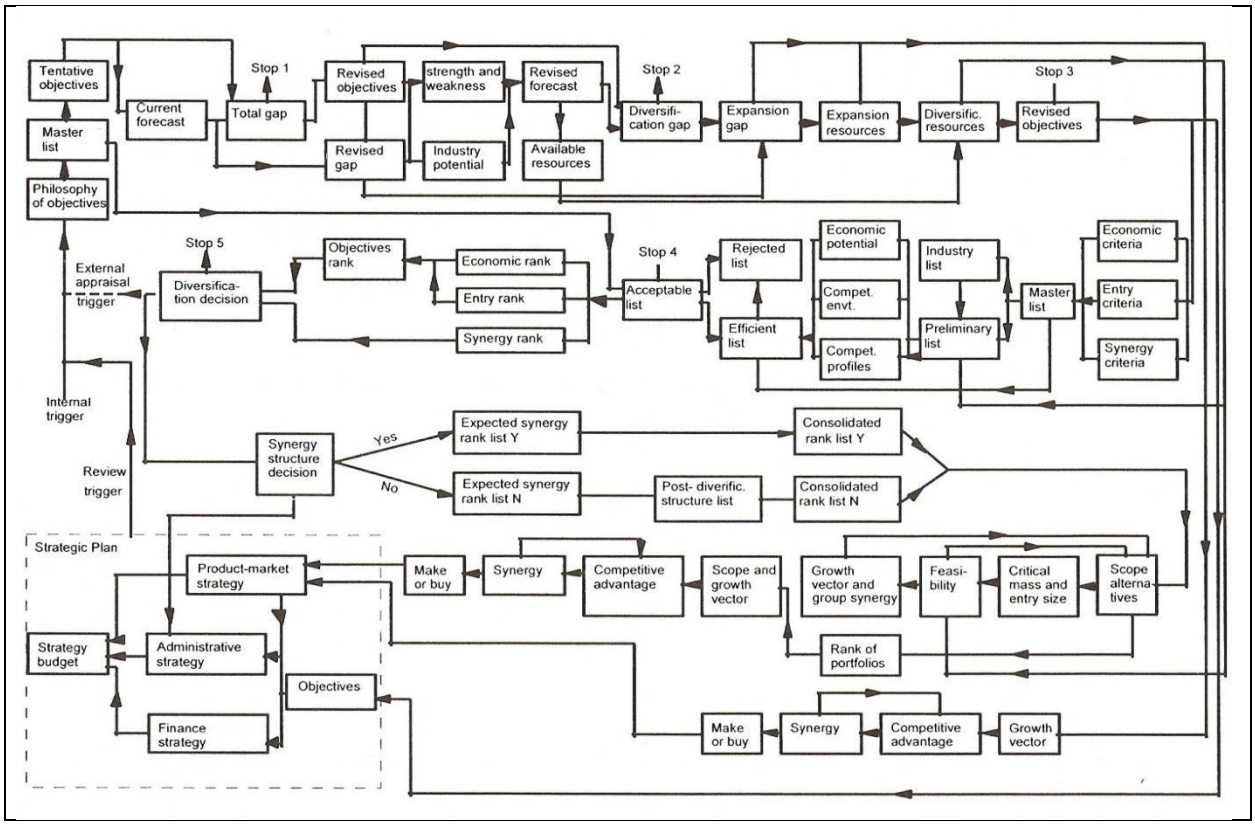

Figure 7: Ansoff's strategic management model[23]

In 1988 Ansoff, updated this model to be able to give statements about the implementation of strategies.[24] He defined the following principal tasks for the implementation of a strategy:[25]

- Promote entrepreneurship
- Monitor the general management capability
- Strategy oriented variation of potentials and capacities
- Balance strategic and operative targets
- Conflict management to overcome barriers

2.4.2 LCAG Scheme

The second model of strategic management, called LCAG (Learned, Christensen, Andrew, and Guth) scheme, is the first one which is self-contained. It provides an analytical view on the companies' peripherals and resources as well as the fundamental

[23] Ansoff (1965), p. 202
[24] Cf. Ansoff (1965), p. 202
[25] Cf. Ansoff (1988), pp. 163 -179

strategic options and personal values of several key managers of the firm, to finally reflect these inputs as components of an extensive strategy process.[26] Figure 8 illustrates the LCAG scheme as a master plan of the strategic management.[27]

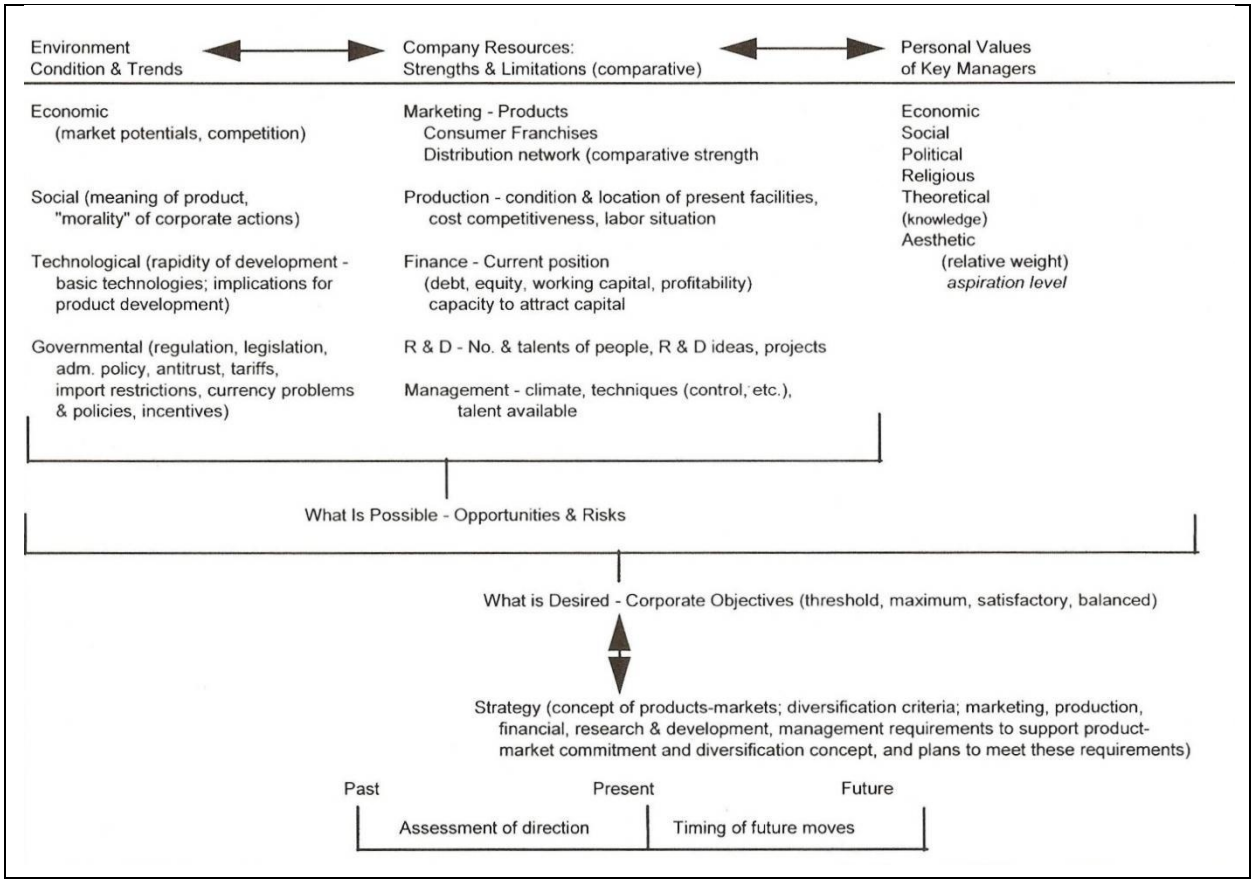

Figure 8: Original LCAG scheme[28]

The LCAG model identifies two main characteristics: strategy formulation and strategy implementation. Under strategy formulation, the following points are relevant:[29]

- Identification of potential opportunities and threats of the company's environment
- Analysis of the available resources
- Taking the values of the involved people into account
- Considering the responsibility of corporate impacts on the society

[26] Cf. Welge (2003), p. 27
[27] Cf. Welge (2003), p. 29
[28] Schreyögg (1984), p. 83
[29] Cf. Welge (2003), p. 27

Under strategy implementation, the following points are relevant:[30]

- Reconstruction and reorganization of corporate structures and processes to match the new requirements
- Creation of behavior related components (incentives, etc.)
- Shaping the board a company's board in terms of organization and human resources

2.5 Main Types of Strategies

Due to the fact that strategies are measures to assure long term business success, we can identify a considerably catalogue of possible approaches.[31]

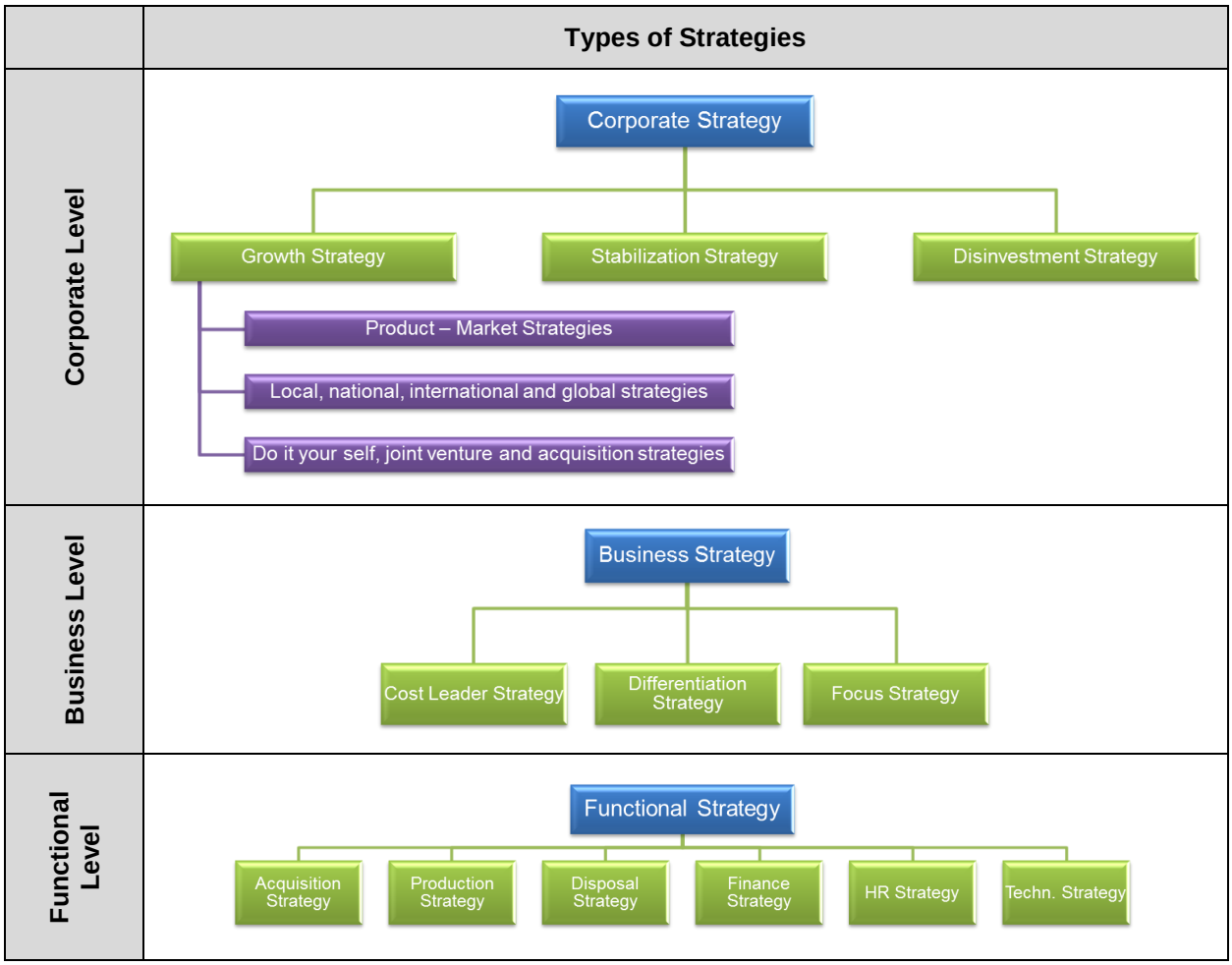

Figure 9: Types and levels of strategies[32]

[30] Cf. Welge (2003), p9. 29 - 30
[31] Cf. Bea/Haas (1997), p. 154

Figure 9 illustrates three strategic levels: corporate, business, and functional. Within each level are listed the main types of strategies. The business level in particular has reached a broad base of recognition. Due to the fact that especially the business level is of high importance for this thesis, it will be described in detail.

Two different approaches can be identified on this level of strategic behavior. Both Porter's "competitive strategies"[33] and Mauborgne & Kim's "competition avoiding strategies"[34] will be dealt with in particular.

2.5.1 Porter's Competitive Strategy

Figure 10 defines the influential factors on competitive strategies. The hub of the wheel contains common corporate targets and objectives, whereas the wheel belt represents the influential parameters which are required to achieve the goals stated at the center.[35]

Figure 10: The wheel of competitive strategy[36]

[32] Cf. Bea/Haas (1997), p. 157
[33] Cf. Porter (1999), p.1
[34] Cf. Mauborgne/Kim (2005), p. 25
[35] Cf. Porter (1999), p. 25

Every company that is part of any market and therefore acts as a competitor uses a strategy, either consciously or unconsciously. The increasing significance of strategic planning can be observed in all kind of firms. This raising this awareness provides the evidence for the assumption that having coordinated interdivisional targets and intentions stated as a strategy, is crucial for success.[37]

Five Forces

Competition is a part of every branch, to determine if a market is a prospective area to invest in, Porter created the five forces model.[38] Every corporation within any sector aims to be protected against those forces illustrated in Figure 11, or to use them for their own competitive advantage.

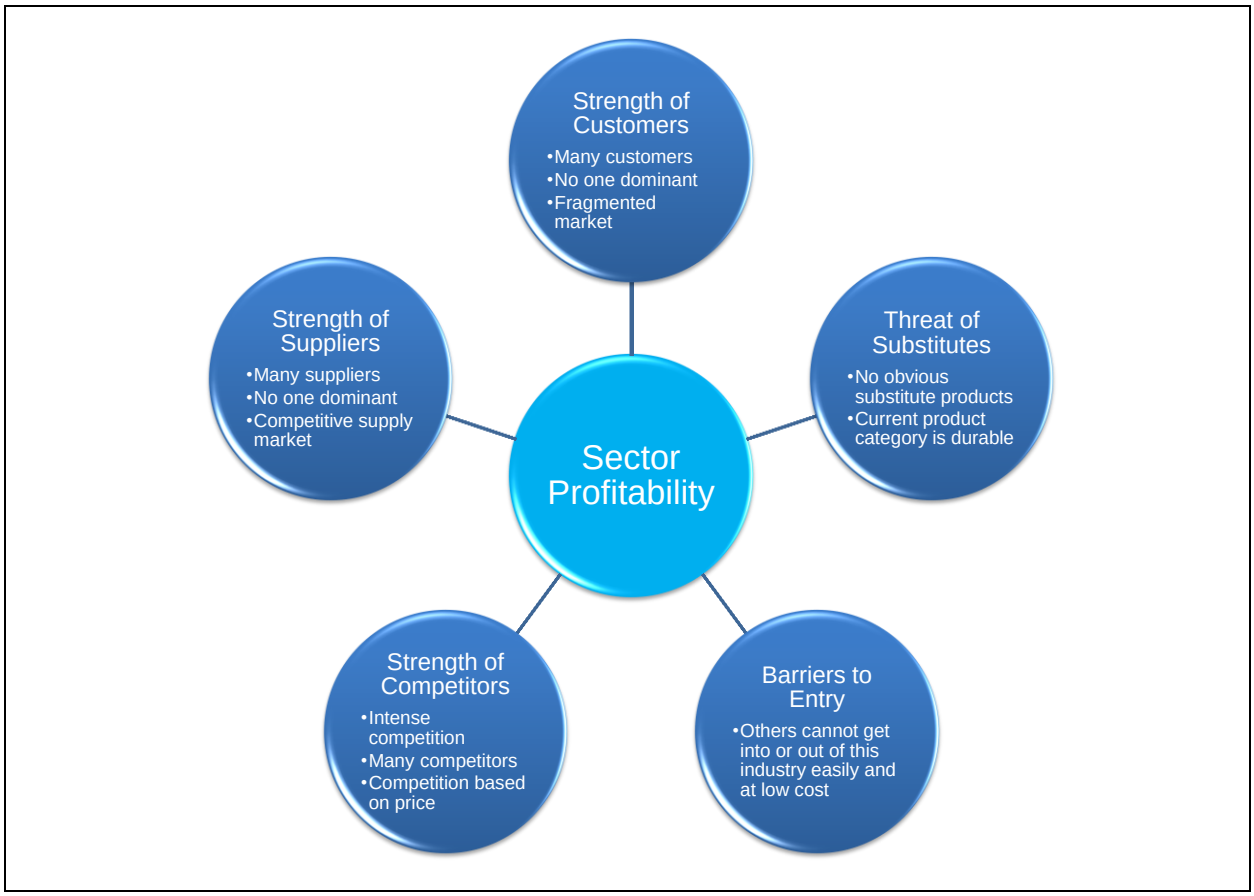

Figure 11: Porter's five forces model[39]

[36] Cf. Porter (1999), p. 25
[37] Cf. Porter (1999), p. 21
[38] Cf. Cooper/Edgett (2009), p.75
[39] Cf. Cooper/Edgett (2009), p.76; cf. Porter (1999), p. 34; cf. Porter (2000), p. 32

Those forces are valid for the every company within every sector and therefore inevitable for competitors as well. Business managers have to identify the source of each of those forces to gain information about their companies' strengths and weaknesses as well as potential sector wide opportunities and risks.[40]

Dealing with the five forces delivers the following main strategic types regarding Porter:[41]

- Cost Leadership
- Differentiation Strategy
- Focus Strategy
- Stuck in the Middle

As a general principle, it is difficult for companies to align their strategy towards more than one of the above.[42]

Cost Leadership

Cost leadership requires an aggressive management of costs, large production scales and tough monitoring of variable costs and overhead costs. To keep costs down it is important to avoid marginal customers, to have firm administration, to minimize expenses on R&D, service, and promotion. Achieving lower costs than the competitors is the top priority. In every way, quality, services, and other critical factors of the sector have to match the sector's standards. A competitive cost advantage allows corporations to be profitable even in times of crises or in markets with a high degree of rivalry. Being a cost leader protects the company against powerful customers who can push down prices only to the level of the second most efficient competitor. The same factors which are responsible for cost leadership additionally create entry barriers by means of economy of scale and cost advantages. Once achieved, cost leadership delivers high corporate margins which can be used to reinvest in even more efficient equipment and state of the art logistic systems to sustain this position.[43]

Having only "some" cost advantages is not enough to capitalize the benefits of this strategy. Only the position of the cost leader is worth pursuing.[44]

[40] Cf. Porter (1999), p. 34
[41] Cf. Porter (1999), p. 71
[42] Cf. Porter (1999), pp. 70 - 71
[43] Cf. Porter (1999), pp. 70 - 72
[44] Cf. Nagl (2009), p. 36

Cost leadership is accompanied by the following risks:[45]

- Technological changes, which shoot earlier investments down;
- Inability to identify necessary product or market innovations;
- Increasing costs which lower the companies' capability to achieve the required margins.

Differentiation Strategy

Differentiation strategies can be achieved in several ways. Branding, special design, technology, promotion, service, distribution network or other diversifications can be used to create special customer desires. The optimum for companies following this strategy would be to diversify themselves in multiple levels. This strategy is viable due to the fact that diversity creates a secure position in the contention of the five forces. It reduces the price sensitivity and increases the corporate margin which is the reason why cost leadership becomes redundant. Due to increasing customer loyalty the power of suppliers and retailers decreases. Unfortunately, differentiation is very often incompatible with high market shares because this strategy is lives up by an exclusive reputation and desire.[46]

Differentiation contains the following risks:[47]

- Decreasing customer loyalty: If the price difference compared to low cost providers is too high, customers neglect the more specific features to save money.
- Decreasing demand: If the market sample becomes too small, there is less need for the service or product.
- Imitations diminish the recognizable differentiations: If competitors' products and services are too similar, customers do not see the difference.

Focus Strategy

The idea of this strategy is to concentrate on only one market segment or niche. Cost leadership and differentiation strategies try to penetrate the whole sector, whereas a segmentation strategy targets only a certain part of the branch. This allows companies

[45] Cf. Porter (1999), pp. 83 - 84
[46] Cf. Porter (1999), pp. 73 - 74
[47] Cf. Porter (1999), p. 84

following this strategy to either accurately meet the specific customer demands (differentiate form other competitors in this area) or to create a cost advantage due to the focus on that niche. Both advantages can be capitalized upon and will result in higher profits. The following this strategy always implicates a trade-off between market share, possible turnover, and profitability.[48]

Focus strategies come with the risks listed below:[49]

- High price differences: If the price is too high it diminishes the advantages of a more focused product portfolio.
- Declining needs: The offset of needs in the niche markets and the total market decreases.
- Increased specialization: Competitors diversify the niche into smaller niches and increase the degree of specialization.

Stuck in the Middle

In some cases, companies try to implement a combination of those three strategies. Picking out some attributes of each approach results in a strategy without a clearly defined statement. As a result, the profitability and competitiveness decreases. To achieve cost leadership these companies are lacking market share, equity investment and the determination to differentiate or to focus on market segments. Another reason why a combination of the three main strategies usually fails is the fact that each of them requires different strengths, types of leadership, and organizational structures. Once a company is stuck in the middle, it becomes difficult to maneuver the company out of it and realign it toward one single type of strategy.[50]

2.5.2 Blue Ocean Strategies

Mauborgne & Kim distinguish between red and blue oceans. In red oceans, the borders of each single sector are precisely specified and accepted by the competitors. Companies try to beat competitors to increase their own market share of the existing demand. This behavior leads inevitably to a higher degree of rivalry within the branch. The tougher the market, the higher is the risk of declining growth rates and profit

[48] Cf. Porter (1999), pp. 75 - 77
[49] Cf. Porter (1999), p. 85
[50] Cf. Porter (1999), pp. 78 - 80

margins. As a result companies get stuck in a vicious circle of overstock goods or unneeded services which lead to low profits.[51]

Blue oceans are defined by unexploited markets, by the creation of demand, and by the prospect of a high profitable growth. Even if those blue oceans can be accessed far away from the borders of a sector, most of them will be developed by broadening the well-known borders of red oceans. In blue oceans, competition does not matter because the rules are to be defined by the pioneer who opened up such an area.[52]

Value innovations are the key to unlock blue oceans. As illustrated in Figure 12, such a value innovation is defined as the area where decreasing costs overlap the increasing value for the customer.

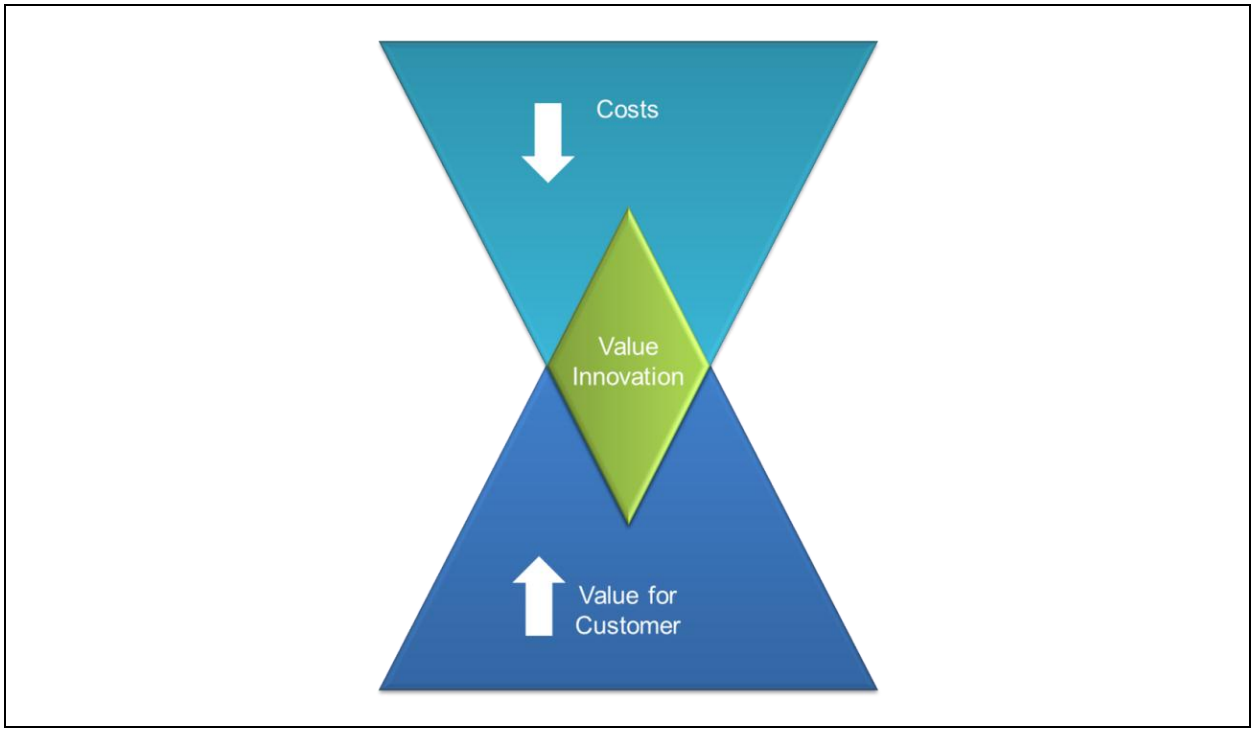

Figure 12: Value Innovation[53]

The decreasing costs are a result of the focus on the elimination and reduction of competition related factors. The value for the customer increases due to the creation or increase of previously non existing elements in this sector. As time passes, the sales volume increases which directly affects the cost structure in a positive way. The main

[51] Cf. Mauborgne/Kim (2005), p. 4
[52] Cf. Mauborgne/Kim (2005), pp. 4 -5
[53] Cf. Mauborgne/Kim (2005), p. 15

target is to increase the benefit for both customer and corporation. A value innovation is more than just an innovation; it is a strategy which positively affects the entire company and its behavior.[54]

Red Ocean Strategies	Blue Ocean Strategies
Competition in existing market	Develop new markets
Outclass the competition	Avoid competition
Use existing demand	Unlock new demand
Direct relation of cost and benefit	Cancel direct relation of cost and benefit
Align business strategy towards either cost leadership or differentiation	Align business strategy towards cost leadership and differentiation

Table 2: Strategies for red and blue oceans[55]

Table 2 illustrates the main characteristics of strategies for red and blue oceans. As a general principal, red ocean strategies represent tactics to outclass competitors whereas blue ocean strategies try to avoid enemies (competition avoiding strategy). Mauborgne and Kim disagree with Porter's statement of aligning a company with one of the three main strategies only by demanding both cost leadership and differentiation.

