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Supplement to the Treatise

WOLFGANG RUNGE: TECHNOLOGY ENTREPRENEURSHIP

How to access the treatise is given at the end of this document.

Reference to this treatise will be made in the following form:
[Runge:page number(s), chapters (A.1.1) or other chunks, such as tables or figures].

This case relates to the case of polyMaterials AG, a contract R&D and contract manufacturing organization in the polymers/plastics industry.

Describing for understanding the development of a mid-sized firm out of an NTBF requires to be much more detailed with regard to management, strategy, technology and product management, customer relationships, explicit steps of execution, etc. This means that for a particular context rather detailed information must be presented – with a consequence for the volume of text.

Shaded part of text provide usually explanations and/or examples to help non-specialists or details. They can be disregarded usually without much affecting understanding.

Wolfgang Runge

Bada AG

Table of Contents

Technology-Oriented Introduction

Bada AG was founded in August 1997 in Bühl/Germany as Bada Plast GmbH & Co. KG. It operates in the polymers and plastics industry. A legal form changing conversion into a stock company ("Aktiengesellschaft", AG) occurred in May 2003.

The current contribution deals with a rare case of technology entrepreneurship and describes not only the foundation of Bada AG, but also its further development as a mid-size technology venture. From a perspective of gross development phases of startups in terms of characteristics of management [Runge:630] Bada skips over the typical startup phases.

Furthermore, this case addresses technology management not just when the firm becomes a mid-size company, but already during the firm's early phase.

It also shows how meticulous the requirements on materials are, whether required properties of materials in applications refer to "static" or "dynamic" situations, for instance, resting materials or moving linearly or rotating in corresponding applications.

Specifically, for material mostly very high friction coefficients in conjunction with friction rings and wheels are needed. At the same time, however, the abrasion should be minimized as much as possible. In addition to the smooth and hard-wearing surface, a steady running performance of the wheels is important as well as the so-called concentricity. The wheels are exposed to forces on the running surface which the material should endure for long periods without deforming [Bada 2015b].

Correspondingly, the service life-time of a moving system with plastic components is highly dependent on the coefficient of friction and the wear resistance of the applied plastic. However, it is also governed by ambient temperature and contact with other materials/media.

Wear and friction characteristics can be adjusted by adding suitable sliding additives, reinforcements like carbon and aramid fibers or PTFE, graphite etc. Many engineering plastics like PA, PBT, POM, PPA, and PPS can be used for related materials [Bada 2015h]. [1]

Finally, depending on applications, polymeric materials's development is subjected to various usage *regulations or industry standards* requiring certifications before release into the market. Making sure by the supplier its products to comply with particular regulations provides an important input for production and part of marketing of the products:

> The individual *requirement profile* for the product, technical and regulatory, has to be taken into account by application developers.

Concerning needed materials *each industry has its own special requirements on the materials*. For example, in applications for the electrical and electronics industry (E&E) flame-retardant or electrically conductive products are often used. The automotive industry needs fogging-optimized and especially scratch-resistant products. And manufacturers of consumer goods are dependent on materials suitable for food contact applications [Bada 2012n].

There are also *various differences in the processing method* for which the corresponding types have to be selected: Sometimes a part is produced by injection molding, sometimes whole profiles are extruded. More and more, 2K parts are manufactured in which the products must adhere to the most diverse hard components. And there is also a specification for the Shore hardness and a special color that must be taken for each application [Bada 2012n].

Multi-component parts have become increasingly important in recent years. Whether it is in the automotive, sanitary, medical or domestic sectors, composite systems are standing for innovative products and economically efficient production.

The two shot (2K) injection thermoplastic molding process allows the injection of more than one shot of different plastics into the same mold to create one integrated product, integration of the

multiple parts. Each component is injected by a separate injection unit. “2K” is the most common (derived from German “2 Komponenten”). But more than “2” is possible. The method allows the combination of different materials (for instance, different polymers or different colors).

Bada’s business is in the polymers and plastics segment of the chemical industry as is that of polyMaterials AG [Runge 2016] founded during a time when the polymer/plastics segment was in a period of distinct change. The focus of both the discussed firms is *polymer blends* (made of two or more polymers) and *compounds* for specific materials (definitions [Runge 2016:2-3]). A description of the technology and business situation is given by Runge [2016:3-11].