[54] Cf. Mauborgne/Kim (2005), pp. 15 - 16
[55] Cf. Mauborgne/Kim (2005), p. 17

3 Innovation Management

The following chapter deals with the term innovation and provides a basic understanding of the innovation management process.

3.1 Innovation

What makes the difference between invention and innovation?

Schumpeter defines them as follows:[56]

- *"… innovation, that is the process of finding economic application for the inventions …"*
- *"… invention is the obvious first step towards any new product or process …"*
- *"… imitation, that is the process by which innovation is diffused throughout the industry or economy …"*

David Needle finds similar words to describe the difference:

"Invention is the discovery or creation of a product or process, whereas innovation is the process through which inventions and ideas become a business or operational reality. An innovation can include new products, processes, strategies and organizations structures. Innovation is claimed by many as an important source of competitive advantage."[57]

Schumpeter and Needle show that only the successful implemention of an invention into the market can be called innovation.

In this thesis, innovation management is seen as the umbrella term for all the actions and efforts taken to ensure that inventions become innovations.

The main purpose of innovations management is to ensure the companies' position on top of its competitiors by creating innovations. To do so the following aspects have been identified in Figure 13.[58]

[56] Schumpeter (1987), p. 100
[57] Needle (2010), p. 326
[58] Cf. Gassman (2008), pp. 6 - 14

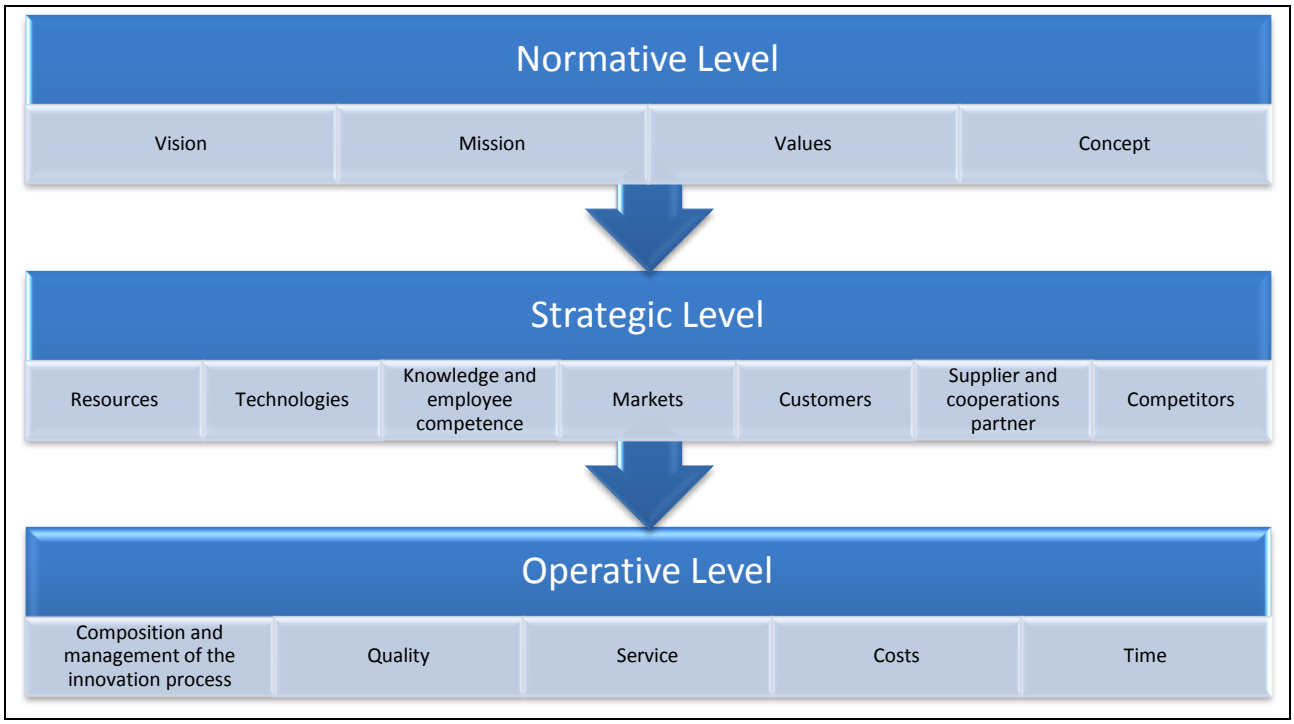

Figure 13: Three levels of holistic innovation management[59]

Among the responsibillites of innovations management one can identify the following tasks:[60]

- Acquisition and evaluation of innovative developments inside and outside a company.
- Installation and support of the companies internal innovations potential.
- Acquistion of external innovations and implementation of them within the company (knowledge transfer).
- Providing the definition of the meaning of innovations for the companies development and the choice of innovations scopes (innovation strategies).
- Distribution of resources for the chosen innovation scope.
- Planning, managing, executing, and controlling of innovations activites.
- Assessing timing of market entry for innovations or their implementation into the company.
- Protecting innovative ideas by using patents or licensing.

[59] Cf. Gassman (2008), pp. 6 - 14; cf. Ulrich/Fluri (1992), p.19
[60] Cf. Corsten et al. (2006), p. 11

3.1.1 Types of Innovation

Following types of innovation can be identified:[61]

- Product innovation: Successful implementation of a new product (e.g., a new model of a car).
- Process innovation: Implementation of an advanced process (e.g., production of goods).
- Organization and management innovation: *"… a marked departure from traditional management principles, processes and practices or a departure from customary organizational forms that significantly alter the way management is performed."*[62]
- Social innovation: Hire and fire attitude, behavior of employees in terms of continuing education and ambition.

3.2 Innovation Process

The following chapter covers the basics of innovation processes which contain all phases from the product idea to the product realization. The subdivision of these phases varies in the level of their details and their designs.[63] Within innovation management, these processes have important impacts on both practice and research.[64]

3.2.1 Innovation Process by Thom

Thom's innovation process contains the three levels as illustrated in Figure 14. They are influenced by the following external factors:[65]

- Customers, competitors, suppliers, research institutes and trade fairs: Responsible for start stimulation.
- Society, politics, ecology, economy, and technology: Responsible for inputs and requirements directed towards the corporation, which influences the impulse as well as all levels of the process itself.

[61] Cf. Needle (2010), p. 328; cf. Thom (1980), p. 32; cf. Knight (1967), pp. 478 - 496
[62] Hamel (2006), p. 75
[63] Cf. Müller-Portmann/Dörr, (2011), p. 31
[64] Cf. Verworn/Herstatt (2000), p. 1
[65] ibidem

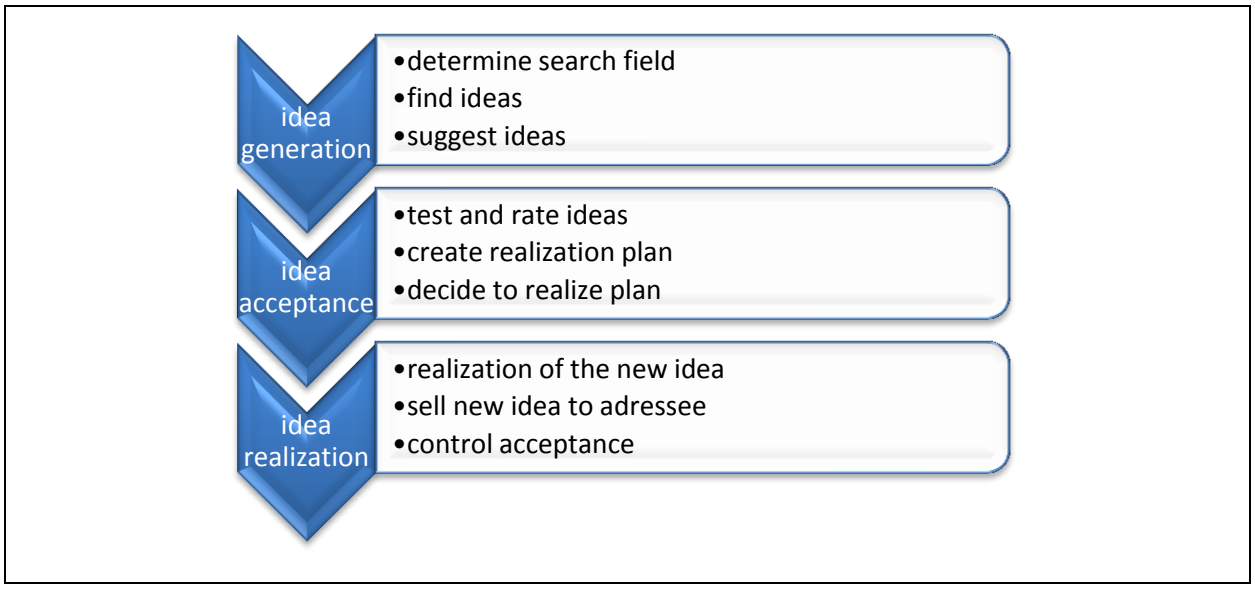

Figure 14: Illustration of the innovation process by Thom[66]

Thom illustrates the way from generating ideas to the realization of ideas. This figure gives a basic overview of such a process, but it does not give any hint of how to do so.

3.2.2 Stage-Gate Process

Cooper's version of an innovation process is illustrated in Figure 15.

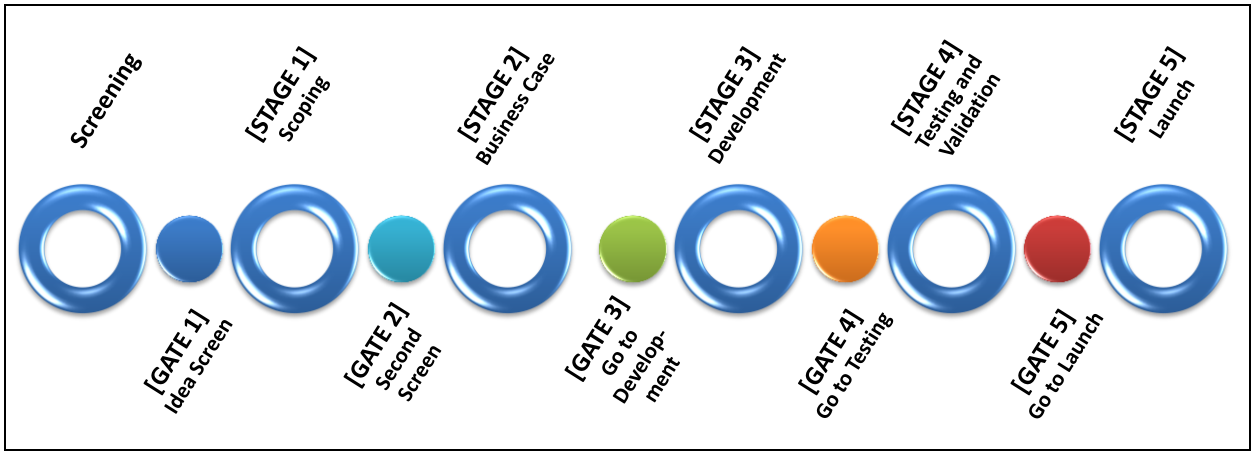

Figure 15: Stage – Gate Process[67]

[66] Cf. Thom (1980), p. 49
[67] Cf. Cooper (2010), p.146

Once an idea has been identified, one has to ensure that it meets the needs of the market and the companies' capabilities. Robert G. Cooper found a way to point out the key issues to successfully implement an idea into the market by the "Stage-Gate Process".[68] He splits the tasks of a project into small pieces (stages) and defines evaluation or quality check mile stones (gates).

Gates can be seen as a tribunal which decides if the project will be stopped, proceeded or set on hold. Project leaders have to show the results of the prior stage and match them with the target value or defined index output. These values have to be decided on the end of each gate and prior to the entry of a new stage. The project team is responsible of defining these criteria to keep the project on the trail of success.[69]

In accordance with Cooper, the following points can be used to describe criteria and outputs which are relevant for the process:[70]

- Criteria
    - Does the procject match the corporate strategy and culture?
    - How big is the competitive advantage for the new product?
    - Does it fit into the company's core competences?
- Outputs
    - Project accepted to proceed
        - Plan for further approach
        - Budget
        - Timeline
    - Project on hold
    - Project stopped

Stages represent smaller clearly identifyable pieces of a project. The number of stages can vary, but typically they won't exceed the count of 6. The main stages contain the following tasks as illustrated in Table 3.[71]

[68] Cf. Arleth (2008)
[69] Cf. Cooper (2010), p. 148
[70] Cf.Cooper (2010), pp. 148 - 149
[71] Cf. Cooper (2010), pp. 146 - 147

Screening	Preliminary work to identify opportunities and ideas
Scoping	Front – end project analysis, desk research
Business Case	Detailed investigation of the market and of possible technical solutions, leads to a product definition and contains a project justification plan
Development	Product design into detail, developing production strategy
Testing & Validation	Pilot marketing, checking on functionality and market response
Launch	Start of production, marketing and sales

Table 3: Description of the main gates regarding Cooper[72]

Due to the special interest within this thesis on business cases and strategies, the stages "Scoping" and "Business Case" will be discussed separately in detail.

	Operation	**Detailed Description**
[Stage 1] Scoping	Preliminary market assessment	Quick assessment of the products prospectives on the market regarding: potential, acceptance and requirements No detailed market research, desk research at this phase
	Preliminary technical evaluation	Assessment of technical risks, feasability and possible solutions; Check on possibilities for production and suppliers
	Preliminary finance check	Quick and dirty overview of financial aspects (e.g., duration of amortization)
	Suggestions and planning	Stop or Go suggestion; To do list for Stage 2 (timeline, personnel, etc.)

Table 4: Stage 1 of the Coopers' Stage Gate process[73]

Table 4 and Table 5 describe relevent operations and shows what has to be investigated to evaluate the market and the idea. [74]

Scoping assess the basic potential of an idea, whereas stage two already requests very specific and detailed information about it.

[72] Cf. Cooper (2010), pp. 146 - 147
[73] Cf. Cooper (2010), pp. 214 - 215
[74] Cf. Cooper (2010), p. 146

	Operation	Detailed Description
[Stage 2] Business Case	Customer demands and desires analysis	Exploring customers' needs to tailor the innovation to their demands; detailed market research (can include interviews, questionnaire, etc.); definition of the product benefit and the value from the customers point of view; therefore especially preferences, dislikes, selection criterion and special desires have to be identified
	Competitor analysis	Focus on the competitors' strength and weaknesses, their products and their pricing strategy; are there new competitiors on the horizon?
	Market analysis	In this stage very detailed including the usage of primary research (field study); outcome is assessment of market size, market potential, market segments, consumer behaviour and competitional situation
	Detailed technical evaluation	Gained data of steps above lead to a concept of a product, which has to be checked on feasability, technical risks, funcitionality and sustainibility; further production strategies possible suppliers and investment costs have to be considered
	Concept check	Final test of the market before development kick off; product concept will be tested at the target market (pilot marketing); measuring positve or negative feedback, buying intention and price sensitivty
	Economic and financial analysis	Focus on economical basis of the project; strategic assessment; Core competences and possible partnerships or outsourcing partners considered; detailed investment research
	To do	Suggestions for further approach (Stop or Go); sction plan for upcoming stages; scheduling the market introduction date

Table 5: Stage 2 of the Coopers' Stage Gate process[75]

The advantage of the implementation of this process is the systematization of the product development. It eases the communication within the team and with the top management.[76]

Talking about processes and setting goals and targets implies that one has to be aware of every tiny aspect of the business one is involved in. To keep up to date, several analysis tools can be identified and will be described in the following section.

[75] Cf. Cooper (2010), pp. 214 - 215
[76] Cf. Verworn/Herstatt, (2000), p. 5

3.3 Analysis Tools

Analysis tools can provide the required filter mechanism to finally lead us to the right decisions. This section will deal with various types of tools to find the best strategy for AVL Racing and their product portfolio. Nevertheless it has to be mentioned that the outcome of every analysis tool is only as accurate as its input.

3.3.1 SWOT Analysis

This type of analysis is the beginning of every proper marketing plan. It captures the specific issues that are related to the area of business a corporation operates in. The outcome of such an analysis should comprise a broad overview of internal strength and weaknesses, as well as external opportunities and threats (SWOT). To feed this tool with proper information, the following approach is recommended:[77]

- Capture corporate external influencing parameters: In this first phase one tries to gain information from the past and the current market situations. By identifying qualitative and quantitative factors which are very important for the corporation but are not capable of influence by the company itself, it is possible to estimate trends and thereby open a window to a closer insight of how the business works.
- External opportunities and threats: The second phase starts focusing on opportunities which are evoked by the market; e.g., emerging markets, new distribution channels, threats, new competitors, or declining prices.
- Internal strength and weaknesses: The third phase concentrates on the internal abilities of a company in relation to their competitors.
- Linking phase two with phase three: This final step provides the SWOT-Matrix. The combination of internal and external parameters draws a picture of marketing issues which have to be solved.

As an example, Table 6 illustrates a SWOT–Matrix for a company in the automotive sector.

[77] Cf. Bruhn (1999), pp. 41 - 44

Strengths	**Weaknesses**
• Global presence of the company • Leading position in passenger protection systems	• No expertise in hybrid cars • No alternative drive systems available
Opportunities	**Threats**
• Emerging markets in the automotive sector • Big market increase evoked by hybrid cars	• Worldwide increasing safety standards • Worldwide tougher emission legislation

Table 6: SWOT–Matrix example[78]

To improve the performance of a company and to increase the innovations potential, it is important to focus on combining strengths and opportunities and simultaneously eliminating the weaknesses.

3.3.2 MA-CA Portfolio

Portfolios in general allow plotting market situations of products, customers, competitors or any other object to finally draw conclusions for a strategic reorientation of the observed object. The following five steps are used to create a portfolio analysis:[79]

- 1. Step:
  - Determine an analysis object and the basic portfolio method (technology portfolio, market attractiveness–competitive advantage portfolio, etc.).
- 2. Step:
  - Gain relevant information to positioning the object truthfully at the portfolio (status portfolio).
- 3. Step:
  - Refine the status portfolio which consists of generic strategies. By incorporating resources of the company and competitors, a strategic impact line can be derived.
- 4. Step:
  - Create new target positions for future objects (target portfolio).
- 5. Step:
  - Formulate new marketing strategies to match the generic strategies with the target portfolio.

[78] Cf. Bruhn (1999), p. 45
[79] Cf. Bruhn (1999), pp. 71 - 72

This thesis deals with the market attractiveness portfolio. Developed by the management consulting company McKinsey & Co in cooperation with General Electrics, the two dimensional tool links market attractiveness and relative competitive advantage to evaluate products or strategies. The required data for those two dimensions are gained via various indicators[80]:

- Relative competitive advantage
  - Relative market position (e.g., market share, turn over, company size, growth rate, profitability)
  - Relative customer potential (e.g., know-how, license partners, location-or cost advantage)
  - Relative R&D potential (e.g., fundamental research, innovation potential of scientists, innovation ability of corporation, innovation cycles)
  - Relative qualification of personnel and leaders (e.g., motivation of staff, level of professionalism of leaders)
- Market attractiveness
  - Market growth and size
  - Market quality (e.g., profitability of the branch, phase of product life cycle, completion intensity, number and structure of potential customers, entry barriers for new providers, possibility of substitution)
  - Energy and recourses supply (e.g., level of interference-prone, number of suppliers)
  - Business environment (e.g., political, economical, socio-cultural, technical, legal, and environmental influences)[81]

These exemplary indicators have to be identified for the special market situation of the observed corporation. In this portfolio, nine different generic strategies can be identified. Figure 16 illustrates the nine possible generic strategies of the market attractiveness portfolio.

[80] Cf. Bruhn (1999), p. 74
[81] Cf. Bruhn (1999), pp. 74 - 75

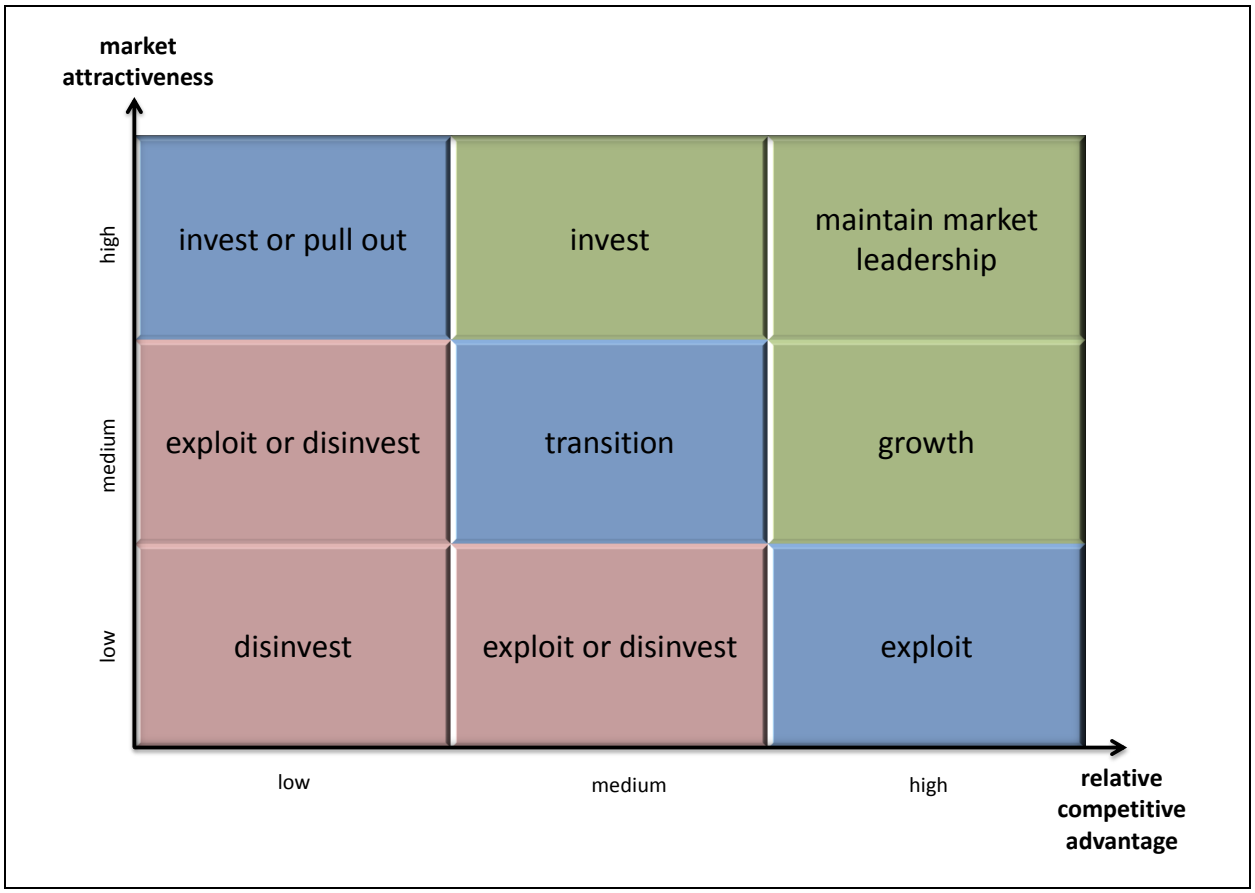

Figure 16: Market attractiveness portfolio by "McKinsey & Co"[82]

One of the benefits of this matrix is the broad level of information gained about the status quo of a company and that competitors are implicated in multiple levels via the relative competitive advantage axis. As a drawback one can name the high amount of costs of the information gathering process and the danger of not choosing the indicators objectively and entirely.[83]

3.3.3 Strategic Canvas

This tool is a diagnostic and useful format to develop strategies to conquer blue oceans. It illustrates the current status by representing the most important influential parameters on a sector and shows different strategic approaches.[84]

[82] Cf. Bruhn (1999), p. 76
[83] Cf. Bruhn (1999), p. 75
[84] Cf. Mauborgne/Kim (2005), pp. 22 -24

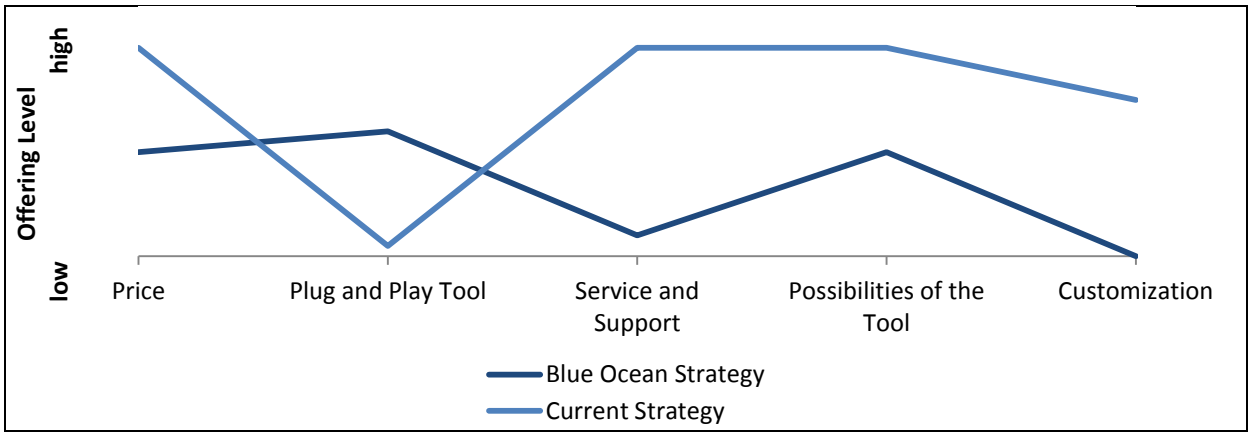

Figure 17: Exemplary strategic canvas[85]

This example shows a possible strategic canvas of the software branch. Figure 17 illustrates the influential factors on the horizontal axis and the strategic behavior on the vertical axis. This canvas helps to redirect the focus from a competition based strategy which concentrates on the current customers, to strategies that look out for alternatives and new costumers.[86]

3.3.4 4-Action Format (ERRC Grid)

ERRC stands for Eliminate, Reduce, Raise and Create. This 4-Action Format forces corporations to deal not only with the key factors, but also to take serious action in these four areas to create a strategic canvas (this special strategic layout is described in detail in the chapter 3.3.3). Some of the benefits of the ERRC – Grid are:[87]

- Users are driven to simultaneously aim for differentiation and cost leadership to link cost and benefit advantage.
- Users immediately see if they are only focusing on creating and rising, which means increasing their cost structure by offering more than required by the customers.
- The grid is very easy to comprehend for managers of all levels.
- Corporations are forced to analyze every factor which is important for the specific competition in their branches.

The basic idea is provided by the 4-Actions Format illustrated in Figure 18.

[85] Cf. Mauborgne/Kim (2005), p. 23
[86] Cf. Mauborgne/Kim (2005), p. 25
[87] Cf. Mauborgne/Kim (2005), p. 32

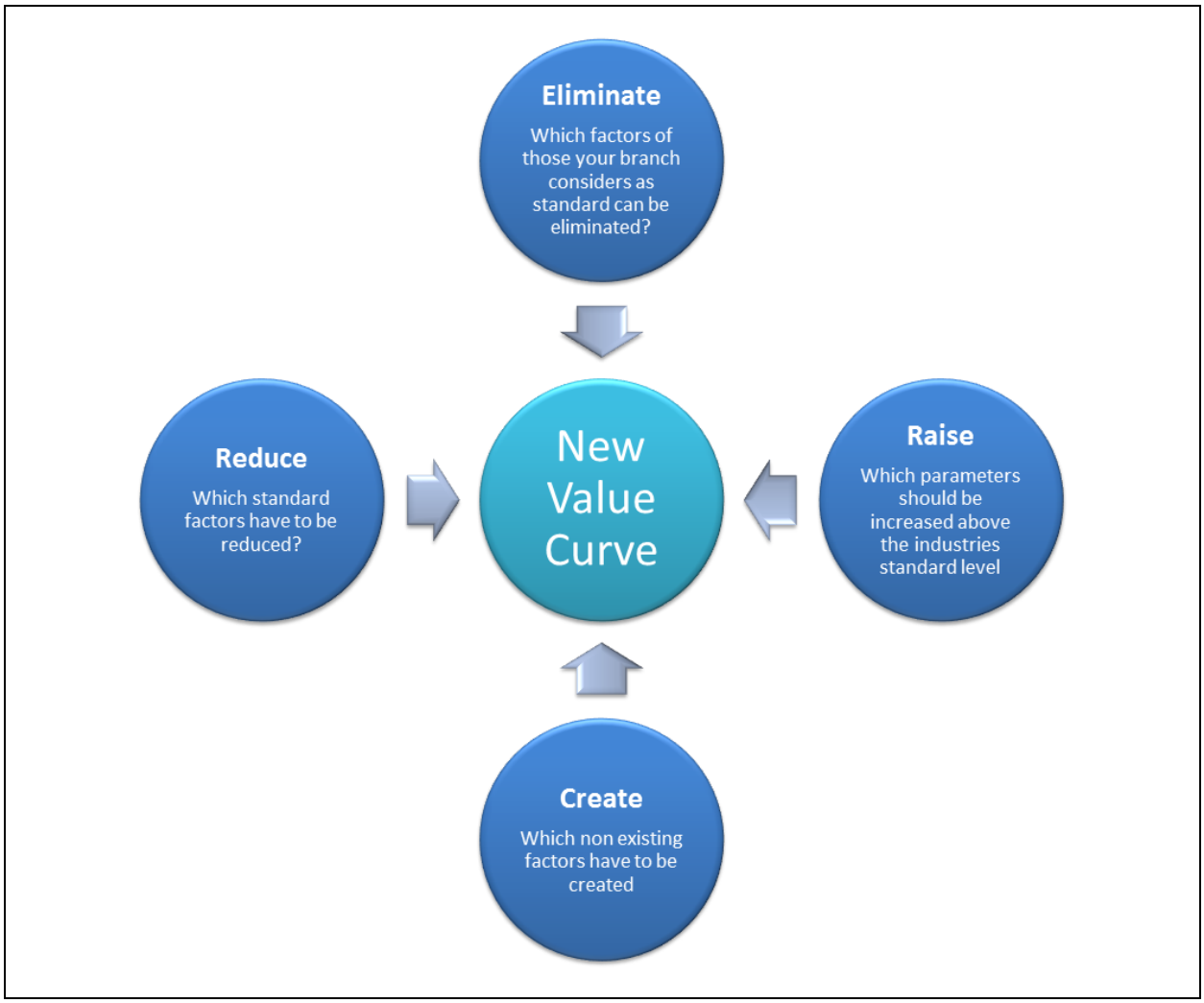

Figure 18: 4-Actions Format[88]

By using the ERRC–Grid every detail of the branch has to be evaluated. The simple methodology of this tool makes it easy for managers of all kind of levels to comprehend and therefore ignites their ambition to create a new strategic canvas.[89]

3.3.5 Value Benefit Analysis (Scoring Model)

The methodology of this tool has to be strictly distinguished from a typical value analysis. For this tool, the basic function is to evaluate the terminus value, whereas cost reduction is the main purpose of a value analysis. To feed the tools with objective data,

[88] Cf. Mauborgne/Kim (2005), p. 26
[89] Cf. Mauborgne/Kim (2005), p. 32

another analysis tool is required (parallel comparison, point scoring). The value benefit analysis allows us to rate different parameters by using weighted scales.[90]

For example this tool compares and rates the relative competitive advantage and the market attractiveness of two different cars (vehicle A, and vehicle B). Figure 19 illustrates the criteria to be evaluated.

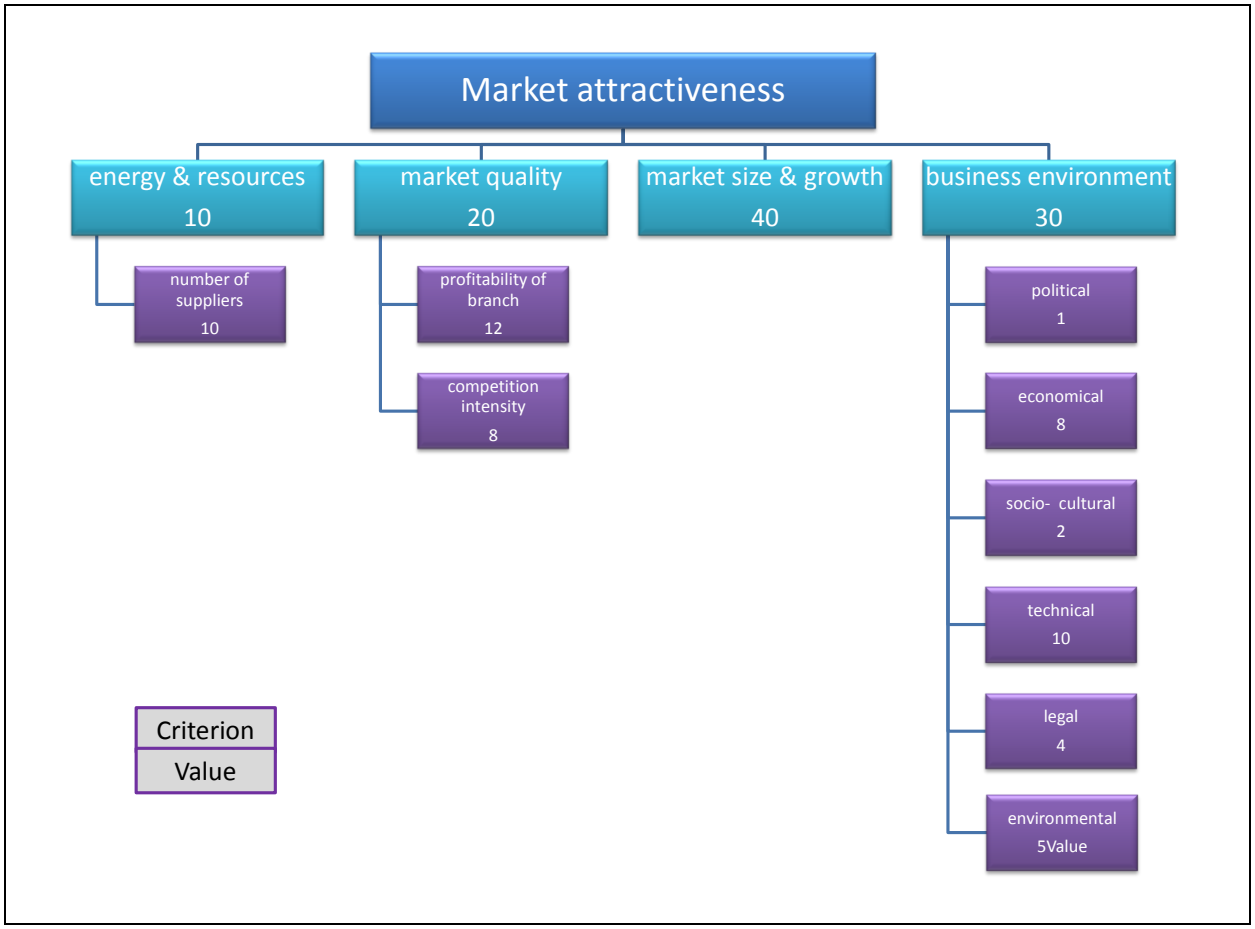

Figure 19: Market attractiveness criteria[91]

Figure 19 shows the weighted criteria tree of market attractiveness, where the numbers represent the importance of each parameter. Those numbers are derived via point scoring. Using the scoring method requires experienced and skilled users. The criteria to be weighted have to be numbered and are applied on the x and y axis of a matrix. The matrix is filled by comparing each single criterion with one of the others. The number of the more important criterion is put in the matrix. Finally we will summarize

[90] Cf. Zangemeister (1971), pp. 45 - 49
[91] Cf. Zangemeister (1971), p.337

how often each criterion has won. This provides an objective system for weighting each criterion.[92]

The next step is to establish a rating scheme with “1” as “very bad” and “5” as “excellent”.[93] Below is an example of using the criteria from the market attractiveness tree. Table 7 is an example using only the business environment branch.

Business Environment					
Criterion	**Weight**	Vehicle A		Vehicle B	
		Rating	Value	Weight	Value
Political	**1**	2	2	1	4
Economical	**8**	1	8	8	24
Socio- cultural	**2**	3	6	2	6
Technical	**10**	5	50	10	40
Legal	**4**	2	10	4	10
Environmental	**5**	2	10	5	20
Sum	-	-	84	-	102
Linear transformed sum	-	-	45	-	60

Table 7: Exemplary value benefit analysis on two types of vehicles[94]

The linear transformed sum, defined with the following equations, delivers a comprehensive result. This example demonstrates that vehicle B is the better option.

$$\frac{\sum Value - \sum Weight_{min}}{\sum Weight_{max} - \sum Weight_{min}} = Linear\ Transformed\ Sum$$

$$\sum Weight_{min} = 30\% * 1\ (Minimum\ Rating) = 30$$

$$\sum Weight_{max} = 30\% * 5\ (Maximum\ Rating) = 150$$

[92] Cf. Zangemeister (1971), pp. 160 - 162
[93] Cf. Zangemeister (1971), pp. 334 - 336
[94] Cf. Zangemeister (1971), p. 336

As demonstrated, a benefit value analysis is an appropriate tool to make objective decisions. The standardized and very simple approach of this makes it easy to comprehend and therefore reaches a very high acceptance. Anyway, it has to be mentioned that this straight forward approach implies the danger of using too many subjective inputs in order to come up with a representative output. The following characteristics (strengths and weaknesses) can be identified:[95]

Strengths

- Universal application
- Forces integrity
- Transparency
- Captures quantitative and qualitative target values
- Considers risks and preference structures of decision makers

Weaknesses

- Spurious accuracy
- Spurious objectivity
- Offers possibility of subtle manipulation
- Time consuming

3.4 Market Research

The basic content of market research is collection, evaluation, and interpretation of required market data of now or future. It provides a profound level of information to identify the correct decisions.[96]

Figure 20 shows an overview of data which are collected to paint an accurate market model. The center of interests at the demand side is the customer and the customer behavior. In most cases, the required data is based on an existing product. Criteria like sex, age, income, profession, household size, values, needs, or attitudes are the crucial factors to consider. The supply side focuses on the competition, which delivers data to evaluate characteristics like relative market position or awareness level.[97]

[95] Cf. Büchner (1999), p. 165
[96] Cf. Bruhn (1999), p. 89
[97] Cf. Grunwald/Hempelmann (2012), pp. 1-3

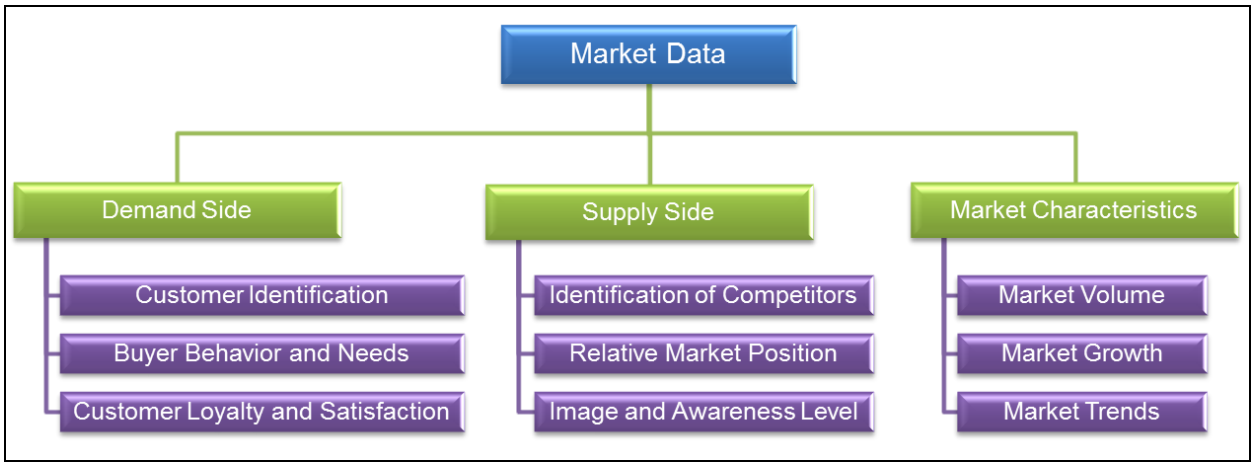

Figure 20: Market data as research objects[98]

A proper evaluation needs measures to compare trends or competitors. Some of those market characteristics are listed in Table 8. The numbers of these indicators are benchmarks for market attractiveness and relative market position of the corporation.

	Description
Market volume	Entire turnover of all suppliers within one segment on the market
Market potential	Maximum of possible turnover of all suppliers within one segment on the market
Market share	Percentage of own turnover in relation to the market volume
Market saturation	Ratio of market volume over market potential

Table 8: Quantitative market characteristics[99]

A further subdivision can be defined by considering the research methodology, as listed in Table 9. In practice, it is very difficult to distinguish between the two research methods. On the one hand, quantitative market research is very often supplemented with qualitative data collecting tools; and on the other hand, qualitative market research uses quantitative analysis tools to evaluate results.[100]

[98] Cf. Grunwald/Hempelmann (2012), p. 2
[99] Cf. Grunwald/Hempelmann (2012), p. 4
[100] Cf. Grunwald/Hempelmann (2012), pp. 4 - 5

	Quantitative research	Qualitative research
Scope	Collecting representative samples	Collecting small and biased samples
Research request	Discovering and interpreting to deliver general accepted statements	Comprehension of social phenomena and illustrating qualitative relations
Range of statement	Universal range, neglecting individual cases	Statements about individual cases or about groups of them
Research logics	Theory verifying	Theory developing
Research method	Very high degree of standardization (written interviews, experiment; data analysis with statistic methods)	Low degree of standardization (observations, group discussions, individual case study)

Table 9: Difference between quantitative and qualitative market research[101]

[101] Cf. Grunwald/Hempelmann (2012), p. 5

3.4.1 Data Acquisition

Researchers can gather information by using secondary data (information which already exists, maybe even in a different context) or primary data (information which does not exist so far and has to be collected for a specific problem).[102]

The following possible data collection approaches can be identified. Figure 21 illustrates the scope of decisions which have to be specified to come up with adequate results.[103]

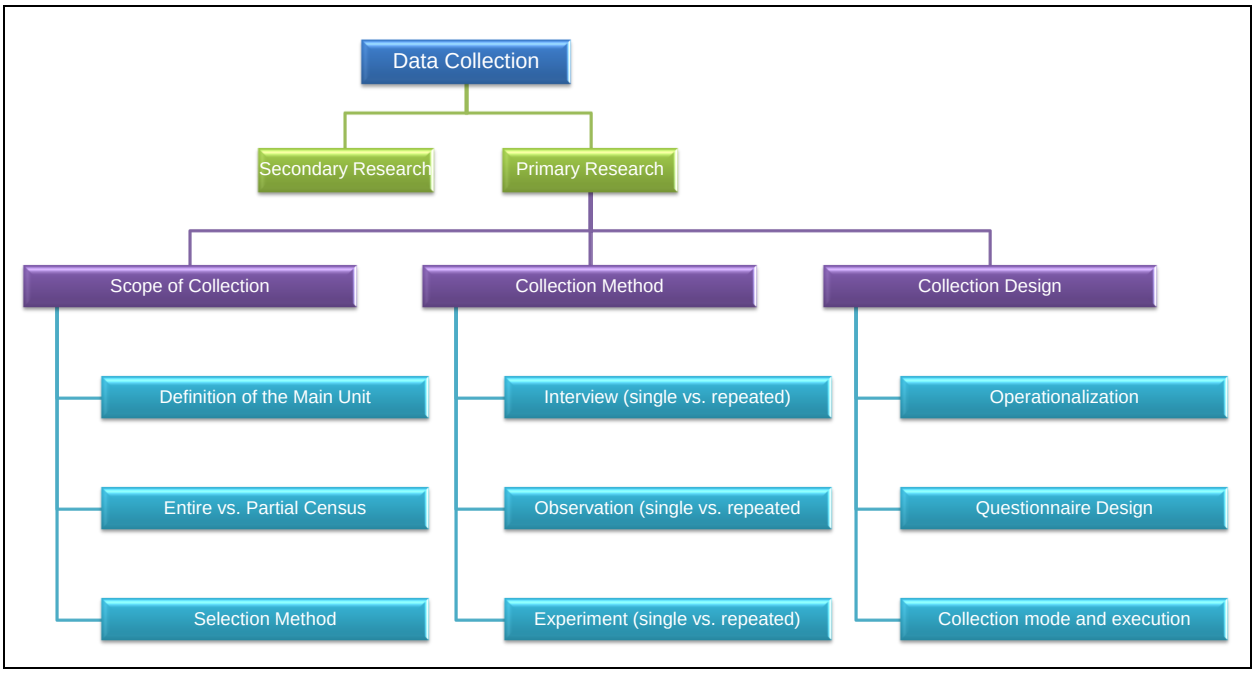

Figure 21: Data collection subdivision[104]

As shown in Table 10, various instruments can be applied to gather proper market data. In the case of AVL Racing, the individual interview is the best option for several reasons. First of all, the entire players in the market have weekly meetings in the form of races or test days which offer a great opportunity to chat with people and fill in questionnaires. Second, the environment is steady and familiar to both participant and interviewer. And the third bonus point is that it is quite cheap because AVL engineers are on the site anyway.

[102] Cf. Kotler/Keller (2008), p. 132
[103] ibidem
[104] Cf. Grunwald/Hempelmann (2012), p. 13

Method	Instrument	Approach	Useful if,	Pro	Contra
Interview	Written interview	A questionnaire is send to participants who should return it fully filled	questions are highly standardized and only a low amount of budget is available	Cheap High degree of anonymity	No monitoring Danger of misunderstandings Long duration (return time of questionnaires) Low return quota
	Individual interview	A questionnaire is personally discussed and filled in together with the participant	participants have to show papers or if they have to check some questions with the interviewer	High success quota Possibility of bigger scope of questions (pleasant interview situation) Monitoring and observations during interview	Relative high costs Influence of interviewer on participant (interviewer bias)
	Telephone interview	A questionnaire is discussed via telephone and directly entered into a system which analyses the results immediately	quick results are required only rough trends are necessary	Low collection effort → cheap solution Reduced interviewer bias	Smaller scope of questions to be discussed (unpleasant interview situation) Difficult to get representative answers
Observation	Personal or instrument based observation in the field	Investigation of the realistic behavior of people who don't know that they are observed	quality of advice needs to be checked sales conversations need to be evaluated	The entire customer behavior can be analyzed including the impact of the surroundings on participant	Values, attitudes and preferences cannot be observed
	Personal or instrument based observation in the laboratory	Investigation of the behavior of people who know that they are observed	products need to be checked on handling and usability the duration of retrospection has to be tested		
Experiment	Combination of interview and observation	Gaining knowledge about the impact of disturbing factors in relation to a measured target variable (cause and effect investigation)	product placement theories have to be verified	Accurate results Gaining cause and effect know how	Expensive and very high effort Applicable for market, store and product tests

Table 10: Description of primary research methods[105]

[105] Cf. Bruhn (1999), pp. 102 - 113; cf. Grunwald/Hempelmann (2012), pp. 46 - 54

3.4.2 Collection Design

Since the individual interview (questionnaire) could be identified as the appropriate instrument for AVL Racing to gain information, it is important to pay attention on the design of the questionnaire.

The following approach has to be considered when using a questionnaire as a research tool:[106]

- Well-structured and clearly defined introduction used as a basis.
- Hard facts have to be supplemented by open questions.
- Interview situation has to be steady and pleasant throughout the entire collecting process.
- Diverse aspects have to be asked in diverse questions.
- Interviewer must stay critical and keep an open mind when using the tool.
- If weaknesses occur, stick with it and don't try to find a work around.

This approach implies several criteria which the designer of a questionnaire has to pay attention to:[107]

- Ensure that questions do not lead the participants towards any direction.
- Ensure that questions are formulated as simple as possible.
- Specify the questions as accurately as possible.
- Avoid the use of abbreviations or cant.
- Avoid technical terms, use standard terms instead.
- Shy away of ambiguous terms, which lead to misunderstandings.
- Don't use denial phrases: e.g., use "Did you ever…" instead of "Did you never…"
- Beware of hypothetical questions.
- When using telephone interviews, beware of terms that can be misheard.
- Use a range of predefined answer possibility when asking for information about factors like turnover, etc.
- Predefined answer possibilities should not be distinctive, not overlapping.
- Always add "other" as an option at predefined answers possibilities.

Adhering to this advice provides the most accurate and unbiased data.

[106] Cf. Aschemann-Pilshofer (2001), p. 9
[107] Cf. Kotler/Keller (2008), p. 136

3.5 Business Model

The business model is a summary of all required tasks and resources to realize a certain idea. It comprises the goods and services and the whole value chain to link all involved parties. A business model delivers answers to the following questions:[108]

- What is the key business area of a company?
- What are the targets of a company-vision and mission?
- How are the targets realized-strategy?
- What are the goods and services of a company-portfolio?
- What are the core competences-USPs?
- How successful is the company-EBIT, ROI?

As mentioned in 2.5, the key factor to be successful is to deliver a value added for customers and to operate in an attractive market. Staying successful requires a clearly defined vision of corporate targets and long term perspectives. A vision formulates customer benefits, helps to position the corporation in the public environment, and builds up identification and motivation of employees. The mission statement comprises the precise business targets for a certain time span. The strategy describes the way how targets have to be realized. The portfolio delivers the USPs and position on the market.[109]

A very important factor of a business model is awareness of the past and the future. Chronological developments of the incorporated model are crucial to show in which direction the company heads. New goods and services have to be checked if they match the following checklist:[110]

- What is new and what is its benefit?
- How do vision, targets, and strategy of the corporation look like?
- Which department of the company is responsible for this project?
- How does the new project fit into the existing corporate portfolio?
- Which desires of the customers will be satisfied?
- What are the core competences of the company?
- Is the business model appropriate to match the success targets?
- Is it possible to adapt the business model easily to changing economical environments?

[108] Cf. Nagl (2009), p. 21
[109] ibidem
[110] Cf. Nagl (2009), pp. 21 - 22

4 Vehicle Simulation Module

Winning race teams are in possession of the best package available. The best package comprises top engineers, drivers, mechanics, and managers. A team will only be successful if every single party does an adequate job.

- The driver has to be fast, reliable and capable to reflect the cars' behavior to the engineers.
- Mechanics have to work precisely and make sure that the vehicle is in proper condition and every screw is tight and safe to provide the required trust into the car for the driver.
- The team managers have to take care of all organizational and social issues to ensure that no deadline is missed and that the whole team is aligned towards one direction.
- The engineers are responsible for the cars' behavior. They have to set up the car to meet the drivers' needs and preferences. Depending on the different types of race cars (GT or formula car), the number of variable factors and possible setup combinations is close to infinity (e.g., the setup for dampers, springs, anti-roll bars, aerodynamics, ride height, differential, etc. is adjustable in increment steps). It is easy to imagine that it can be tricky to keep the overview of all these parameters, particularly in such a demanding environment and stressful atmosphere which race weekends usually cause. This is the reason why they aim for a virtual environment, which can help them to get the best out of the car in a short amount of time.

4.1 Vehicle Simulation

Already back in the period of 1937-39, vehicle dynamists and engineers of Mercedes Benz tried to formulate mathematical equations to model the vehicles' straight line and cornering behavior. What they came up with was what is now used as a basis for "Lap Time Simulation" (LTS).[111]

In the early years of racing, setting up a race car properly always relied on empirical data from test sessions or on basic vehicle dynamics calculations. In those days (even in Formula 1), it was good enough to arrive at the circuit, to give the drivers some practice and use the knowledge from previous years to setup the car.

[111] Cf. Casanova (2000), p. 1

Nowadays, race engineers arriving on the circuit already have a precise idea of the setup. This is important to safe track time and resources. Even in lower categories like Formula 3, it became standard to use a driver simulator, vehicle simulation tools (e.g., LTS) and accurate information about every tiny screw on the car (measured in special test rigs or dynos) to setup the car prior to arriving on the site. Reasons for that are real car testing regulations (in Formula 1 even a test ban), and the very high competition which requires tuning the car to the limit of its capabilities.

Another very important application of vehicle simulation is hardware in the loop simulations (HiL). It simulates a vehicle's behavior by using parts of the real car on a dyno (e.g., using an LTS but replacing the mathematical engine model with the real engine) integrated in the simulation process. This approach can be used to setup the hardware more accurately and to improve the whole vehicle package.

The benefit of these tools is that they allow engineers to model and test expensive race cars to their limits without risking to crash them or to hurt the drivers. At the same time vehicle simulation provides a high number of variables which can be simulated fully factorial to identify the theoretical best setup configuration.[112] LTS or HiL can be also used to develop cars, regulations or strategies.

4.1.1 Types of Lap Time Simulation

There are three different modeling strategies that can be identified:[113]

- Steady state strategy
- Quasi – static strategy
- Transient strategy

Most of the methods which mathematically describe the vehicles behavior are based on Newton's laws, which allow predicting the accelerations of the vehicle due to the applied forces to it. Accurately describing racing cars' behavior requires a very precise replication of the external forces acting on it. Until a certain level of speed is reached, the entire forces acting on a vehicle are generated by the tires. This is why an accurate tire model is especially important. The most common tire model is the "Pacejka Magic Formula"[114] method which is based on an empirical approach.[115]

[112] Cf. Siegler et al. (2000), p. 1
[113] ibidem
[114] Cf. Pacejka/Bakker (1991), pp. 1 - 18
[115] Cf. Siegler et al. (2000), p. 2

For a simulation of a full lap, the path of the racing car is split up into several segments (the smaller the segment, the more accurate the results) and the external forces are applied to the vehicle. The main difference between the three types of modeling mentioned above is the way forces are calculated.[116]

Steady State Strategy

This strategy is the most basic application of LTS. In this case, the longitudinal and lateral acceleration performance is modeled separately which implies that the car first brakes and then turns in (actions are sequential, not simultaneous). Furthermore, only the performance of the lateral acceleration is considered. This mathematical system is solved with an equilibrium in which the time dependent variables are zero.[117]

Quasi- Static Strategy

This type of modeling is very widely used across the automotive industry. Basically, it is a sequential accumulation of steady state equilibrium segments which are discussed in the prior section.[118] Each segment of the vehicle's acceleration is derived via the same steady state approach which means to allow the simulation to settle down its time dependent values to steady state. This strategy runs efficiently and quickly.[119]

Transient Strategy

The steady state and quasi- static approaches assume linearity and ideal conditions. In reality, cars which are cornering can never be in a steady state situation because vehicles are always accelerated or rotated in some direction. The transient or dynamic approach tries to avoid these errors by taking into consideration the vehicles' response times of changing its attitude and travel direction. [120]

The mathematical method of resolution is a system of differential equations which are solved with an integrator. In this case every time step depends on the one before.

[116] Cf. Siegler et al. (2000), p. 2
[117] Cf. Siegler et al. (2000), p. 3
[118] Cf. Brayshaw/Harrison (2005), pp. 725 - 726
[119] Cf. Siegler et al. (2000), pp. 3 - 4
[120] Cf. Siegler et al. (2000), p. 4

	Steady state	Quasi- static	Transient
Mathematical method of resolution	Equilibrium of forces applied on a specific segment of the path of the vehicle	Sequential accumulation of segments Same equilibrium method as used for steady state Only vehicle speed is solved with an integrator	System of differential equations Solved by an integrator
Advantages	Very fast and reliable	Still fast and robust Full lap simulation Line follower (no driver model required)	Highly accurate Capable to simulate the impact of and on dampers, yaw, etc.
Disadvantages	Low accuracy Confined to a segment of the full lap only	Low accuracy Impossible to simulate parameters like dampers, yaw, etc.	Low simulation speed Sophisticated model which requires very precise data (difficult to get) Requires a driver model

Table 11: Overview of the three main LTS strategies[121]

As a conclusion, Table 11 illustrates the main characteristics and capabilities of each solving strategy.

4.1.2 AVL Vehicle Simulation Module (VSM)

AVL offers a product that is capable of all three types of modeling, but focuses on the transient strategy. As a general principle, AVL offers a package consisting of three tools.

- AVL VSM (LTS tool)
- AVL Drive (post processing tool)
- AVL Optimizer (filter tool)

The three tools are linked together which results in a new type of simulation process which is illustrated below in Figure 22.

[121] Cf. Siegler et al. (2000), pp. 2 - 4; cf. Brayshaw/Harrison (2005), pp. 725 - 726

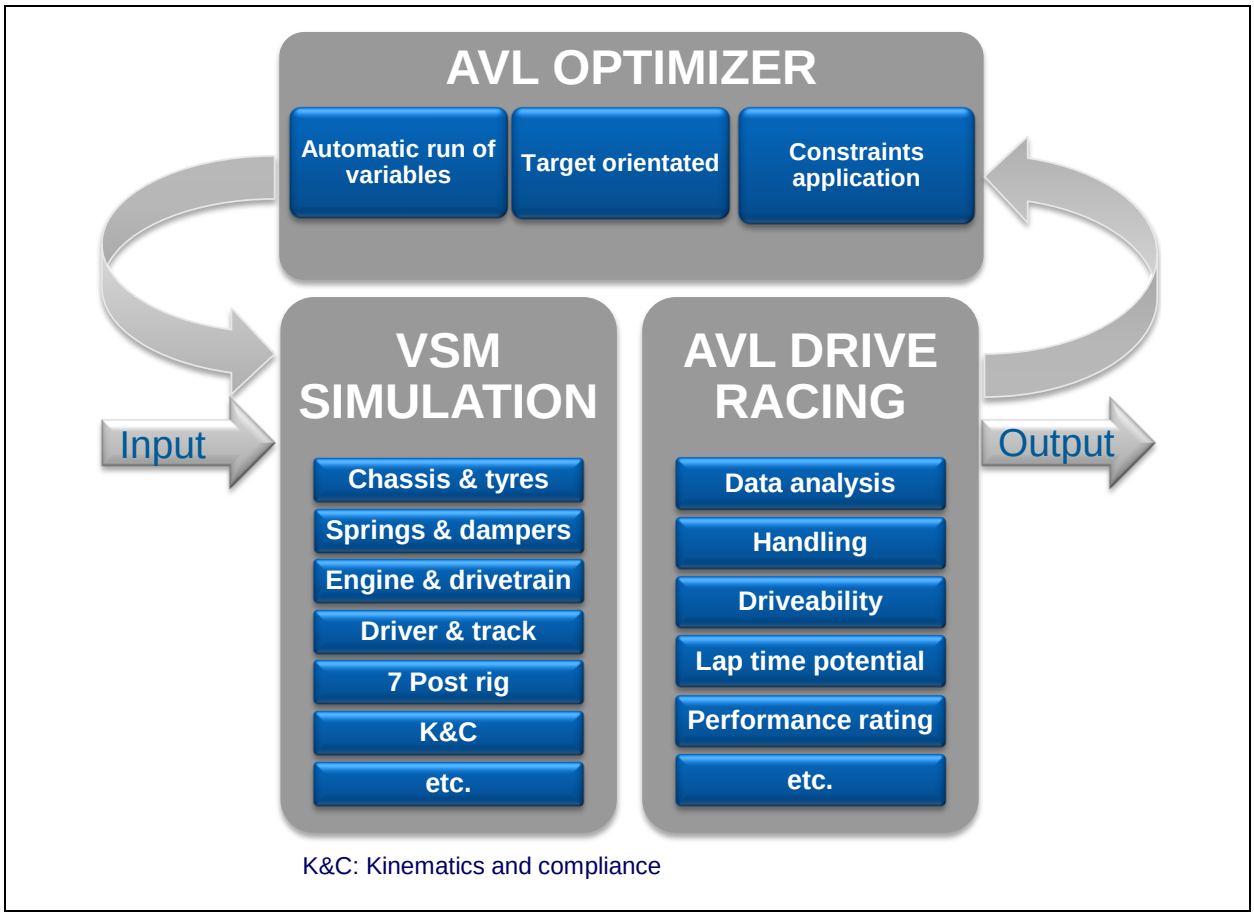

Figure 22: AVL simulation process[122]

The big advantage of LTS is that engineers can try out as many setup combinations as they wish in a short amount of time (e.g., 2000 laps in less than three hours). In this case, the engineers would have to screen every lap to evaluate if the behavior of the car has improved or not. AVL Racing's approach reduces the number of laps to be screened by filtering laps which does not affect the behavior in a positive way. The definition whether the setup change is positive or not can be defined by the engineers themselves (e.g., ride height at the end of the straight > 55mm would skip every lap which does not meet this criterion), or by using AVL Drive ratings. Those ratings are patented by AVL and are capable of fully automatically evaluating every segment and parameter of a race car.

The accuracy of the results depends on the quality of the input parameters. VSM offers a very high number of possible input variables. Figure 23 illustrates the main parameters which can be modeled in VSM.

[122] AVL Intranet (2012)

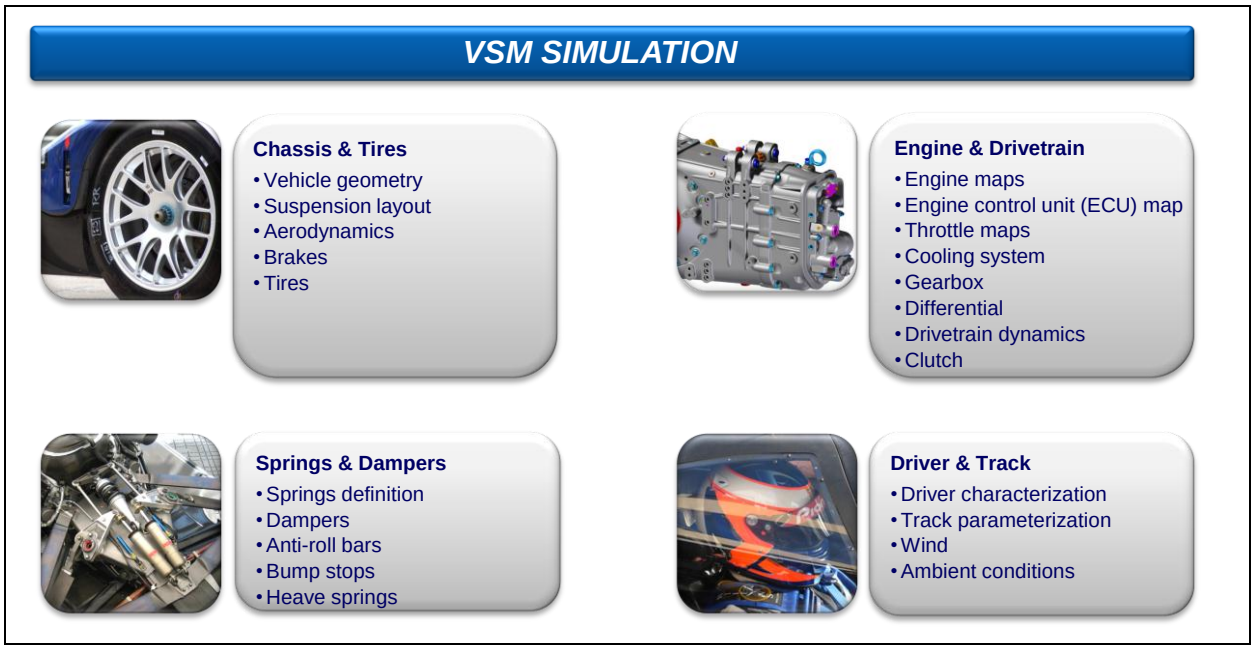

Figure 23: VSM input parameters[123]

Due to this highly sophisticated modeling approach, VSM is able to take influences of road-roughness, dampers (even hysteresis damper curve), transient aerodynamics, etc., into account. The driver characterization is particularly outstanding compared to competitors. It allows engineers to model the drivers' behavior in terms of throttle and brake-pedal aggression as well as considering the different steering types of drivers'.[124]

The interface between engineer and mathematical model is illustrated in Figure 24. The interface provides an easy copy and paste data editing process combined with tab structured menu navigation. The tabs are clustered into the main features of a race car. "Chassis + Tyres," "Springs + Dampers," "Engine + Drivetrain," "Driver + Track," "Data I/O," and "Settings" are the basic tabs which come with every license. The tabs "KnC Rig" and "ERS" represent specially tailored modules of VSM which can be unlocked as optional.[125]

VSM is structured modularly to allow a maximum of flexibility for users to perform simulations for any kind of vehicle. This structure makes it easy to react on customer demands and on regulation changes immediately (e.g., KERS module, DRS module, etc.).[126]

[123] Cf. AVL Intranet (2012)
[124] ibidem
[125] ibidem
[126] ibidem

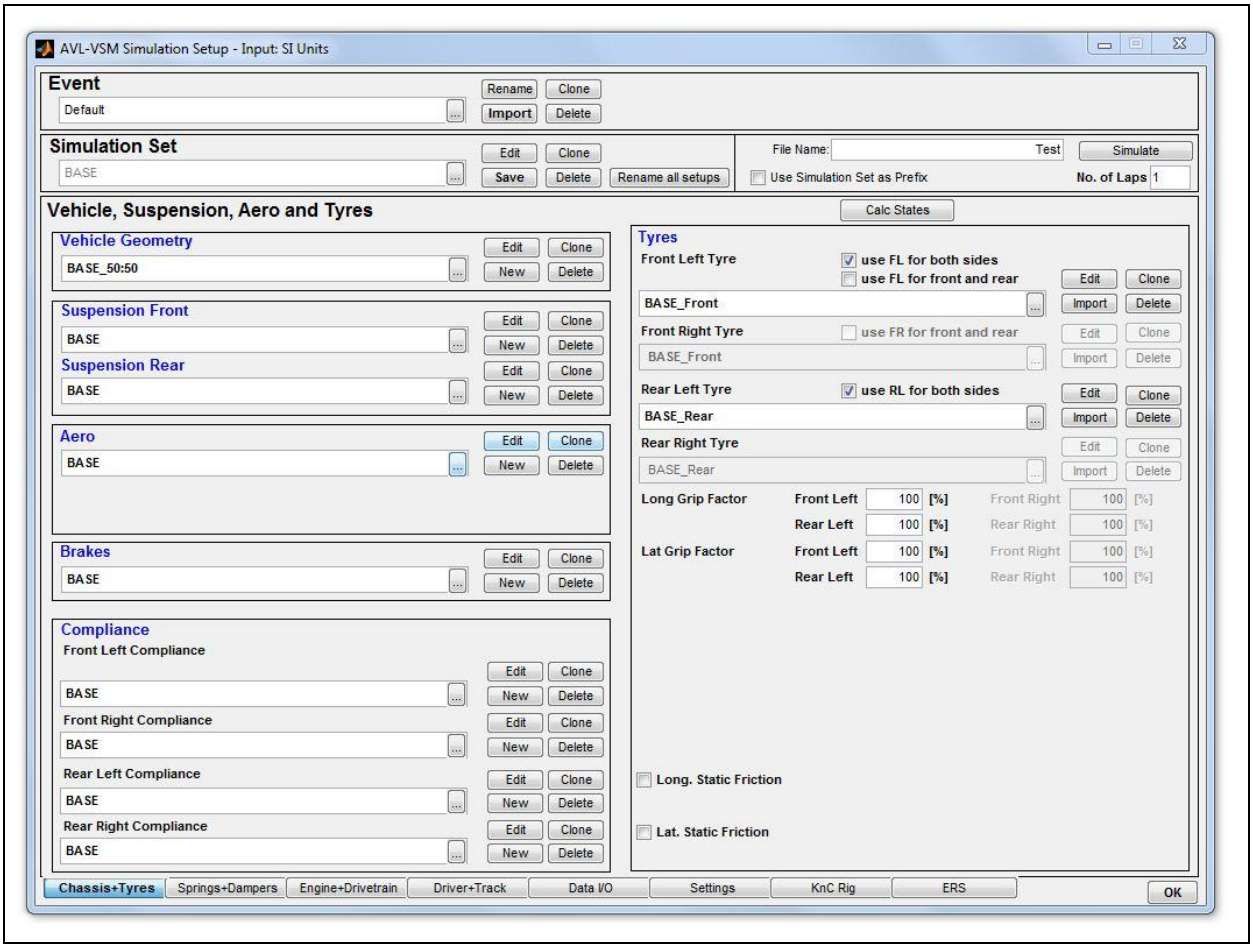

Figure 24: VSM's Graphic User Interface (GUI)[127]

VSM is a real-time transient vehicle dynamic simulation and therefore can be used in HiL configurations as listed below:[128]

- Engine dyno
- Gearbox test bed
- 7 Post Rig
- Driver simulator

The HIL approach has the unique advantage of having the real model in the simulation loop which allows simulating realistic stresses at the dyno test. Figure 25 shows a whole electric car in the simulation loop.[129]

[127] AVL Intranet (2012)
[128] Cf. AVL Intranet (2012)
[129] ibidem

Figure 25: Formula Student vehicle in a HiL configuration[130]

In this case the mathematical model of the entire powertrain had been replaced by the real car. This approach increases the accuracy of results and can be used to correlate the mathematical model to the real vehicle as well.

AVL VSM offers a wide range of possible applications for users. The combination of the modular structure and high number of possible input parameters is unique in this segment.

[130] Own illustration

5 Status Quo of AVL Racing

This chapter describes the current status of the AVL Racing Department and the business model of its main product VSM. Therefore it will give answers to questions about the staff utilization, sales, the customer structure and the strategic behavior of AVL Racing. The information was gathered via interviews and workshops with the managers at AVL Racing.

5.1 USP

A unique selling proposition (USP) is the characteristic capability of a product, which allows it to create a special customer benefit which cannot be reached by the competitors or only to a certain extent. Therefore it should be the core element in every sales meeting.[131]

AVL Racing is the technology leader in the market. This is an enormous competitive advantage. The most important USPs are listed below:

- Large department size (20 Software Engineers): This allows AVL Racing to act quickly and deliver solutions promptly
- AVL corporate reputation: AVL has gained a very high reputation in all sectors of automotive industries
- Service and know how (track support)
- Tailored to customer needs
- Test bed background: Can be seen as a linking path of theoretical and practical optimization
- Data Post Processing Tool AVL Drive: Patent protected tool
- Tendency prediction of the Vehicle: AVL Racing has developed setup optimization to a new level, focusing on stability
- Hardware or driver in the loop: AVL Racing provides the ability to run the software on a test bed and on a driver simulator
- ARES Engine Model: Fully transient engine model, the only one available on the market
- Damper model
- Electric layout: Ability to use electric engines in various combinations and modes

[131] Cf. Bruhn (1999), p. 128

To be aware of the own uniqueness it is important to adjust the sales strategy and to plan the route of future R&D investments.

5.2 Strategy

AVL List GmbH has defined a corporate strategy including a mission and vision statement.

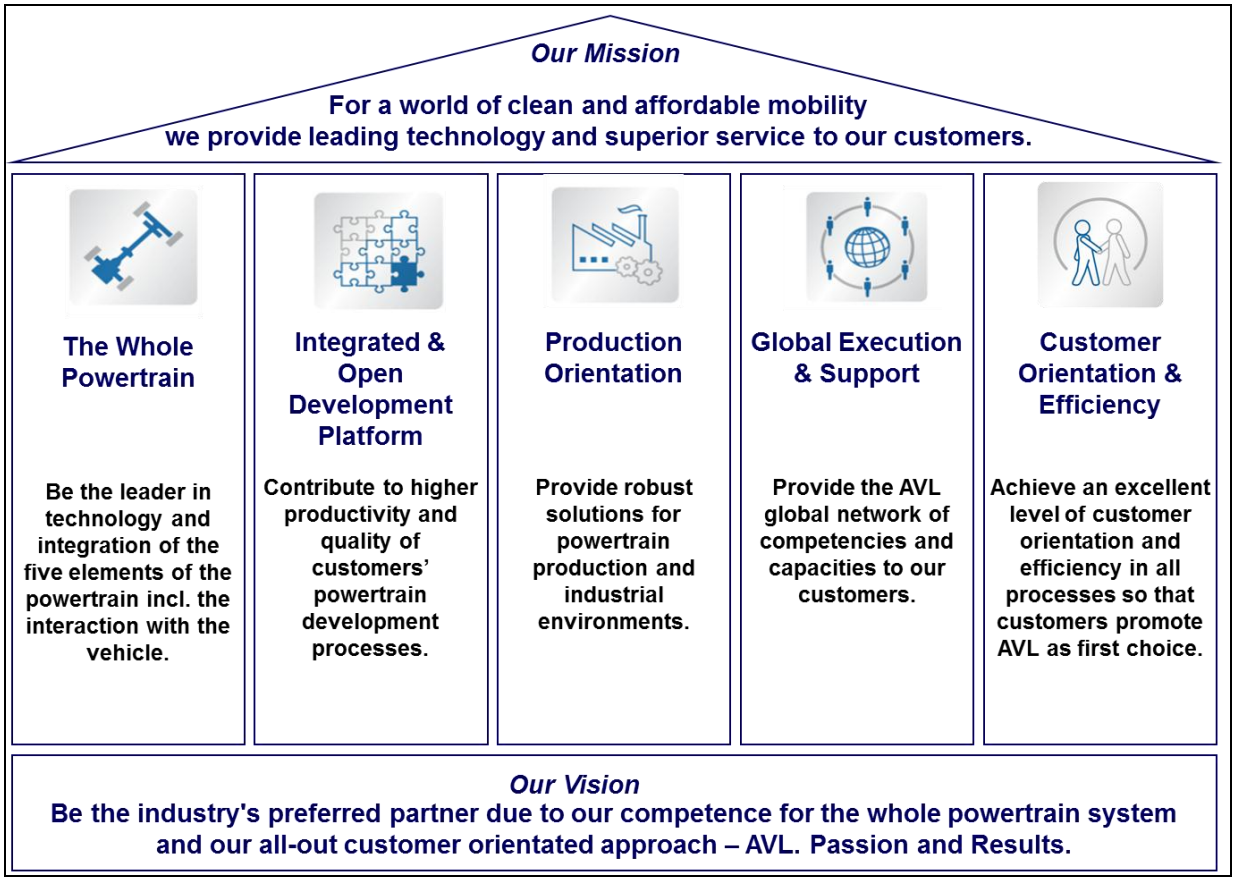

Figure 26: AVL corporate strategy[132]

Figure 26 illustrates AVL's strategic approach. It covers the entire company and therefore does not match AVL Racing's specific demand. The mission statement *"For a world of clean and affordable mobility we provide leading technology and superior service to our customers"*[133] points out the direction in which AVL is committed. Go green, go high quality and go for leading technologies. This mission is perfect for the

[132] Cf. AVL Intranet (2012)
[133] AVL Intranet (2012)

production car market which is heading in exactly this direction, but it is probably not the same route that the racing department will take in future. AVL Racing definitely needs a tailored strategy to their market situation and its special needs.

The current strategy is a commitment to goals, and the options available to reach them, rather than an actual strategy. A separate mission and vision statement does not exist. Such a target plan is shown in Figure 27 below.

Target	Activity	Measure	Deadline
Increase Turnover	• Identify customer demands earlier • Increase staff motivation • Merchandise Drivability / VSM patents	Increase turnover by 15%	12.2012
High customer satisfaction	• High quality support • Customer orientation • Passion for customer demands	80% customer satisfaction feedback rating	12.2012
Increase market share	• Innovative and revolutionary F1 solutions • VSM for new racing categories	• New customers for the 2014 F1 engine model • One new F1 customer • One new NASCAR customer • one Indycar customer • Entry to new Categories	12.2012
Innovations	• Increase the innovation potential of employees • Develop innovations which help customers to progress more rapidly	• Over one new USP per year	12.2012

Figure 27: Activity list of AVL Racing[134]

[134] Cf. AVL Intranet (2012)

Deriving a strategy from this plan results in the following approach:

- External strategy
  - Differentiation by tailoring the product to individual customer requirements, and by focusing on dynamic simulation;
  - Focus on the top leagues of motorsports (F1, NASCAR, etc…);
  - Remain in the background, word of mouth marketing;
- Internal strategy
  - Be a player in the top motorsport leagues to enhance company image
- Strategy is defined via the activity list (see Figure 27)

Applying the strategic canvas on these criteria delivers the following graph (the ratings are a result of a workshop conducted with the skill team leader and the product manager).

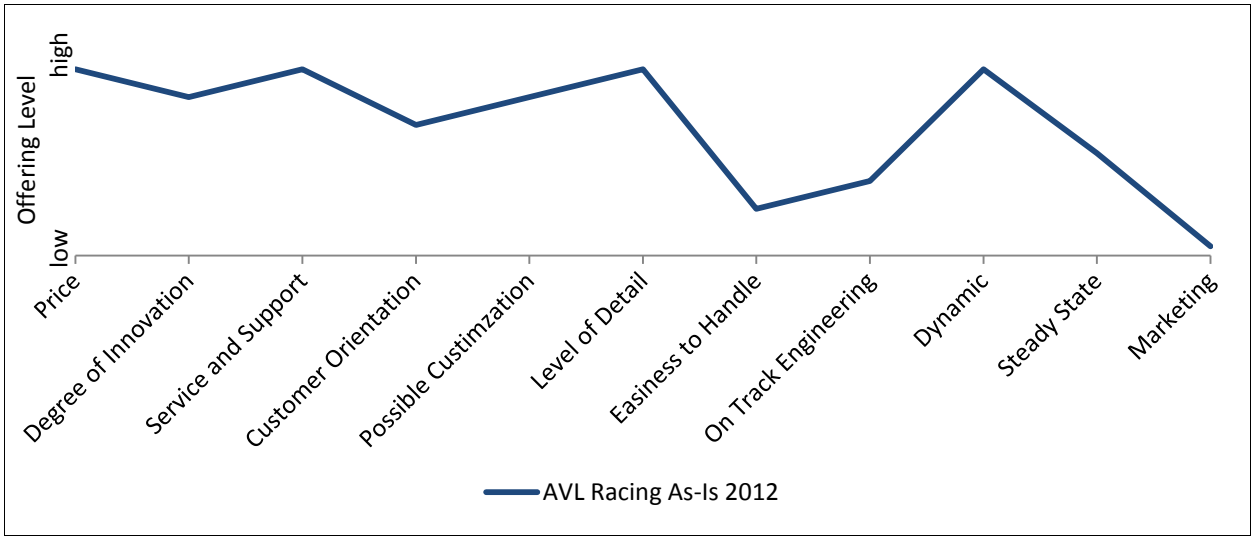

Figure 28: AVL Racing's strategic canvas in 2012[135]

The strategy is clearly defined to tackle the top motorsports market.

The highest risk by following the current strategy is to lose the competitive advantage of being a technology leader over time and to get mired attempting trying to acquire top teams in F1 and other top leagues. These customers are very demanding and they have very high negotiation strength since every supplier in around the world wants to be involved in those top categories.

[135] Own illustration

To evaluate one's own approach to the market it is very important to be aware of the competitors. In this case two main competitors can be identified within the current market. Figure 29 illustrates their strategic canvas compared to AVL Racing.

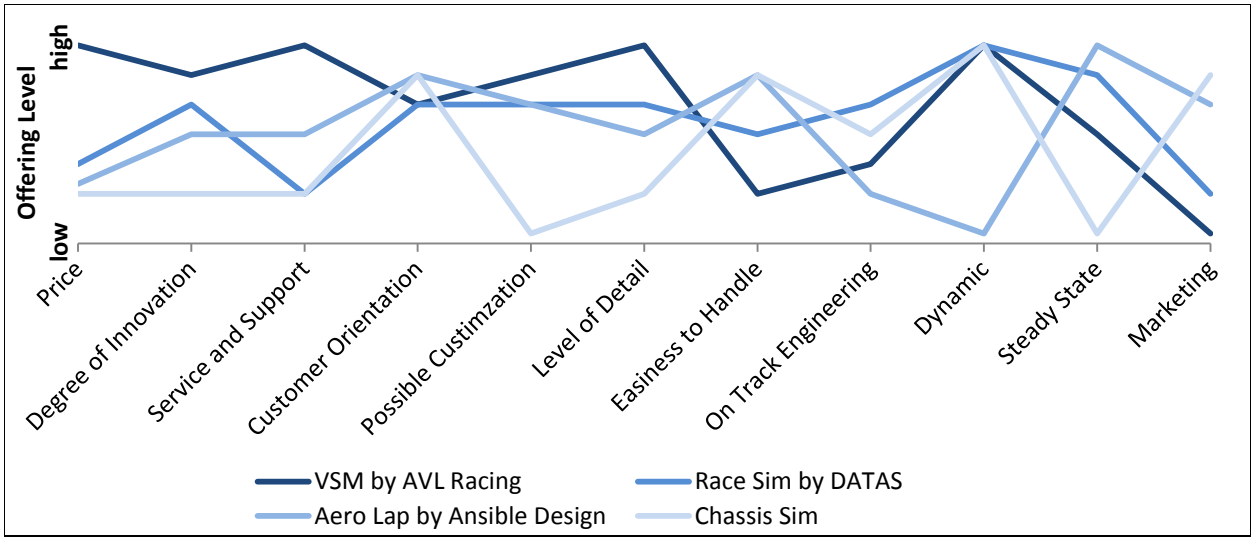

Figure 29: Competitor strategy benchmark[136]

The values used to rate the competitors are the combined results of a workshop conducted with AVL management, and a software benchmark of AVL Racing. It is clear that for nearly every individual strategy, AVL Racing differs significantly from the competitors. There are different approaches in terms of pricing, customer support, possible customization, handling and marketing.

The lower prices of the competitors are a result of their less-sophisticated products, and the fact that those companies are smaller and therefore operate with lower overhead costs.

Race Sim by DATAS and Aero Lap by Ansible Design can be considered as competitors throughout the markets, whereas ChassisSim is the main competitor in the fight for small racing team customers.

A very significant disadvantage of VSM compared to its competitors is the complexity of the product's features. Teams need over three months to learn the most important functions of the program. The GUI (graphical user interface) of these three competitors is self-explanatory, whereas VSM's user interface is very clean but not visually appealing.

[136] Own illustration

One of VSM's key USPs is the option to tailor the software to the needs of each customer. This allows AVL Racing to get in touch with potential new clients, but it bundles manpower and R&D resources before any possible order (see Appendix IV). The competitors abandon this USP to keep the costs and the risk down. Regardless, research is necessary to maintain technology leadership, even if it sometimes does not pay off. Another challenge for VSM is that top category race teams prefer to buy cheap basic solutions, which can be upgraded by themselves. The reason for this is data security and fears of giving away knowhow.

A very different strategic behavior can be identified when it comes to marketing spending. AVL Racing decided not to spend any money on marketing and image creation. The strategy is to make business by word of mouth. Unfortunately word of mouth does not work vertically (through levels of categories) and it takes a lot of time. Especially for emerging categories, image is key and needs to be built up fast.

5.3 Project Management and Pricing

Defining prices is one of the most difficult fields of a business model. To do it right, accurate and up to date numbers are essential. When talking about the adequate price of a product, the following question must be answered:

Which costs have to be covered by the product?

The cost of every employee is calculated with hourly rates. These rates cover the actual salary, IT costs, office and equipment costs and allocations. Taking this rate and multiplying the incurred man hours a year, delivers the required amount of coverage. Furthermore the hourly rate will be called "overhead one". The required amount of man hours to finish a project delivers the production costs.

Furthermore company-wide cost centers (e.g., distribution, etc.) have to be paid separately. Those additional costs are called "overhead two" and are comprised of all of these cost centers and a gross profit margin. The "overhead two" is taken into account with a factor defined by the top management of AVL.

The actual selling price is calculated as demonstrated in Table 12 (numbers are exemplary)

- overhead one = 100 $^{€}/_{h}$
- overhead two factor (corporate margin) = 1.8
- required man hours = 100 h
- production costs = 100 $^{€}/_{h}$ * 100 h = €10,000.00
- selling price = € 10,000.00 * 1.8 = € 18,000.00

Table 12: Price calculation[137]

Selling services or licenses is the task of the sales managers. They try to acquire new customers by offering projects. Such a project can be the lease or sale of a license (including a 12 month service contract) or an engineering service.

Those projects are distributed to the project leaders, who will take care of the contractually agreed tasks.

At the project start a project number will be defined. Project leaders have the permission to book their hourly rate on this project and by doing so the money on the project account decreases until it is empty. The reason for this is to reach a debit balance instead of an underfunding at the department's cost center. Employees, who are not booking on a dedicated project, directly affect the departments cost center. This is why AVL instructs every project leader to empty their project account to unload the cost center. AVL Racing very often develops new features for the software together with the customer and not in an R&D frontloading project, which makes it difficult to distribute the hourly rates of the software developers accurately to the related projects.

Ultimately there is a pool of project numbers to book the hourly rates on, and there is a pool of software engineers who can get any arbitrary project number allotted to them at the beginning of each month. Even if there is an attempt to distribute them truthfully, the number does not always belong to the actual project that one is working on.

This handling makes it difficult to determine have true costs and to evaluate whether a project bring or cost money.

With regard to engineering projects (e.g., track support) it is easier to comprehend who is to which extend involved, and if the department earns or loses money. The root of this problem is the software development and support process. The software has to be tailored and fixed for every different customer. It is evident that it is very difficult determine if a new tool that is specially developed for a customer is a value benefit for the whole tool (in this case future clients) or only relevant for the one customer.

[137] Own illustration

5.4 Sales

AVL Racing offers the following products and services (as already described in the technical part of the literature review):

- AVL VSM Software License
  - Online (to be used on test bed)
  - Offline
- AVL Drive
- Updates
- Engineering Services (on track support, in house simulation for customers)
- Support

The sales strategy thus far is to offer potential customers a 12 month license lease for AVL VSM and AVL Drive including a 12 month full support that comes with the license fee. Currently this is the preferred option of both customers and AVL Racing (due to cost accounting and project account unloading).

Another option is to sell the license with a 12 month service contract. After the first year, the license belongs to the customer, but further services are charged separately. Due to the fact that the software engineering segment and the regulations of race categories are very fast moving, updates are required very often. This is where AVL Racing earns money after having sold the license. For a major update (including additional support services) AVL charges about 18% of the retail price. If there has been no update for more than three years, customers must buy a new license.

Engineering services are the third part of the sales strategy and can be comprised of two different tasks. The first option is that customers can request an AVL Racing engineer who works with them on the race track. The engineer does all the simulation work, provides setup suggestions, and any other required information that can be derived from AVL VSM and AVL Drive. The second option is that clients can order projects which are defined by the customers themselves (e.g., test bed engine calibration, setup performance evaluation, etc.) and are executed by engineers at the AVL headquarters in Graz.

Support services cover anything else that does not fit into those described above.

Figure 30: Distribution of AVL Racing products and service sales strength[138]

As shown in Figure 30 AVL Racing's main business is to sell VSM Offline leasing licenses, followed by engineering services.

5.5 SWOT Analysis

The following results are the outcome of an internal workshop (participants: skill team leader, product manager, project leaders) to evaluate the department's capabilities.

Strengths

AVL is well known for its expertise in powertrain engineering and test bed solutions. AVL Racing can benefit from shortcut information sharing with other departments that are not directly involved in racing (e.g., gearbox calibration, etc.).

One of the outstanding strengths is the staff of this department. Everyone is highly educated and can tackle new issues promptly and appropriately. Having 20 engineers (developers and users) together in one department allows fast action and the creation of solutions with highly compressed work-schedules. Racing is very demanding, whether one is a supplier or a team member. Very often quick and accurate solutions

[138] Cf. AVL Intranet (2012)

are required. Therefore it is very important to be able to rely on skilled and professional people.

AVL Racing is a global player and involved in multiple race categories like F1, NASCAR, WRC, Le Mans, F3, etc. This is a big advantage over competitors and for internal corporate policy (e.g., at R&D budget negotiations).

Every Tuesday, the whole department has a big meeting to update staff with the latest information. In this meeting technical and organizational issues are discussed. The meeting ensures that everyone knows what the others are doing in the current workweek.

Weaknesses

One of the main problems when pricing and calculating is lack of information. As mentioned in the section 5.3, true costs do not exist. This inevitably leads to problems when pricing.

As already mentioned in the strategy section, AVL Racing has no separate strategy. There is a strategic plan, but no mission and vision statement.

Selling engineering competence requires up to date know how and experienced employees. As already discussed in the strengths section, the team is very educated and skilled in the area of theoretical vehicle dynamics and software development. This expertise is key, but to serve the market demands, practical experience is also required. AVL Racing's race engineers are very experienced, but sometimes they lack the self-confidence to realize and claim they are valuable experts in vehicle dynamics and not just ordinary software supplier.

The fact that AVL Racing does not run its own car, (e.g., for testing and correlation) is indicative of this problem.

AVL Racing has to deal with a very small R&D budget (in terms of absolute numbers). Highly desirable and necessary correlation tests with race cars and test equipment (e.g., seven post rig, driver simulator hardware, etc.) exceeds the department's resources.

Another important issue is motivation. Passion for what one is working on is rare, but one of the most important factors for success. Especially if tasks are very demanding and solutions have to be developed in a very short time. People long for recognition and acknowledgement. Even the way tasks are delegated is important to keep people motivated.

Opportunities

Due to the highly sophisticated nature of the product, one straightforward approach would be to increase the market share within the markets AVL Racing is involved in. New categories in the top leagues of motorsports, such as WEC, provide the most obvious opportunities.

Emerging markets (BRIC, etc.) are starting to build up their own automotive competencies. New OEMs try to conquer worldwide markets. To do so they have already begun to invest money in motorsports (worldwide and nationwide) to develop image and reputation. These OEMs also animate western OEMs to invest more money in domestic race categories within these emerging countries. This could be a great opportunity for AVL Racing, if they can ensure that they are onboard from the very beginning.

To be successful in future, it will be necessary to take lower categories into consideration. Selling in those categories requires a totally different market approach. Small race teams operating in these categories do not have the resources to use the standard VSM tool. Therefore a light version could be appropriate to get into this very big market. Such a “Lite” version can easily be defined by simply downgrading VSM. Another benefit of such a “beginner tool” is that users become familiar with the common AVL interface.

Engineering seems to be a very attractive field of activity for AVL Racing. It creates know how and provides an inside view into several categories. The department already comes with the required competences and the tools to be a successful contender. Selling race engineering services can be very appealing to gain experience and to use it as demonstration platform for VSM or any other AVL application. Another opportunity in engineering is hardware in the loop (HiL) simulation, which is in high demand. AVL is the only company that is able to provide a complete turnkey solution. Therefore HiL is a potential blue ocean.

Motorsports is fast moving. Regulation changes, electrification, fuel efficiency and test bans can create business for AVL. It provides a great opportunity to capitalize on the capabilities of VSM.

Continually increasing computer hardware processing power leads to shorter simulation times which also provides a direct benefit for customers, and therefore for VSM.

Threats

Due to the rising number of new competitors (start-up companies with low overhead costs) pricing will become more important than it is now. VSM is already at least twice as expensive as its closest competitor. The fact that AVL Racing is not known for its vehicle dynamics competence in categories below F1 and NASCAR does not make it easy to charge adequate license fees. Even those top categories suffer from budget limitations and stock market uncertainties.

Global financial problems lead to austerity packages which will immediately affect the business of AVL Racing. In times of crisis, teams and customers try to survive by bundling resources and getting rid of everything that is not considered to be a core essential to run a race team. Simulation has traditionally not been deemed to be essential.

For a product like VSM the complexity of setting up the car is vital. In lower categories like GT racing setup options are limited. Therefore a tool like VSM is simply not required. Even a “Lite” version of it will likely struggle to show a true benefit to customers. The root cause of this can be found by looking at the simulation awareness in those racing leagues which tends toward zero.

Top motorsport leagues (F1, DTM, etc.) are very sensitive about the confidentiality of their own data, but accurate and real data is vital for VSM to deliver proper results. Accurate data is also necessary for developers to test the program. Therefore it can be dangerous to develop relationships with more than one main player in any given league.

To have a few main clients only might be attractive, but the drawback of this allocation is that if one of them decides to pull out of racing, AVL Racing loses a vital customer which can constitute over one third of their annual turnover.

Conclusion

Table 13 illustrates the entire findings of the SWOT analysis as discussed in the subsections above.

Strengths	**Weaknesses**
• Engineering competence • Flexible, skilled and multi-disciplined personnel • Developers and users located in one department • Department size • Professional team culture • Involvement in multiple categories • AVL company background • Information management	• Weak cost accounting • No straight pricing model • Lacking self confidence in vehicle dynamics • Not running a car of their own • Small R&D budget • Personnel grown inside AVL • Lack of racing spirit • Hierarchy not in operation • No strategy defined
Opportunities	**Threats**
• New race categories, e.g., WEC • Track support, AVL engineers on track • HiL (e.g., differential mapping, driver simulator, etc.) • VSM – Lite, VSM Steady State • Regulation changes • AVL Racing image • Electrification, strategy tool • ARES • Test ban and budget limitation • Increasing PC power	• Price sensitivity • New competitors • AVL Racing unknown in emerging markets • Stock market uncertainties • Regulations • Simulation time limitation and budget limitation • Political market behavior • Key account structure (only some large customers)

Table 13: SWOT Analysis AVL Racing[139]

This table will be used onwards as the basis for future workshops within the AVL Racing department and continuously improved.

[139] Own illustration (workshop result)

5.6 Comprehensive Status

In this section AVL Racing's financial and operational status will be discussed.

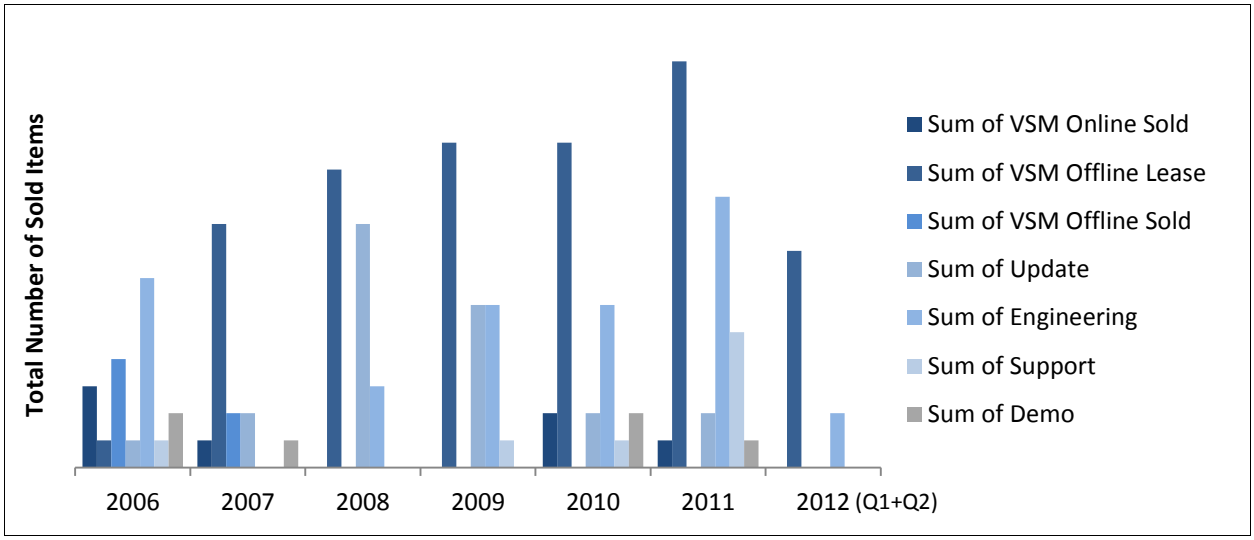

Figure 31: Sales trend of AVL Racing's products and services in detail[140]

As illustrated in Figure 31 the core business is license leasing. We can see a steady increase from 2006 until today. For 2012 only the first half of the economic year has been taken into account, this is why the figures have not yet reached the level 2011.

Leasing is the preferred sales option for both AVL Racing and the customers. It allows for rapid response for new demands and it helps to unload cost centers adequately, because the total amount of money dedicated to such projects (a common leasing contract lasts three years or longer) arrives stepwise and annually. Referring to Figure 32 the total number of license leases from 2006 onwards is [redacted] of the total amount of activities.

The second largest business field making [redacted] is the sale engineering services. Engineering promises to be one of the future core businesses of this department, as mentioned in the opportunities of the SWOT analysis (race engineering, HiL services, etc.).

The annual sales of updates, support, and VSM Online (test bed application) projects are highly variable. In some years, for example 2008 and 2009 such projects kept the

[140] Cf. AVL Intranet (2012)

department healthy, whereas the tendency shows that the significance of support and updates decreases over time.

To illustrate the size of each business in numbers, and to increase the understanding of the pricing model, the Table 14, Table 15, and Table 16 were required. Due to confidentiality reasons the customer names have been removed. The tables show the year and the corresponding retail price of the license.

Deriving the average prices is one of the steps toward a new selling strategy. These prices can be seen as the baseline for future projects.

In the following tables, every capital letter (e.g., B, D, E, etc.) represents an individual customer. It is apparent that AVL Racing has only a small number of major customers.

Average VSM Offline License Retail Price		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
Average Price		[redacted]
Total Turnover Licenses		[redacted]

Table 14: Average VSM Offline license retail price[141]

The years 2006 and 2007 were the last in which licenses were able to be sold. The price differences are the result of differing individualization requirements between customers. Particularly large differences in retail prices between customers and years can be seen in Table 15. This is partly due to customization, but mainly a result of deals for big clients. Such deals comprise of, for example, one extra license (volume discount) after a certain amount of annual turnover.

[141] Cf. AVL Intranet (2012)

Average VSM Offline License Lease					
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
			[redacted]	[redacted]	[redacted]
Average Price					[redacted]
Total Turnover Licenses					[redacted]

Table 15: Average VSM Offline leasing price[142]

As shown above, customers of top categories spend in average [redacted] for one license per year, including support and updates. The price differences between the individual clients are also caused by regional factors. Numbers show that Japanese and American teams are usually willing to spend more than the typical European customer. The reasons for this are well founded in their different mentality and their simulation ego. European teams are aware of the fact that their racing leagues are considered to be the best in the world. They exploit in negotiations with suppliers. Furthermore, especially in the UK, it is common sense to do all the simulation work and even the programming in-house. This attitude often results in the loss of a competitive advantage over other teams.

Japanese and American teams are very open minded and willing to consider suggestions on new ways to improve performance. If a product shows promise to them, they will fully cooperate to achieve the highest possible benefit from it. This is why they do not push down prices at the first step.

[142] Cf. AVL Intranet (2012)

The achievable prices for VSM Online applications on the market alternate but decrease nonetheless from 2006 to 2011.

Average VSM Online License Retail Price		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
Average Price		[redacted]
Total Turnover Licenses		[redacted]

Table 16: Average VSM Online retail price[143]

As described above, the following Figure 32 illustrates the customer structure of AVL Racing.

[redacted]

Figure 32: Key Accounts of AVL Racing as a percentage of total turnover[144]

[143] Cf. AVL Intranet (2012)
[144] ibidem

As pointed out in Figure 32, AVL Racing relies on several big customers. The pie chart shows the total expenses of each customer as a percentage of the total turnover of AVL Racing over respective period. It shows that customers usually spend big money in a certain time span. In the plot below we can see the customer structure of 2011.

Figure 33: Key Accounts of AVL Racing in 2011 as a percentage of the annual turnover[145]

In this case customer G was responsible for [redacted] of the annual turnover. Figure 33 provides the evidence for the assumption that AVL Racing attracts big customers for a period of time, then loses them for any particular reason (most of the time because those clients pull out of racing), but immediately replaces them with another big client. This is fine if a replacement can be found easily, but it would be favorable to have more small customers in addition to the key accounts, thereby reducing dependency on one or two large customers. This is another reason why a VSM "Lite" version should be considered.

The total turnover from 2006-2012 can be seen in Figure 34. For 2012 only the first half of the economic year was considered. After the difficult years of the financial crisis, 2011 was the first year which indicated a positive trend toward increasing turnover.

[145] Cf. AVL Intranet (2012

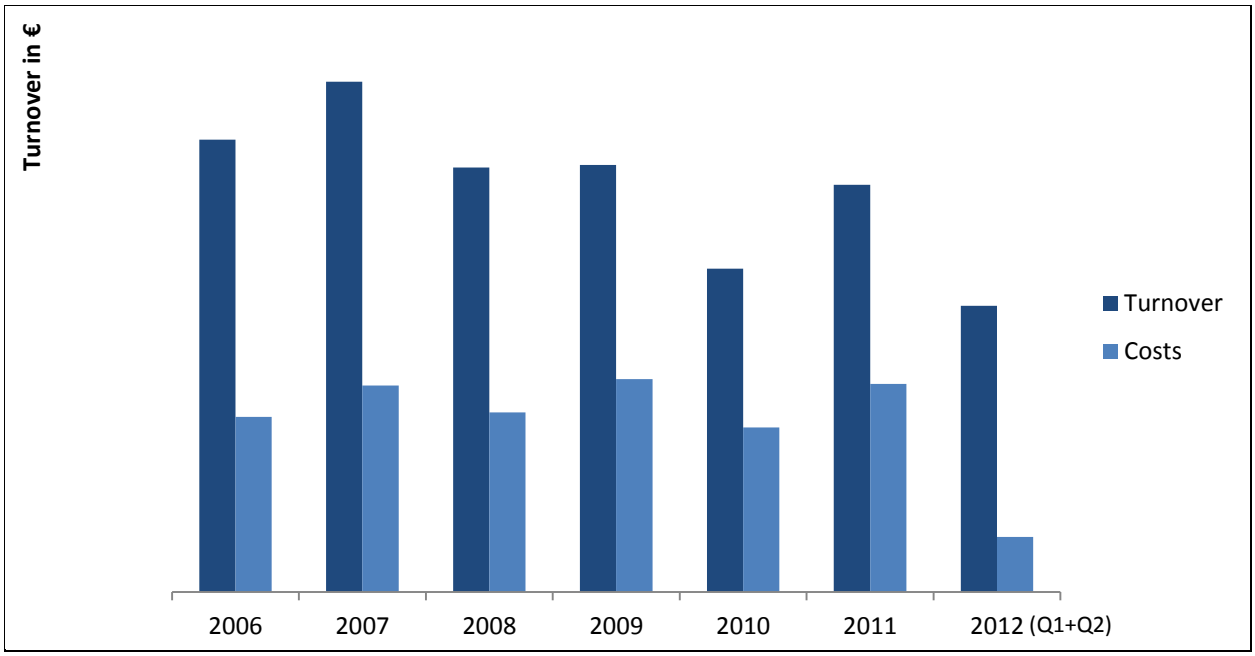

Figure 34: Turnover vs. "overhead one" costs[146]

As mentioned above in 5.3 the "overhead one" costs comprises of manpower, office costs, etc. So even if there is no straight borderline to distinguish variable costs from fixed costs, we can assume the "overhead one" as variable. In this case the difference between turnover and "overhead one" represents the contribution margin. In 2012 we can see an outlier in the ratio of turnover in relation to costs. In this case the true amount of hourly rates of employees has not been fully booked, whereas the money has already arrived from the customers (not true costs!)

The attempt to calculate the total costs for the department was impossible due to the data confidentiality policy of the AVL Corporation. The normal method of calculating total costs at AVL is illustrated in the Table 17.

This method delivers the most accurate results. For the AVL Racing department the only available data is the hourly rate, the number of employed people and the 100% utilization line, which represents 1730 hours per person per year. Using this approach delivers a good estimation of the annual costs of running the AVL Racing department.

[146] Cf. AVL Intranet (2012)

AVL Cost of Sale Method		
	Turnover (Sum of RP including “overhead two” factor)	
-	Costs of turnover (Hourly Rates, “overhead one” costs)	
=	**Contribution Margin I**	**To be covered by corporate margin (“overhead two”)**
-	Debit balance/ Underfunding of cost center	
-	Additional costs	
=	**Contribution Margin I***	
-	Distribution	
-	R&D	
-	Imputed costs (depreciation of wear and tear, interests)	
-	Administration	
=	**Success**	

Table 17: Cost of sale method of AVL[147]

The error in this calculation is that the “overhead two” factor, which is included in the CM (corporate margin), is taken into account by using the 100% utilization curve. This approach comprises R&D expenses as well as customization costs. Figure 35 illustrates the 100& utilization line.

Figure 35: AVL Racing’s utilization in 2011[148]

[147] Cf. AVL Intranet (2012)
[148] ibidem

In Figure 35 we see 12 bars, each representing a month of 2011. The dark blue bars represent the amount of hours booked on customer projects. The light blue bars are hours booked on R&D and customization projects. This justifies the use of the 100% utilization line to calculate the EBIT (Earnings Before Interests and Taxes).

Subtracting these total costs from the total annual turnover delivers the EBIT as listed in the table below.

Year	Turnover	"Overhead One" Costs	Total Costs	Contribution Margin	EBIT
2010	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2011	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2012	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 18: EBIT calculation for 2010, 2011 and the first 6 month of 2012[149]

We see that the department is healthy, nevertheless new markets have to be found to sell their products and services and to increase the market share. The EBIT of 2012 is higher than in the years 2010 and 2011 because of the total amount of hours available have not been fully booked by the employees and therefore the “overhead one” costs are too small. Furthermore the expected total turnover and the total costs will not increase in parallel.

5.7 Product Portfolio Status

In this section the current products will be analyzed by using the portfolio method “marketing attractiveness – relative competitive advantage” (MA-CA) as described in 3.3.2.

At this point it is important to mention that the criteria, as well as the weighting and the evaluation scaling were defined in a workshop in which key project leaders and the skill team leader of the department participated.

The analysis process starts with the criteria definition. In this case characteristic attributes for both axes, relative competitive advantage and market attractiveness, had

[149] Own illustration

to be found. Table 19 illustrates the agreed influential factors to judge the current product portfolio. For a specific explanation of the criteria, see Appendix III.

Market Attractiveness Criteria	Relative Competitive Advantage
Market size (volume)	Access to assets
Market growth rate	Competences
Market profitability	Customer loyalty
Entry barriers	Quality/ value added for customer
Technology development potential	Relative brand strength
Demand	Market share
Competitive intensity / rivalry	Relative cost position
Overall risks	Distribution strength
Opportunity to differentiate	Customer support
Access to the market	
Segmentation	

Table 19: Characteristic criteria for a MA-CA portfolio analysis[150]

As described in 3.3.2, both axes are rated by using a value benefit analysis. To impose an objective weighting scheme a parallel comparison matrix was used and delivered the numbers illustrated in Table 19.

As pointed out in Table 20, for market attractiveness the single most important criterion is the opportunity to differentiate with 16.67 out of 100 possible points. With 12.12 points market growth rate, demand, and competitive intensity/rivalry came in second place. Segmentation is considered as dispensable with only 1.52 points.

For the axis of relative competitive advantage the criterion of highest priority with 20 points is quality/value added for customer. Also very important and ranked second, relative cost position can be identified. Customer support, competences, and market share follow with 13.33 points whereas relative brand strength achieved 2.22 points seems to be non-relevant.

[150] Own illustration, cf. Bruhn (1999), pp. 74 - 75

Market Attractiveness Criteria	Weight [%]	Relative Competitive Advantage	Weight [%]
Market size (volume)	7.58	Access to assets	6.67
Market growth rate	12.12	Competences	13.33
Market profitability	10.61	Customer loyalty	8.89
Entry barriers	9.09	Quality/ value added for customer	20.00
Technology development potential	6.06	Relative brand strength	2.22
Demand	12.12	Market share	13.33
Competitive intensity / rivalry	12.12	Relative cost position	17.78
Overall risks	4.55	Distribution strength	4.44
Opportunity to differentiate	16.67	Customer support	13.33
Access to the market	7.58		
Segmentation	1.52		
Sum	100	Sum	100.00

Table 20: Weight of each criterion[151]

Now, the basic framework is defined. The one part that is missing is the rating scale. On general principle a range of 1–5 was agreed, in which 1 represents the worst and 5 always represents the best rating. In most cases a simple partition, from very low to very high, is accurate enough (and sometimes the only option) to define the ratings. Nonetheless sometimes a more specific breakdown is applicable (e.g., “market profitability” can be distinguished by using the chargeable corporate margin). Those subdivisions were defined by the responsible sales and project leaders of AVL Racing to be as realistic as possible.

[151] Own illustration

Market Attractiveness		
Rating	Market profitability: CM = corporate margin	Entry barriers
1	CM: < 0%	very low
2	CM: 0 - 7.5	low
3	CM: 7.5 - 15%	medium
4	CM: 15 - 30%	high
5	CM: > 30%	very high

Table 21: Exemplary rating fragmentation[152]

The output of this rating is the following plot, as illustrated in Figure 36, which provides information about the current status of each product rated. In this case VSM, DRIVE, and Engineering were evaluated.

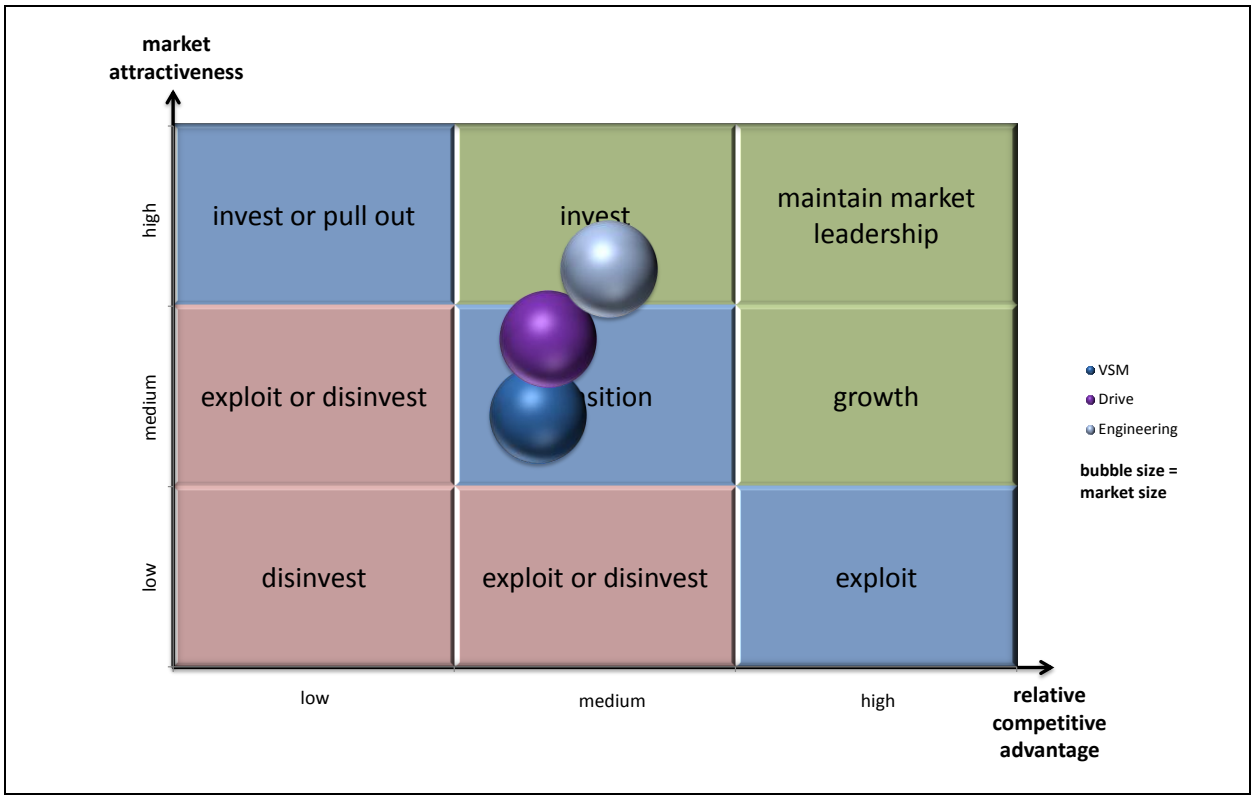

Figure 36: Product portfolio of AVL Racing[153]

[152] Own illustration
[153] ibidem

The bubble size represents the market size; in this case the markets are the same for all three products. The first impression already reveals that all three products are midfield contenders. Several reasons for this can be identified.

Technically, VSM is the most sophisticated product available on the market, but this advantage is diminished by the fact that the complexity and level of detail overburdens the users and therefore does not match the required level of ease of use. Another limiting criterion is the market profitability and its access.

Similar to VSM, the post processing tool DRIVE is stuck in transition phase. The patent protected tool has the unique ability to rate the behavior of real or simulated cars and was created for production car applications. It comes with a VSM license, but can be sold separately. AVL management believes in the power of this product and its race application. Figure 36 shows that there is potential, but there is a lack of evidence of a true value added for the customers and the basic level of usability avoids a “take off”. Marketwise DRIVE suffers from the same difficulties as VSM.

Engineering services show the best performance. Reasons for this are the positive influences of market, know-how and corporate network. Due to the experiences of AVL engineers in different categories and the excellent reputation of AVL as an engineering company, the racing department earns the right to play. Furthermore the test beds and the on-location competence in Graz, e.g., the whole powertrain research and the thermodynamics department, can be fully capitalized on. A drawback of offering services for race teams is the data confidentiality issue and the fact that teams do not like to give away any know-how, especially since they know that AVL Racing is operating worldwide in different categories.

This portfolio analysis approach delivers a standardized and comprehensive evaluation tool which allows rating of the current product portfolio. By adapting the weighting and the rating scales it is easily possible to evaluate future projects whether they are likely to be successful in a specific market or not.

5.8 Conclusion

AVL Racing’s current business model is tailored to the needs of high-end racing teams. The highly educated and motivated team makes it possible for the department to pursue a strategy oriented toward service, support, and customization. This behavior is particularly responsible for the high retail price in comparison with the competitors.

The core business of the department is represented by selling VSM license leases. Even though it is stuck in the transition phase (see Figure 36), it contributes the main

part of the annual turnover. In the course of this thesis, VSM is used as the baseline for the new business model to approach emerging markets.

The next chapter “Market Analysis” will deal with the business environment and the identification of market desires, which provides the required information of how to realign the department’s product portfolio, to move out of the transition phase, and into the growth or market leadership position.

6 Market Analysis

The understanding of the customer needs and desires is a fundamental baseline to create a value innovation. To obey this request, the following investigations have been executed.

6.1 Secondary research

TechNavio analysts predict a compound annual growth rate (CAGR) of 11.4% for the whole software and testing industry in the period 2011–2015. This growth is driven by improvements in terms of efficiency and the increasing effectiveness of the product development cycle. [154]

Since VSM is not predominantly used as a development tool, this number is not representative for AVL Racing, but it shows that the whole business is growing which is a great opportunity for the department. Vehicle simulation software can be seen as a future must-have for any team to be successful in racing. An indicator for this assumption is the growth in the sector of data acquisition. Several years ago, only the top leagues of motorsports (F 1, DTM, NASCAR, etc.) had such a system in use. Nowadays even go-karts are fully equipped with data loggers.

Due to the high level of rivalry and the high density of competitors, racing is a very challenging market to be involved in. The following tables were derived to identify potential racing leagues for a possible new AVL Racing product.

6.1.1 Emerging Leagues

Table 22 illustrates the findings for the emerging markets, which are described in the following sub-sections.

[154] Cf. TechNavio (2012)

	Emerging Leagues						
	F-Nippon	**F3**	**GP2**	**GP3**	**WTCC**	**FIA GT**	**WSR**
Market potential	€ 25,500,000.00	€ 8,000,000.00	€ 52,000,000.00	€ 14,850,000.00	€ 10,000,000.00	€ 25,000,000.00	€ 20,000,000.00
Market volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Possible volume factor	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Market share	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Turnover 2011	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total market size	**€ 1,888,500.00**						

Table 22: Assessment of the market characteristics of emerging race leagues[155]

Market Potential

The market potential can be seen as the total annual turnover of the racing league. AVL Racing's internal database provides the number of teams and their estimated annual budget. For example a GP3 team charges on average € 550.000 for one season per car; given 27 cars racing each a year, this results in a total market potential of € 14.85 million.

Market Volume

The total market volume is the amount of money which is currently spent on LTS or HiL-simulation in the respective racing categories. The numbers are derived by the multiplication of the market potential by a volume factor. Due to a different understanding of the significance of vehicle simulation in-between the race categories, these factors vary from [redacted] These numbers are well validated by consideration of annual budgets in relation to the actual expenses on LTS.

Market Size

The total market size represents the accumulated market volumes of each category. Table 22 points out the total market size of the emerging racing leagues. It has to be mentioned that for this thesis only the widely known leagues have been taken into

[155] Cf. AVL Intranet (2012)

consideration. This is the reason why the market size of € 1,888,500.00 is rather small. A more specific investigation (focused on emerging leagues in the BRIC, etc.) would reveal that there are many other categories of the same potential which would increase that number dramatically. This assumption is supported by the following Table 23.

	Mexico	Brazil	Argentina	China	Malaysia	South Africa
Population in Mio	100	170	37	1265	23	43
Number of circuits	14	12	33	1	3	7
Number of licenses		3000	800			6000
Major championships	Formula de las Americas F3 Mexico Ford Mustang	Sudam F3 Stock Car Formula Chevrolet	Sudam F3 TC2000	Formula Renault Formula Campus	Asian Festival of Speed	Formula Gti Stock Car
Markets	Domestic	South America	South America	Domestic	Asian	Domestic

Table 23: Emerging countries and their motorsports activities[156]

Even though this table was published in 2001, it indicates that there is a big market potential in these regions. The number of racetracks implies that there are many national racing activities already occurring. Some categories (e.g., TC2000 in Argentina) can be compared with famous European championships like DTM or the Blancpain Endurance Series in terms of budget size and professionalism. Another important outcome of this table is that the Chinese racing sector has until now been very underdeveloped, which offers a great opportunity to get onboard from the very beginning. In this case in particular it has to be mentioned that China is already investing in motorsport infrastructure and Chinese OEMs are starting to build up and collect know-how in this area. In the course of this diploma thesis and for any further investigations a market is considered as a racing league, no matter where the races take place.

[156] Cf. Aylett et al. (2001), p. 10

Market Share

The market share indicates how successful AVL Racing sells their products in each category. F3 and F–Nippon are already very highly penetrated. The high market share in those racing leagues is a result of the rivalry among the OEMs involved and the high number of possible setup options. Categories like GP2, GP3, WTCC and FIA GT, in which the degrees of freedom of setting up the car are limited, are untapped.

6.1.2 Conclusion and Comparison with Top Motorsport Leagues

It provides evidence that the current VSM software is applicable if setting up the car is very complex and if the rivalry is very strong (particularly between competing OEMs). For lower categories, VSM is too sophisticated and overburdens the customers. As illustrated in Table 24, the market size of the top leagues is reasonably bigger than the emerging leagues' market size. Particularly NASCAR, F1, and Indycar make a major contribution.

	Top Leagues					
	F1	NASCAR	Indy Car	DTM	LMP1	IRC
Market potential	€ 1,920,000,000.00	€ 1,340,000,000.00	€ 81,000,000.00	€ 44,000,000.00	€ 24,000,000.00	€ 8,500,000.00
Market volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Possible volume factor	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Market share	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Turnover 2011	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total market size	**€ 31,360,000.00**					

Table 24: Assessment of the market characteristics of top leagues in motorsports[157]

F1 can be identified as an outlier. The reason for the very small market share is related to data confidentiality issues and the high simulation ego of the teams, which has already been explained in section 5.6. Being actively involved with Formula 1 demonstrates the capabilities of a company and creates the image of being innovative and smart. F1 teams are certainly aware of this factor and therefore use their strong

[157] Cf. AVL Intranet (2012)

negotiation position to exploit suppliers. As a bottom line, F1 is very interesting in terms of market volume and image creation, but the entry barriers are very high and the profitability is low.

The fundamental assertion of Table 22 and Table 24 is that AVL Racing has to continue making business with top leagues of motorsports, but to increase profitability and the total turnover the department has to take the minor racing leagues into consideration as well.

6.2 Primary research

In accordance with “Blue Ocean Strategies”, the creation of a value innovation requires a holistic understanding of the market situation. In this case, little information can be gained by screening already existing data.

The main focus of this field study was to find answers to the following questions:

- What is the image of AVL Racing in the emerging leagues markets?
- What are the requirements (monetary and technical) in these categories regarding LTS?
- How educated are the race engineers in terms of LTS?
- Which competitors are already in the market?

To answer these questions a field study is the appropriate instrument. A questionnaire (see Appendix I) was set up and filled in by team members on the following occasions:

- Blancpain Endurance Series, Monza 13. – 15. April 2012
  - Meetings with GT, WSR and F3 Teams
- Grand Prix of Spain, Barcelona 11. – 13. May 2012
  - Meetings with GP2 and GP3 Teams
- WTCC, Salzburg 18. – 20. May
  - Meetings with WTCC Teams
- DTM, Spielberg 1. – 3. June
  - Meetings with F3 Teams

Those meetings were used to fill in the questionnaire and to demonstrate the capabilities of VSM. The working environment and the method of filling in the form were equivalent for all participants. The interviewer read out the questions from the questionnaire and when necessary the questions were explained in more detail. The participant gave answers and the interviewer filled-in the document. Consequently the entire interviewing process became a discussion, which allowed the interviewer to gain

insight information into why the participants answered in any specific way. The outcome of the questionnaire is discussed in-depth in the following section “Data Analysis”.

To validate the significance of this field study, the following table provides the total number of samples and interviewed teams in relation to the entire field in each category.

	F3	GP2	GP3	WSR	FIA GT	WTCC
Teams Total	8	13	9	10	30	10
Number of Samples (Teams Asked)	4	5	6	5	6	4
Sample in % of Total	50%	38%	67%	50%	20%	40%

Table 25: Control sample size[158]

As pointed out in Table 25, this field study was able to provide very high response rates throughout all categories. A limiting factor for this field study should be mentioned: in some cases, particularly in WTCC and FIA GT, teams receive extra vehicle dynamics simulation support directly from the manufacturers of the cars they race. This specific data was not available.

6.3 Data Analysis

Table 26 illustrates the most important parameters in terms of area of use, data analysis tools, and required data. The following tables show the respective coherence as a percentage of the total number of answers given by the interviewed partners.

Area of Use

The common areas of use are very important to be aware of, because knowing them allows stripping down the current standard VSM to the specifications required by potential new users. In this case race engineers predominantly seem to use LTS tools to set up the aerodynamics, the mechanical balance, and the gearbox of the vehicle.

[158] Own illustration

		Formula Racing				GT Racing		
	Software Requirements regarding Questionnaire	**F 3**	**GP 2**	**GP 3**	**WSR**	**FIA GT**	**WTCC**	**Average**
LTS Area of Use	Aero Setup (Down Force , Aero Balance)	100.0%	100.0%	100.0%	100.0%	66.7%	75.0%	90.3%
	Mechanical Balance	75.0%	100.0%	100.0%	80.0%	100.0%	75.0%	88.3%
	Damper/ Spring Setup	50.0%	40.0%	50.0%	60.0%	66.7%	50.0%	52.8%
	Camper/ Toe/ Kinematics	50.0%	20.0%	50.0%	40.0%	33.3%	50.0%	40.6%
	Race Strategy	25.0%	60.0%	33.3%	40.0%	33.3%	50.0%	40.3%
	Other Areas of Use	25.0%	40.0%	33.3%	40.0%	66.7%	25.0%	38.3%
	Ride Height	25.0%	40.0%	0.0%	20.0%	33.3%	25.0%	23.9%
	Weight Balance	25.0%	0.0%	0.0%	20.0%	0.0%	25.0%	11.7%
Data Analysis Tools in Use	WIN Tax	100.0%	100.0%	100.0%	100.0%	100.0%	50.0%	91.7%
	WIN Darab	75.0%	40.0%	33.3%	80.0%	100.0%	50.0%	63.1%
	PI Toolbox	75.0%	60.0%	33.3%	80.0%	33.3%	75.0%	59.4%
	MoTeC	50.0%	60.0%	50.0%	80.0%	66.7%	25.0%	55.3%
	Own Software	0.0%	20.0%	16.7%	20.0%	33.3%	0.0%	15.0%
	Other Acquisiton Tool	25.0%	0.0%	0.0%	20.0%	0.0%	25.0%	11.7%
	AIM	25.0%	0.0%	0.0%	20.0%	0.0%	0.0%	7.5%
	ATLAS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	AVL Drive	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Required Data	Tire Data (Pacejka,...)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Engine Maps (Torque, Power)	75.0%	80.0%	66.7%	80.0%	100.0%	75.0%	79.4%
	AeroMaps	100.0%	60.0%	66.7%	100.0%	66.7%	75.0%	78.1%
	Damper/ Bumpstop Characteristics	25.0%	80.0%	33.3%	40.0%	66.7%	50.0%	49.2%
	Compliances	50.0%	60.0%	50.0%	40.0%	33.3%	50.0%	47.2%
	Suspension Kinematics (Motion Ratio,...)	0.0%	40.0%	33.3%	40.0%	100.0%	50.0%	43.9%
	Mass, Center of gravity height, Inertia	0.0%	60.0%	33.3%	20.0%	66.7%	50.0%	38.3%
	Anti roll bar (ARB)	0.0%	20.0%	16.7%	0.0%	0.0%	50.0%	14.4%
	PreSimulation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	On Track Simulation	50.0%	60.0%	66.7%	60.0%	66.7%	75.0%	63.1%
	Advantage to have pre defined parameter	50.0%	40.0%	50.0%	60.0%	66.7%	75.0%	56.9%

High compliance

Low compliance

Table 26: Fundamental requirements of each category and their averages[159]

[159] Own illustration

Data Analysis Tools in Use

The most commonly used data analysis tools are “WinTax”, “WinDarab”, “PI–Toolbox” and “MoTeC”. Particularly smaller teams prefer to use only one tool (usually the data analysis tool which is already in use) to analyze the output of LTS software and for comparing it with real measured car data. On the one hand because they are familiar with the software and on the other hand because it is easier to maintain an overview of the data. A potential new USP could be to allow those teams to export the simulated data in the respective data format of their data analysis tool.

Data Demand

In the conversation with participants it became obvious that smaller teams especially suffer from an insufficient database of vehicle parameters which is required to build a proper simulation model. Accurate tire data, aero maps, and engine data are very difficult to find. Since AVL Racing owns a widespread database of many parameters, it ability to provide this data could be another USP to conquer these markets.

The idea of having some parameters already pre-defined (e.g., the ARB stiffness, spring and damper characteristics, etc.) to speed up the modeling process, is favored by 56.9% only. The number is smaller than expected, which is caused by the fact that engineers want to comprehend where the data comes from and they want to be able to modify the data to their own needs. Despite the fact that engineers dislike the concept of pre-defined data that is embedded in the product, they nonetheless have a need for the type of data available from AVL Racing.

Attitude towards LTS

In general the interviewed people have trust in LTS and its capabilities. Every participant is already using, or has used, such a tool in the past. Due to the tight schedule on a race weekend, the majority of the engineers use LTS prior to arriving at the racetrack. More than 60% of them would even use it trackside, if it was fast and user-friendly enough.

Selling Argument from a Customer's Perspective

Additionally to the results pointed out in Table 27, the following requirements were mentioned by the participants in the discussion about selling arguments from a customer's perspective.

Selling Argument from the customer point of view (USP)	In Percent of Total
Correlation and Accuracy of Results	40.0%
Charge per lap	33.3%
Usability (Handling, Interface, Comprehensiveness)	26.7%
Post Processing, Proper Data Viewer	13.3%
Support (on and off track)	13.3%
Car Behaviour Analysis	6.7%
Stability of the System	6.7%
Driver Development	6.7%
WinTax Export	6.7%
Fully Integrated Tool (LTS + Data Acquisition + Analysis Tool)	6.7%
Automatic Variation of Parameters, Optimizations Process	6.7%
Low price	6.7%
Data Confidentiality	6.7%
HiL or unique measurement methods	6.7%
Data Supply by AVL (Tire, etc.)	6.7%
Laser Scan Tracks e.g. for Driver Line comparisson	6.7%
Setup Sheet Linked as Input for LTS	6.7%
High compliance	
Low compliance	

Table 27: Selling arguments from a customer's perspective, as a percentage of total number of participants[160]

Unsurprisingly the most important selling proposition is correlation and accuracy of results. AVL Racing has to provide enough evidence to convince the teams that the mathematical model is accurate enough and corresponds to the behavior of the real

[160] Own illustration

vehicle. Ease-of-use, including an attractive interface and a self-explanatory way of entering and editing data, is considered very important as well.

Charge per Lap

Table 27 shows another important preference which could change the charging strategy for the products of AVL Racing dramatically. The idea of charging for every single simulated lap instead of selling or leasing licenses seems to meet the preferences of smaller teams with limited budgets especially. Such a system would mean that future clients would no longer be provided with the software. Instead of having the LTS tool installed on their own computer, they would have access to a cloud network which would host the entire tool portfolio of AVL Racing. The only thing they would have to pay for is the amount of laps or simulations they actually consume. The price would depend on which tool they use and how many laps they simulate. It is comparable to pay-as-you-go systems which some mobile phone network providers currently use.

Competition and Recognition Values

Another outcome of the survey is that VSM and all of AVL Racing's activities, particularly their vehicle dynamics competence, are widely unknown. 91.1% of the interviewed engineers know AVL as one of the best companies of the world in terms of powertrain engineering and testing systems, but only 34.2% claim to be aware of the racing competences of AVL. A comparison to the level of awareness of ADAMS, ChassisSim, Race Sim by DATAS, and Lap Sim by Bosch immediately indicates the drawback of AVL Racing's current marketing strategy. Word of mouth has not reached these categories so far, and maybe never will.

As illustrated in Table 28, people in these race categories do not know that VSM exists, hence nobody uses it. The lack of awareness of VSM in the race engineering community allows competitors like Lap Sim by Bosch, Aero Lap by Ansible Design, and Race Sim by DATAS to hold most of the LTS market share in these racing leagues. Of note, the widespread use of Bosch's simulation tool can be attributed to the fact that it is available free of charge. In discussion with the engineers it became obvious that this is the only reason they use this particular software.

		Formula Racing				GT Racing		
Competition	**Status**	**F 3**	**GP 2**	**GP 3**	**WSR**	**FIA GT**	**WTCC**	**Average**
Lap Sim by Bosch	in use	50.0%	40.0%	33.3%	40.0%	16.7%	25.0%	34.2%
Aero Lap by Ansible Design	in use	25.0%	40.0%	50.0%	40.0%	16.7%	25.0%	32.8%
Race Sim by DATAS	in use	50.0%	20.0%	50.0%	20.0%	16.7%	25.0%	30.3%
ADAMS by MSC	in use	0.0%	0.0%	16.7%	20.0%	0.0%	0.0%	6.1%
Car Sim by Mechanical Design	in use	0.0%	20.0%	0.0%	0.0%	0.0%	0.0%	3.3%
OptimumK by OptimumG	in use	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	2.8%
Chassis Sim	in use	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IPG CarMaker	in use	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Vedyna by Thesis	in use	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
VI Grade	in use	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AVL (Company)	know	100.0%	80.0%	83.3%	100.0%	83.3%	100.0%	91.1%
ADAMS by MSC	know	75.0%	100.0%	83.3%	60.0%	100.0%	75.0%	82.2%
Chassis Sim	know	75.0%	80.0%	83.3%	80.0%	66.7%	50.0%	72.5%
OptimumK by OptimumG	know	75.0%	80.0%	50.0%	60.0%	83.3%	50.0%	66.4%
Race Sim by DATAS	know	50.0%	80.0%	50.0%	80.0%	50.0%	75.0%	64.2%
Lap Sim by Bosch	know	50.0%	40.0%	50.0%	60.0%	66.7%	75.0%	56.9%
Aero Lap by Ansible Design	know	50.0%	60.0%	33.3%	40.0%	33.3%	0.0%	36.1%
VSM by AVL Racing	know	50.0%	60.0%	33.3%	20.0%	16.7%	25.0%	34.2%
VI Grade	know	25.0%	40.0%	16.7%	20.0%	50.0%	50.0%	33.6%
Car Sim by Mechanical Design	know	25.0%	20.0%	33.3%	40.0%	50.0%	25.0%	32.2%
IPG CarMaker	know	0.0%	40.0%	16.7%	20.0%	16.7%	25.0%	19.7%
Vedyna by Thesis	know	25.0%	0.0%	0.0%	20.0%	16.7%	25.0%	14.4%

High compliance

Low compliance

Table 28: Competition screening, answers as a percentage of the total number of participants[161]

[161] Own illustration

Expenditure on LTS

Referring to the answers provided by the team members, the average budget for an LTS tool is € 14,375.00, as a one-off purchase .Particularly the GT Racing segment is very conservative when spending money on vehicle simulation software. Table 29 shows that teams of all categories are willing to increase their expenses on LTS in the next one or two years. It indicates the increasing importance of LTS in all types of racing.

	Formula Racing				GT Racing		
	F 3	GP 2	GP 3	WSR	FIA GT	WTCC	Average
Average Budget for LTS	€ 17,500.00	€ 27,500.00	€ 20,000.00	€ 12,500.00	€ 8,750.00	€ -	€ 14,375.00
Team Budget	€ 1,000,000.00	€ 4,000,000.00	€ 1,650,000.00	€ 2,000,000.00	€ 850,000.00	€ 1,000,000.00	€ 1,750,000.00
Expenses on LTS in % of Budget	2%	1%	1%	1%	1%	0%	1%
Plan to Increase Sim Budget	100.0%	66.7%	60.0%	50.0%	66.7%	100.0%	73.9%
Web based LTS Tool	66.7%	75.0%	40.0%	75.0%	66.7%	100.0%	70.6%
High significant							
Low importance							

Table 29: Attitude about a web based LTS tool and current budget for LTS[162]

6.4 Conclusion

The following conclusions can be drawn by combining the answers collected on the questionnaire and the insights that were gained from the conversations.

It is evident that the entire market is looking for tools which meet their expectations in terms of the degree of technical innovation, accuracy of results, and ease-of-use. This leads to the following list of requirements in accordance with the results of the primary market research:

- Correlation & accuracy of results (AVL has to deliver proof the capability of their mathematical models)
- User friendliness, fully integrated application (plug & play)
- Proper post processing tool
    - Provide an export interface to the common data analysis tools, used by the teams

[162] Own illustration

- Supply of necessary data (tire data, etc.)
- Charge per lap pricing strategy, highly requested by the interviewed people

It can be stated that the higher the complexity of the race car setup, the more money the teams are prepared spend on LTS. This statement leads to the following market characterization, in accordance with the results of the field study:

GT Racing:

- Limited budget
- Limited setup options
- VSM too advanced for their needs
- There is interest in the Virtual 7 Post Rig tool
- Trackside simulation engineering services are highly desirable
- Large interest in a tool that is simple to use
- Large interest in test bed use for transmission optimization and differential mapping (HiL)
- Main competitors: Lap Sim by Bosch, Race Sim by Datas, and Aero Lap by Ansible Design

Formula Racing:

- Limited budget
- VSM too advanced for their needs
- “Lite” version possible (quasi static or dynamic)
- Large interest in a tool that is simple to use
- VSM user interface needs a facelift
- Large interest in test bed use for transmission optimization and differential mapping (HiL)
- Engineering services for a short period of time (approximately 3) attractive for teams
- Main competitors: Lap Sim by Bosch, Race Sim by Datas, and Aero Lap by Ansible Design

In order to meet the expectations of the customers in the new target markets, the proposal for the new business model is based on the findings of this market research.

7 Business Model

The following chapter combines the data gained from the status analysis and the market analysis to derive a new business model for AVL Racing which aims to be holistic and market orientated.

7.1 Product Portfolio Structure

The core element of the new business model is a completely reorganized product structure which is illustrated in Figure 37.

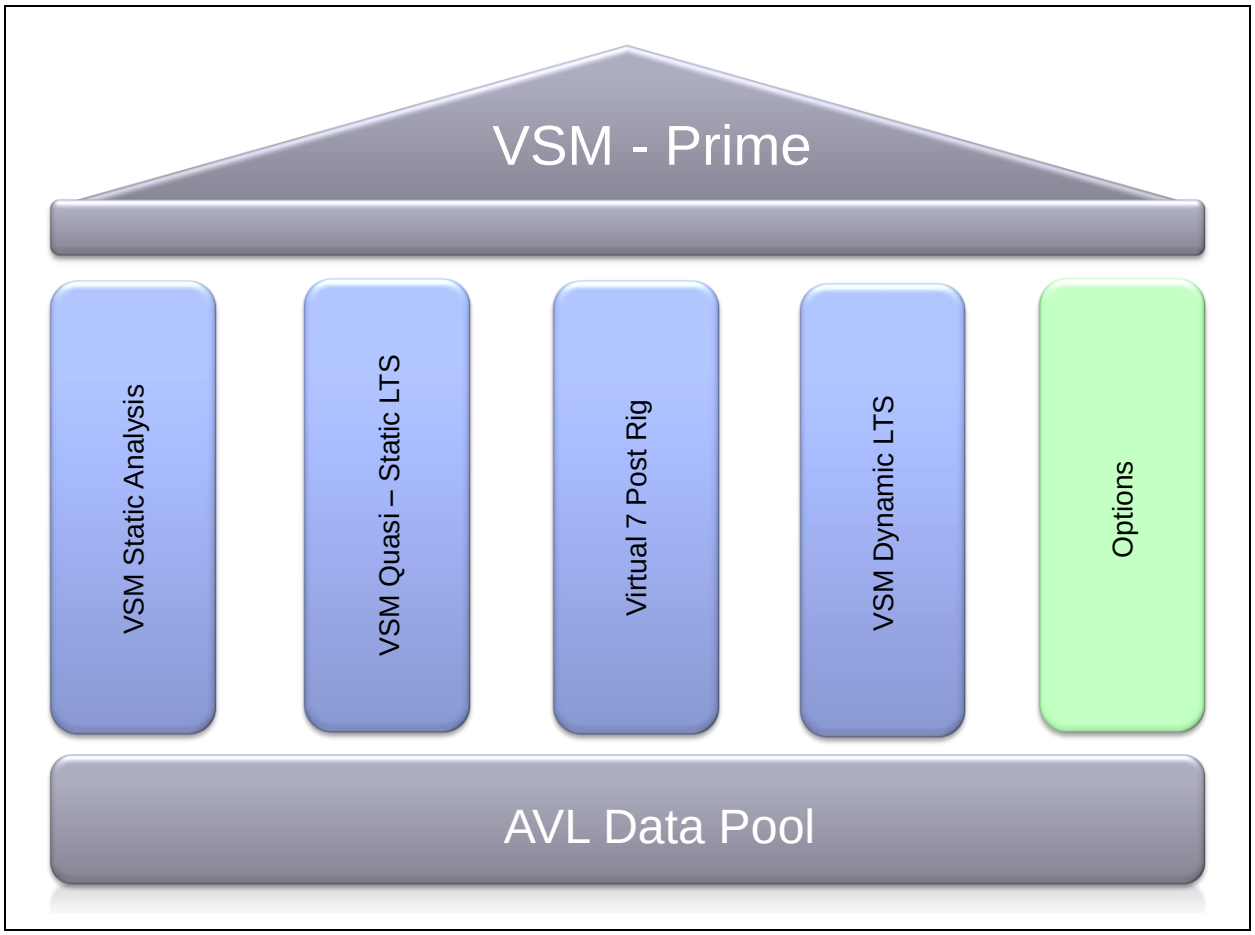

Figure 37: AVL Racing's new product structure[163]

[163] Own illustration

VSM Prime is supported by five self-contained modules which can be sold separately. This structure delivers four new off-the-shelf products which are specifically tailored to the requirements of the race categories investigated, and provides further upgrade options to satisfy special demands. The foundation of this composition is represented by the AVL Racing data pool which provides the necessary data to build accurate models. This approach creates a product family which replaces the former disorganized module and cost structure.

Target Market Allocation and Product Description

Figure 38 illustrates the key features and USPs of the four products and the available optional features for the entire product portfolio in coherence with their dedicated target markets (indicated by the icons of the individual race categories).

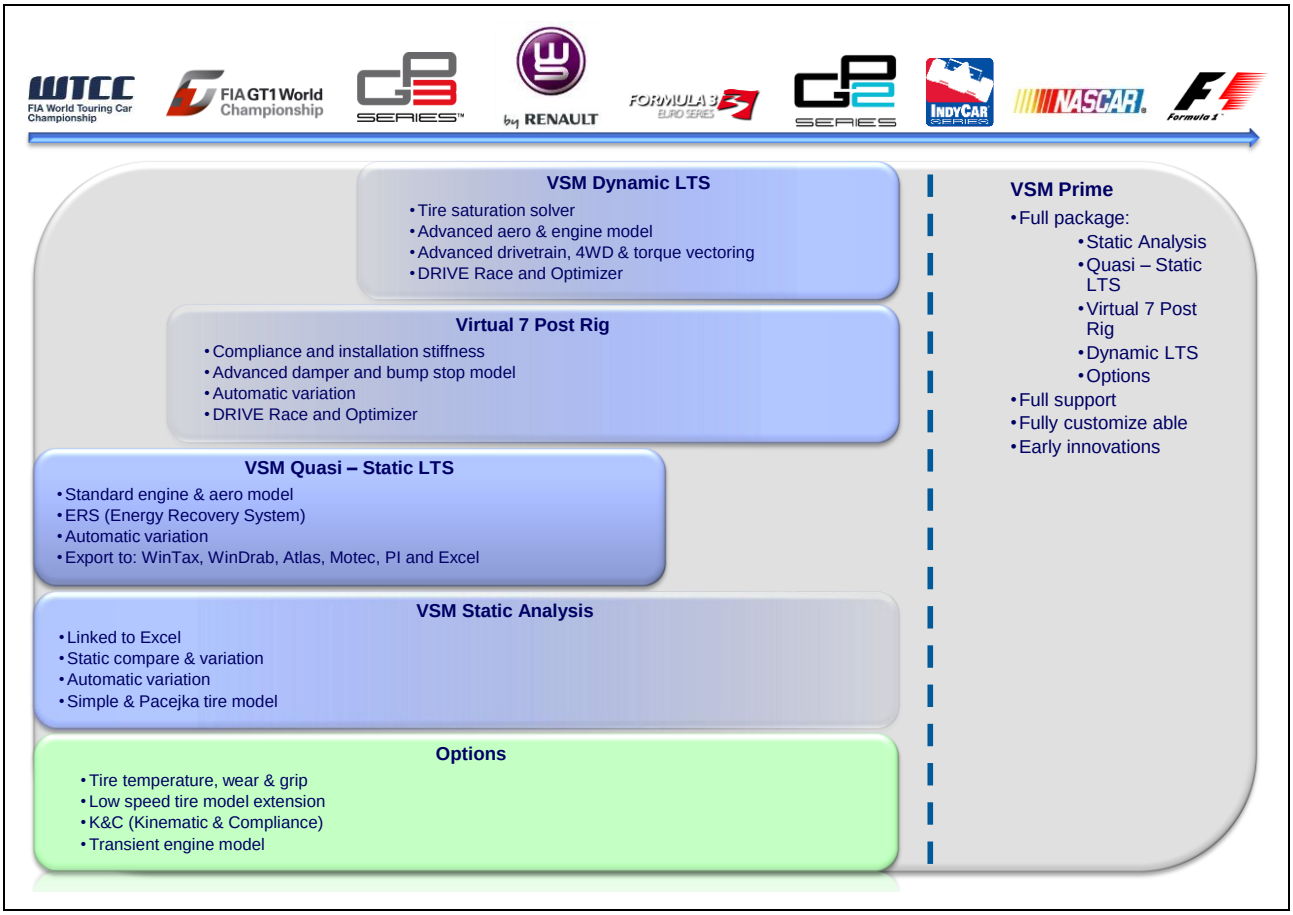

Figure 38: Products and their key features in relation to their target markets[164]

[164] Own illustration

Important Product Characteristics

None of these products (in exception of VSM Prime) offer any additional service or support. They come with comprehensive user-manuals and online tutorials. Any additional service will be charged separately. This affects the cost structure and the retail price positively which results in a win–win situation for both customer and company.

A detailed list of contained modules for each of the new products can be seen in Appendix II.

VSM Static Analysis

As shown in Figure 38, VSM Static Analysis is meant to be the most basic application and mainly targets the low price segment. As per the definition of a static analysis tool, it is limited to investigations of only one vehicle state at a time. The main benefit of it is the short simulation time and the MS Excel™ interface implementation, which makes it a competitive alternative to the standard setup sheet used by race engineers.

VSM Quasi-Static LTS

VSM Quasi–Static is the first LTS tool in the product range. It is an extended version of VSM Static Analysis and uses the same mathematical solver and the same interface. The target markets are teams in the mid–budget categories with a basic level of setup options (e.g., WTCC, FIA GT, GP3 and WSR).

Virtual 7 Post Rig

The Virtual 7 Post Rig module is the first in the family of dynamic simulation products. The target markets for this tool is continue to be NASCAR and Indycar, but there is great potential to sell it to mid-to-high-budget teams in European championships (e.g., F3, GP2, and FIA GT).

VSM Dynamic LTS

VSM Dynamic offers the main features of the current VSM software. Due to the level of detail of this tool it requires a very comprehensive understanding of the vehicle and its

parameters. VSM Dynamic targets the top teams in the top championships of the investigated leagues.

Options

On top of this product portfolio, customers are able to upgrade their product of choice with several optional features (e.g., advanced damper, transient engine model, etc.) which are charged separately. These options are also available for VSM Prime where they are part of the customization process.

VSM Prime

VSM Prime comprises the entire product portfolio including full support and tailoring options. This premium product is required to sustain the market share in the top leagues of motorsports such F1, NASCAR and Indycar.

7.2 Recommended Course of Action

The following chapter shows criteria which have to be considered to achieve the new product structure and satisfy the market. In accordance with the ERRC–Grid, this section discusses strategic suggestions in terms of sales, distribution, and marketing actions. The procedures correspond to the five columns of the new product family structure. The roof of the structure, VSM Prime, is only affected secondarily by the measures explained in this section. The ERRC–Grid helps to identify the four fields of action as illustrated in Figure 39.

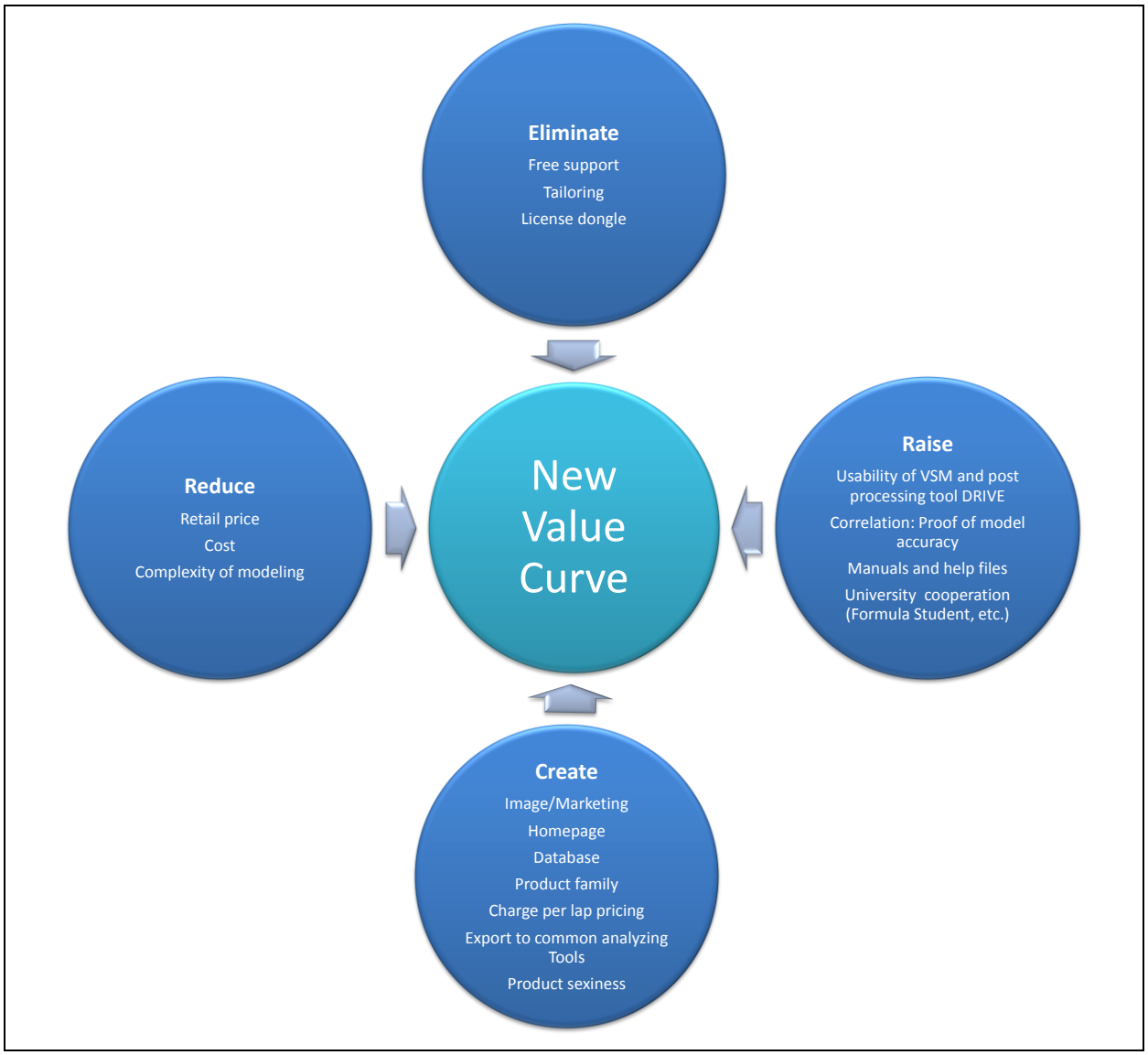

Figure 39: 4-Actions format (ERRC-Grid) of AVL Racing[165]

[165] Own illustration

The illustration of the 4-Action Format demonstrates the most important issues to be considered when dealing with determining a new value curve, which is necessary to enter the new markets and maintain technological leadership.

Eliminate

To be a successful player in any market segment a lean cost structure is mandatory. To achieve this structure AVL Racing has to abolish free support and tailoring services for the entire product portfolio with the exception of VSM Prime. Both factors are time-consuming and therefore cost-intensive. In other words the efficiency of the whole distribution and service process has to be improved. One step towards this is to eliminate the dongle system. Dongles are used to allow customers to install VSM on several computers, but restrict the possible number of licenses in use at any given time. The whole system is complex and expensive.

Reduce

A leaner cost structure can be used to decrease the retail price to attract customers who have thus far not been able to afford any kind of simulation tool. The market analysis shows that the average budget customers spend on simulation is way below the current VSM retail price. A reduction of cost and price is not only required to enter new markets, but also to sustain already-penetrated markets.

A reduction of the modeling complexity would improve the usability of the software and make it easier to attract new customers. Providing a simple and fast methodology to enter the necessary data into the software would enable engineers to have quick access to the entire AVL Racing toolbox.

Raise

Usability is one of the key words of this thesis. Referring to the outcome of the field study, engineers use LTS preferentially as a pre-event simulation tool. Nonetheless it has to be usable trackside whenever problems or issues occur during a race weekend. Consequently it is of high importance to provide a proper self-explanatory GUI and data editing process.

AVL Racing has already started creating a new GUI that uses the same menu navigation as Windows™ which nearly every engineer in the world is already used to,

thereby making it an intuitive process to enter and edit data. The new basic framework will be supported by graphical features to check and analyze various data characteristics. Due to these measures the whole modeling and analysis process will be improved.

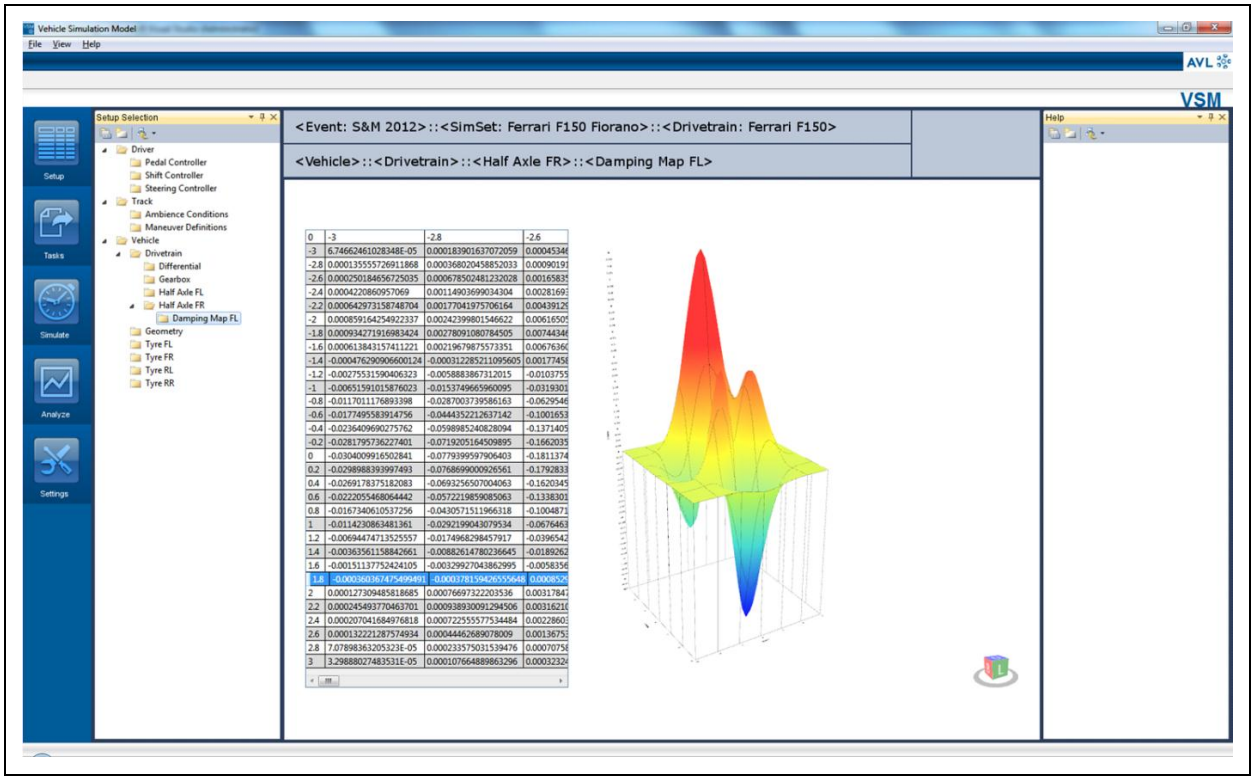

Figure 40: New VSM GUI (Graphical User Interface)[166]

Implementing this GUI as illustrated in Figure 40 follows the corporate identity and future design language of AVL, which leads to high recognition value.

Referring to the results of the field study, correlation and accuracy of results is the most important selling argument from a customer's point of view. Due to a very extensive collaboration with an F3 team for several years, AVL Racing was able to demonstrate that the mathematical model behind VSM delivers the most accurate results in the business. Nevertheless it is very important to continuously check and validate the model. Collaborating with a Formula Student team would be the easiest option to meet this demand, firstly because the vehicle is already equipped with the most important sensors and secondly, because the manpower cost is very low.

[166] AVL Intranet (2012)

Due to the fact that the support services have to be eliminated to achieve the required cost structure, the user-manual files have to be dramatically improved. Every VSM product needs a database of self–explanatory documents (e.g., Windows™ help, etc.) and an example case study which explains the main features of the tools step by step.

Create

Many teams would like to use simulation software but simply do not have enough accurate data to feed the model properly. This is the reason why providing a database of basic vehicle data, free of charge, is of very high importance. Doing it for free limits the risk of getting into trouble if the results are not good enough from a customer's perspective, but can be used as a catchpenny to attract new customers.

Using marketing to raise the awareness level is another very important factor. As shown in the market analysis, AVL Racing is unknown in wide areas of the new markets compared to their competitors. The first step towards a new and beneficial identity would be the creation of a dedicated website. On such an internet platform AVL Racing should advertise its entire product portfolio in a clear and structured way. It could comprise of demonstration videos, information folders, and visual aids, and provide the new basic platform for the interaction between customer and company. Such a cheap and simple measure creates trust in the products and can be used to demonstrate AVL's core USP, the outstanding network of corporate competencies and know-how directly available to the customer.

This network and the new product family can be advertised as a "One Stop Shop" which creates benefit for other departments inside AVL as well. The idea is to provide a holistic platform which offers the entire service portfolio of AVL. Teams that want to increase the overall performance of their car would not only be able to use the vehicle dynamics expertise of the racing department, but also the engine and gearbox calibration capabilities, and any other know-how of the entire corporation.

Online tutorial videos demonstrating the capabilities of VSM and vehicle dynamics basics could be provided via a YouTube channel and support the viral marketing strategy. Another possibility to create trust and a positive image is to publish articles on the web and in specialist literature.

The cooperation with Universities and Formula Student teams would have several positive effects. Supplying young engineers with VSM creates a positive image and familiarizes them with the product. Once they leave University they would be skilled VSM users and know about the capabilities of the AVL Racing product portfolio. Using

this word of mouth strategy is not new (c.f. CATIA™, MATLAB™, etc.), but very powerful. Another positive aspect of it would be the possibility to use these engineers as guinea pigs to evaluate new and risky innovations to avoid upsetting customers.

A further possibility to raise awareness is to show presence on race weekends. It can be used to support existing clients, or to initiate talks with potential new customers. Simply just being there builds up trust in the products and the commitment of AVL Racing.

Instilling VSM in the brains of engineers and students is a key to success in the market. To harvest the success, a new sales strategy is required. Particularly for low budget teams the pay-as-you-go scheme (charging per lap) seems to be appropriate to push. Such teams are not willing to spend for example € 20,000.00 on software if they are not fully convinced of the benefit of the tool. This approach provides the entire product portfolio in the web-based cloud which can be accessed at any time by the registered customers. Once they enter their model into the cloud (which is absolutely free of charge), they are able to use any type of simulation tool. Of course the fee would differ whether they used VSM Static Analysis or VSM Dynamic. Regardless, every lap would be counted and charged separately, or the customer could decide to sign up for a special deal (e.g., purchase 100 laps, get 10 for free) or even for a flat rate. The advantage for AVL Racing would be that all the data that is entered by teams to model their car could be used for internal purposes (correlation, validation, etc.) and that software updates and services could be executed easily. Furthermore using the cloud system opens the door to the worldwide market and diminishes entry barriers for new customers.

Strategic Layout

The four actions described in the ERRC–Grid lead to the following new strategic canvas illustrated in Figure 41.

The strategic canvas of “AVL Reorganized Product Family” represents the current strategic behavior, which will continue to be used for VSM Prime. The new strategy can be seen as an addition to the VSM Prime strategy.

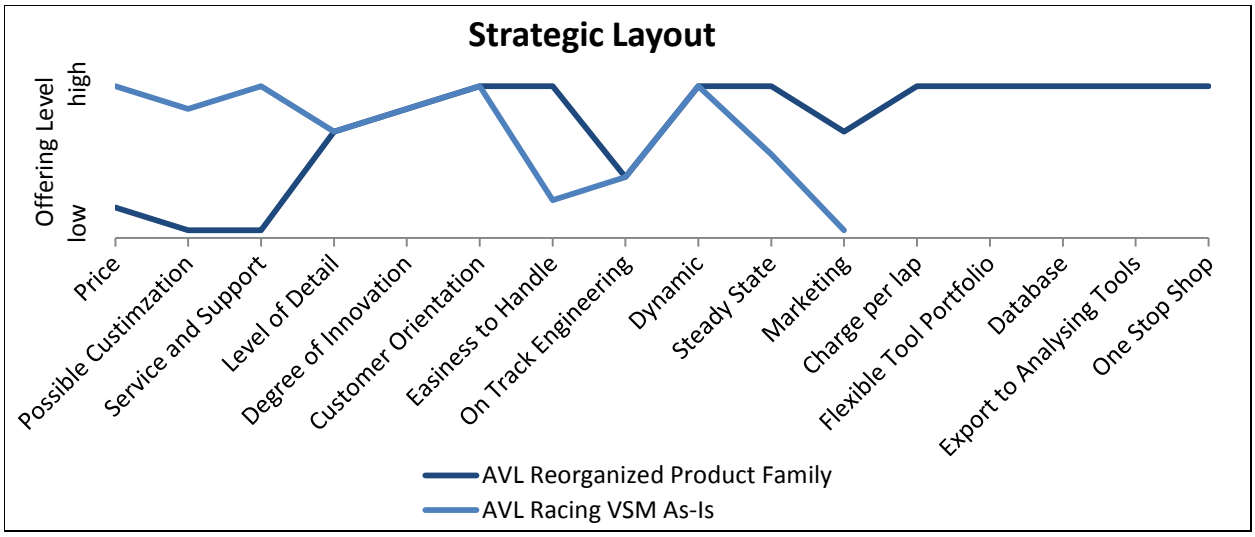

Figure 41: Extension of existing criteria due to ERRC–Grid suggestion[167]

As pointed out in Figure 41, five new market criteria could be identified and an offset to the current AVL Racing strategic layout could be implemented. The offset is mainly caused by a new pricing and service approach. A successful value curve is characterized by differentiation and new customer benefits. The extension of five new influential parameters on the business segment should also be mentioned in this context.

7.3 Price Structure

In this section the first price estimation is presented. The prices are related to the average current expenditure of teams referred to in the field study.

The numbers provided for the “Charge per Lap” section are a result of the average number of races multiplied by the number of simulated laps which are needed to achieve adequate results (this number is validated by experienced AVL race engineers who have executed such pre–event simulation tasks several times in the course of a customer project).

The four new products differ from each other and from VSM Prime in terms of retail price and distribution strategy.

[167] Own illustration

	VSM Static Analysis	VSM Quasi Static	Virtual 7 Post Rig	VSM Dynamic	VSM Prime
Retail Price	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Leasing Fee	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Charge per lap	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 30: AVL Racing's price structure of the new product portfolio

VSM Static Analysis has to be sold at a very attractive price. On the one hand, because AVL Racing has to convince the new customers that the product is much better than their current product (common Excel™ setup sheet), and on the other hand because it can be used as a catchpenny for more sophisticated applications such as VSM Quasi Static and VSM Dynamic.

Those products are sold and not licensed because smaller teams, referring to the survey, prefer to own the product and to do a one-off purchase. However, the majority of the interviewed partners like the charge per lap idea even better. Smaller teams are expected to purchase only one license for their entire racing activities. If AVL Racing can continue offering important updates (e.g., innovations, model updates to match regulation changes, etc.) every few months, selling updates can become a very important source of income.

VSM Prime will continue to be leased instead of sold. The reason for that is the completely different target customer. These top teams with very high budgets and lots of setup options are expected to order two or more licenses a year. Therefore the leasing approach makes it easier for the teams to justify the expenses and to increase the flexibility of ordering or canceling licenses annually. The actual price depends on the amount of ordered licenses (volume discounts are available) and the level of required tailoring and support services. As a starting point [redacted] (no tailoring, one year of support and the entire product portfolio included) can be considered.

7.4 Opportunities

Figure 42 illustrates the potential of the new tool structure by applying the same ranking scheme to the four new products of AVL Racing, as it was used for the portfolio analysis in chapter 5.7. All of them can be seen as potential stars. For the market size of the new products, only the emerging leagues were taken into consideration for this

plot. The whole emerging racing sector is likely to be much larger than detailed in this thesis, as explained in 6.1.

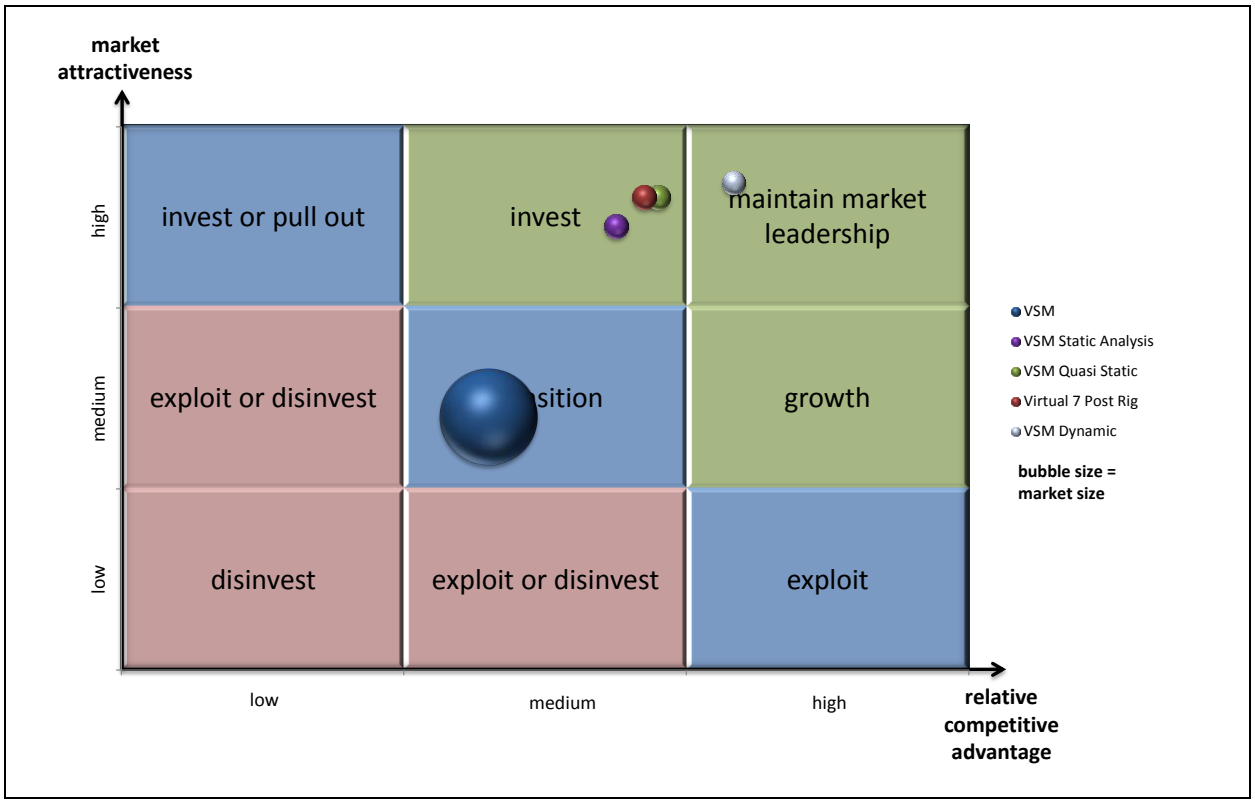

Figure 42: MA–CA portfolio of the four new products compared to the current VSM[168]

The new structure offers the unique opportunity to establish a completely new brand image and reputation on a new terrain for AVL Racing and for vehicle simulation as a whole. Particularly the tailored product portfolio and the new marketing concept provide high potential for market share growth in the near future.

Furthermore AVL Racing is in the beneficial position of only having to downgrade and split the existing product into the modules described in the prior section and in Appendix II, which saves time and therefore costs. Introducing the new distribution and pricing system (charge per lap) offers a great opportunity to conquer derelict land on worldwide markets.

[168] Own illustration; cf. Bruhn (1999), p. 76

7.5 Risks

Developing new user-manuals and the installation of the cloud system are the most critical parts of the new strategy. Abolishing the free of charge help and support services is a key issue to make the strategy successful. If AVL Racing is unable to provide high quality manuals, customers will feel left alone and reject the tools.

The charge per lap system could result in a very complex charging process which requires a lot of effort to create and maintain. Another risk is that it increases the price pressure and the rivalry of the whole segment and in doing so decreases the gross profit margin. From an AVL internal point of view this system can face difficulties in terms of project accounting. Since every invoice needs a customer project account within AVL's project management system, it appears to be too expensive and time consuming to create a new project in every instance when only a small amount of money is involved.

As shown in Figure 42, the market size for the new products is rather small which makes it necessary to investigate potential markets in a higher level of detail than has been covered within this thesis. Serving such a small market always comes with the risk of investing too much money for too little business.

Any kind of reorganization of structures or portfolios will face the employees' and customers' fear of change. This fear is a significant barrier to overcome in order to successfully implement new systems.

New products on new markets can provide a great opportunity (as mentioned in 7.4) but also bring big risk. New products are very often immature (bugs, reliability, etc.) which can result in big losses of reputation, or in the case of AVL Racing it can close the door to those new markets for several years.

Perhaps the biggest threat to the new product family structure is that VSM Prime customers may start to disappear and choose cheaper solutions like VSM Dynamic or something similar. In this case AVL Racing could lose the opportunity to sell the customization and support services to these prime teams and consequently switch from the status of an engineering-partner to an ordinary software provider, which would also result in loss of know-how.

8 Conclusion and Outlook

The implementation of the new product structure offers a great opportunity to conquer new markets. It is a combination of the internal strengths and the external opportunities, and is based on profound market research. The results of the field study provide evidence to either confirm or deny assumptions in various fields of interest and to illustrate the market desires and capabilities (monetarily and technically). Moreover, the collected data serves to demonstrate the status quo of this department in terms of image and financial success.

Due to the application of relevant management tools, it was possible to demonstrate that AVL Racing has great potential to maintain technological leadership in the top categories of worldwide motorsports, and to gain ground in the aspiring leagues by updating their product portfolio and business strategy.

The core elements of this new business model are:

- The reorganized product structure, which is tailored to the needs of the emerging race categories;
- The elimination of customization and free of charge support services;
- The demand oriented pricing strategy;
- The creation of a value innovation.

It provides the framework to achieve a leaner cost structure which is required to match the common market prices (in accordance with the market research), and to gain access to derelict markets.

To implement this strategy, several actions, including the creation of a marketing strategy, and the enhancement of collaboration with Universities, are proposed. The required software specifications can be generated by splitting up the current VSM features and reassembling them in the designated way. Beyond that, this thesis revealed some very important scopes for future investigations.

The impact of topics like true costs and lack of business strategy on pricing issues and turnover would be interesting to analyze in more depth. Moreover a detailed investigation of how the implementation process of this product strategy could look, and how much it would cost (initial investment, ROI, etc.), has to be considered as well.

Furthermore detailed market research about the racing scene in emerging countries (BRIC, Argentina, etc.) is advisable for AVL Racing. On the one hand, to be aboard from the very beginning and to expand in terms of turnover and market share, and on the other hand, to identify the critical market factors in these regions.

A detailed cost analysis and feasibility study for the charge per lap pricing strategy is required to create a real competitive advantage. This investigation has to deliver the implementation, running, and maintenance costs of a cloud computing system. In addition to that, a profound research on the key pricing factor, which is expected to be the total number of simulated laps per year, has to be done in order to improve the price calculation.

HiL applications and engineering services have only been slightly touched upon in this thesis. A proper analysis of costs and potential markets would be appropriate to boost this segment of AVL Racing as well.

The idea of creating a “One Stop Shop” for all racing related departments inside of AVL should be investigated in detail. Particularly the corporation-wide impact of such a platform in terms of chargeable corporate margin, turnover, market share, and the interactive dynamics is well worth further investigation.

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11 List of Figures

12 List of Tables

13 List of Abbreviations

ACO;	Automobile Club de l'Ouest
AST;	Advanced Simulations Technologies
BRIC;	Brazil Russia India China
CAGR;	Compound Annual Growth Rate
DTM,	Deutsche Tourenwagen Masters
EBIT;	Earnings Before Interests and Taxes
ERRC;	Eliminate-Reduce-Raise-Create
F1;	Formula One
F3;	Formula Three
FIA;	Federation Internationale de l'Automobile
GT;	Gran Tourismo
GUI;	Graphical User Interface
HiL;	Hardware in the Loop
IRC;	Intercontinental Rallye Championship
ITS;	Instrumentation & Test Systems
LCAG;	Learned, Christensen, Andrew, Guth
LMP1;	Le Mans Prototype 1
LTS;	Lap Time Simulation
MA – CA;	Market Attractiveness – relative Competitive Advantage
Mio;	Million
PTE;	Powertrain Engineering

R&D;	Research and Development
ROI;	Return of Investment
RP;	Retail Price
SWOT;	Strengths, Weaknesses, Opportunities, Threats
USP;	Unique Selling Proposition
VSM;	Vehicle Simulation Module
WEC;	World Endurance Championship
WRC;	World Rallye Championship
WSR;	World Series by Renault

Appendix I: Questionnaire

Diploma Thesis AVL: Questionnaire about Simulations software

Dear Sir or Madam,

In the course of my Diploma Thesis at Graz University of Technology, I am going to investigate the market niche for Vehicle Simulation Tools in terms of functionality and optimum composition in detail. All of your details will be treated with high security standards. The purpose of this study is to evaluate your needs and requests for an optimum Simulation Tool. Therefore your expertise is of very high importance.

Duration: ca. 10min

Content:

5 Modules to evaluate various fields of interest

Your participation is highly appreciated. Thank you for your time!

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AVL LIST GMBH
A-8020 Graz, Hans List Platz 1
http://www.avl.com

Module 1:

Do you know AVL List GmbH? yes ☐ no ☐

Do you know AVL Race Department? yes ☐ no ☐

Which competences of the AVL Race Department do you know?

☐ Test Bed ☐ Chassis Development

☐ Vehicle Simulations ☐ Engine Simulations

Which of the AVL Products below do you know? (Multiple answers possible)

☐ AVL Drive ☐ Impress XD

☐ AVL VSM ☐ Others:

☐ AVL Cruise

☐ AVL Puma

☐ AVL Concerto

☐ Design Explorer

Which of the products below do you know or use? (Multiple answers possible)

	I know	in use
CarMaker by IPG	☐	☐
Chassis Sim	☐	☐
Lap Sim by Bosch	☐	☐
Aero Lap by Ansible Design	☐	☐
Race Sim by DATAS	☐	☐
Car Sim by Mechanical Simulation	☐	☐
ADAMS by MSC Software	☐	☐
Vedyna by Thesis	☐	☐
OptimumK by OptimumG	☐	☐
VI Grade	☐	☐

Module 2:

Do you know the difference between Static and Dynamic Simulation? yes ☐ no ☐

Do you use a Static Vehicle Simulation? yes ☐ no ☐

Do you use a Dynamic Vehicle Simulation? yes ☐ no ☐

If you use a Simulation, do you use it for multiple race categories? yes ☐ no ☐

In which categories does your Team compete in?

☐	ADAC Formel Masters	☐	ELMS
☐	ADAC GT Masters	☐	Mini Challange
☐	Carrera Cup	☐	PMSC
☐	DTM	☐	Seat Supercopa
☐	Formula 1	☐	VLN
☐	Formula 3	☐	WEC
☐	FIA GT	☐	WS by Renault
☐	GP2	☐	WTCC
☐	GP3	☐	Others:

Would you describe a full Dynamic Vehicle Simulation as useful? yes ☐ no ☐

In which phase of a race weekend would you use a Vehicle Simulation Tool?

☐ On Track Simulation (at the Race weekend)

☐ Pre Simulation (Prior arrival at Track)

In which of the areas below do you think a Vehicle Simulation tool can be useful? (Multiple answers possible)

- ☐ Aero Setup (Down Force, Aero Balance)
- ☐ Weight Balance/ Distribution
- ☐ Mechanical Balance
- ☐ Damper/ Spring Setup
- ☐ Ride Height
- ☐ Camper/ Toe/…Kinematics
- ☐ DRS, KERS Tactics
- ☐ Strategy
- ☐ Others:

Module 3:

Which of the Data Acquisition Tools below do you use? (Multiple answers possible)

- ☐ MoTeC
- ☐ PI – Toolbox
- ☐ WIN Darab
- ☐ WIN Tax
- ☐ ATLAS
- ☐ AVL Drive
- ☐ Own Software
- ☐ Others:

Module 4:

Which data is difficult to get, to build a proper model? (Multiple answers possible)

- ☐ Tire Data (Pacejka, …)
- ☐ Compliances
- ☐ Aero Maps
- ☐ Suspension Kinematics (Motion Ratio, …)
- ☐ Engine Maps (Torque, Power)
- ☐ BSFC Map/ Consumption Map
- ☐ Mass, COG Height, Inertia
- ☐ Damper/ Bump stop Characteristics
- ☐ ARB
- ☐ Others:

Which of those data could you get on your own with a small effort? (Multiple answers possible)

- ☐ Tire Data (Pacejka, …)
- ☐ Compliances
- ☐ Aero Maps
- ☐ Suspension Kinematics (Motion Ratio, …)
- ☐ Engine Maps (Torque, Power)
- ☐ BSFC Map
- ☐ Others:
- ☐ Mass, COG Height, Inertia
- ☐ Damper/ Bump stop Characteristics
- ☐ ARB

Would it be a big advantage to have only pre- defined parameters available within the Simulation Tool (e.g.: setup sheet with dropdown boxes comprising ARBs)?

yes ☐ no ☐

Which Tracks do you need apart from those used in your championships (e.g.: Test tracks)? (Multiple answers possible)

☐ Balocco

☐ Nardo

☐ Idiada

☐ Others:

Which of the following functions is the most basic application of a Simulation Tool? (One answer possible)

☐ Lap Time Simulation

☐ KnC Rig

☐ 7 Post/ 4 Post

☐ Setup Variation

☐ Static Analysis (Set- Up Sheet)

☐ KERS

☐ DRS

☐ Setup Optimization

☐ Sensitivity Analysis

☐ Other:

Is it an advantage to Simulate Online (WEB)? yes ☐ no ☐

Reasons:

Module 5:

Which position do you hold within this Team?

Are you the end user of such a Simulation tool? yes ☐ no ☐

How many people are permanently employed in this Team?

☐ 0 - 15

☐ 16 - 30

☐ 31 and more

What would be a selling reason for a Simulation Tool from your point of view?

Optional

What is the name of the Team for which you are answering this questionnaire?

How much money do you currently spend on Simulation? (in € or % from Budget)

Do you plan to increase your Simulation Budget within the next 2 years?

yes ☐ no ☐

Do you plan to decrease your Simulation Budget within the next 2 years?

yes ☐ no ☐

Would outsourcing Simulations Engineering be an option for you?

yes ☐ no ☐

Would it be helpful to have experienced Simulation Engineers on the track to support you?

yes ☐ no ☐

Do you have any queries or ideas to improve Simulation software?

Appendix II: Lists of Product Specific Features

Main modules of the products:

VSM STATIC ANALYSIS
Compliance
Installation stiffness
Bump stop standard
Asymmetric setup
Aero standard
Tyre simple
Tyre Pacejka
Engine standard
Automatic variation
Export to Excel
Link to Excel
Steady State Compare
Steady State Variation

VSM QUASI - STATIC LTS
Compliance
Installation stiffness
Bump stop standard
Asymmetric setup
Aero standard
Tyre simple
Tyre Pacejka
Engine standard
KERS
Automatic variation
Export to PI - Toolbox
Export to Motec
Export to WinDarab
Export to Atlas
Export to WinTax
Export to Excel
Multiple core (per core)
QUASI - STATIC LAP SIM

VIRTUAL 7 POST RIG
Compliance
Installation stiffness
Damper advanced (incl. Damper Dyno import)
Bump stop advanced (incl. Damper Dyno import)
Asymmetric setup
Aero standard
Tyre simple
Tyre Pacejka
Automatic variation
Export to PI - Toolbox
Export to Motec
Export to WinDarab
Export to Atlas
Export to WinTax
Export to Excel
Multiple core (per core)
Run file generator for track replay
DRIVE-RACE
OPTIMIZER (incl. batch)
VIRTUAL 7 POST RIG

VSM DYNAMIC LTS
Compliance
Installation stiffness
Damper standard
Bump stop standard
Asymmetric setup
Aero standard
Aero advanced
Tyre simple
Tyre Pacejka
Tyre saturation solver
Advanced Driver model
Engine standard
Engine advanced
Advanced Drivetrain & 4WD
KERS
Automatic variation
Export to PI - Toolbox
Export to Motec
Export to WinDarab
Export to Atlas
Export to WinTax
Export to Excel
Multiple core (per core)
Run file generator for track replay
DRIVE-RACE
OPTIMIZER (incl. batch)
Torque vectoring & Traction Control
Advanced Cycle (Maneuvers)

Options
Damper advanced (incl. Damper Dyno import)
Bump stop advanced (incl. Damper Dyno import)
Tyre temperature, wear & grip
Low Speed Tyre Model Extension
K&C
Engine Full Dynamic

Appendix III: Parameter Description for MA-CA

The criteria are specified as follows:

Market Attractiveness

- Market size: See Table 8.
- Market profitability: What are chargeable corporate margins?
- Entry barriers: What are limiting factors for a prospective market entry, e.g. monopolies, protective tariffs, etc.?
- Technology development potential: How mature is the current standard technology in this market?
- Demand: How big is the demand for the product; is there a market pull situation?
- Competitive intensity/rivalry: How many competitors are already in the market and how strong are they?
- Overall risks: What are financial risks and risks of losing the reputation?
- Opportunity to differentiate: What are the USPs required? Is AVL Racing able to offer more than the standard solution? Does AVL Racing have the right to play?
- Access to the market: What are available contacts and other special links which can help to gain ground in a specific market?

Relative Competitive Advantage

- Market share: See Table 8.
- Access to assets: What are available financial and human resources?
- Competences: Does the product fit to AVL Racing’s expertise?
- Customer loyalty: How related are costumers to AVL Racing (right to play)?
- Quality/ value added for customer: How mature is the product? What is the benefit for the customer?
- Relative brand strength: What is the recognition value and reputation of AVL Racing?
- Relative cost position: What is AVL Racing’s cost structure in relation to the competitors?
- Distribution strength: What are available distribution structures and channels?
- Customer support: How satisfied are customers in general? Is the support fast and extensive?

Appendix IV: AVL Racing Project Handling Process