Foundation of polyMaterials in 1999/2000 targeted exploiting the opportunities provided by these changes. Hence, the founders, who had rather broad experiences with the business and technologies of polymers/plastics, were confronted with much learning and experimentation with new approaches but also with changed attitudes and convictions of their customers.

To support non-specialist in the field of plastics a note [1] to an almost entire list of plastics acronyms and/or abbreviations for specific polymers provides a quick solution of this issue.

Since the 1990s changes in the plastics industry concerned specifically the raw material development. A central question processors had to face was: Where will new polymers and grades come from in the future, specifically needed for requirements of various other industries for new materials associated with demand for short development times? And the answer was: In the future we will not see new polymers developed.

The main direction was no longer on totally new plastics or polymer blends, but the development targeted the *combination of existing materials* – new plastic formulations (recipes) creating compounds. Furthermore, on the customer side *more individualized (customized) products were demanded in ever smaller quantities*.

Formulations or combinatorial issues play also a key role in other areas of industrial chemistry, such as coatings and paints as well as adhesives (cf. [Runge 2015]) or the business of ionic liquids [Runge 2014].

Bada [2014e] illustrates that developing specific blends is still a basis of business. The underlying principles may focus on specific properties of polymers and performance:

> Engineering plastics like polyamide (PA), polycarbonate (PC), PBT (polybutylene terephthalate) or ABS (acrylonitrile-butadiene-styrene) or ASA (acrylonitrile-styrene-acrylate) have excellent properties and can be used in a broad range of application.
>
> Each individual plastic has its strengths and weaknesses, why a material may be less suitable for specific applications. Hence, the question is how the strong points of several plastics can be combined while eliminating their weak points.
>
> For instance, a commonly used example is blending of PC with ABS. The ABS component achieves enhanced notched impact strength in the cold while the PC component ensures very high heat distortion temperatures. But for outdoor applications, it is recommended to replace ABS by ASA, which has very high light-ageing resistance.
>
> For precision parts requiring highest dimensional stability and rigidity, Bada provides PBT/PC blends. Here, the high rigidity of both components is complemented by the very good dimensional stability of PBT.

Compounding technology or polymer/plastic compounding is a process for adding additional materials into a molten basic plastic to produce a material with desired properties. These *additives* and *modifiers* in *very small amounts* may result in plastic with a particular color, texture, strength, etc. A manufacturer may incorporate several additives into the base material in the process of compounding. The end-product is a homogenous blend of the different raw materials.

> Hence, play Lego:
> Use existing building blocks in infinite combinations (and known processes) to create new materials and new combinations of properties [Brandstetter 2004; Runge 2016].

Referring to the tremendous combinatorial options and opportunities of blending and/or compounding it is almost natural that a "*compounding industry*" of typically mid-sized companies had been developed for the plastics segment.

The compound/blend *value system (supply chain*) [Runge:58-60,1216] includes resin producers, compounders, injection molders, product designers, and materials specifiers at original equipment manufacturers (OEMs) and end-users.

> Both in the field of compounds as well as for *masterbatches* the following trends had emerged: Technical materials ("engineering resins") are increasingly optimized ready according to specific applications, effects for sophisticated applications will continue to be trimmed according to cost efficiency and technology niches offered a complete package ready for use – consisting of raw materials and handling systems.

A masterbatch is a concentrated mixture of pigments and/or additives encapsulated during a heat process into a carrier resin which is then cooled and cut into a granular shape. Masterbatches allow the processor to color raw polymers economically during the plastics manufacturing process (according to Wikipedia).

> Key operational determinants of the compounding/blending industry are its dependency on raw materials, auxiliaries and other operational materials which depend on the oil price and the economic development of Asia as markets (scarcity of input) and origins of competitors.

With a focus on technical thermoplastics and elastomers Bada AG develops, produces and distributes high-value specialty compounds on the basis of engineering (technical) plastics. Bada targeted niches of high-performance and high temperature plastics, tailor-made and customer-oriented modified to satisfy individual customer requirements and also innovations developed with and for customers at their special request ("*customization*").

Additionally Bada provides the precise coloration of the compounds according to individual customer requirements producing masterbatches.

Bada's development proceeded to a state in 2014/2015 described as follows [Bada – Home Page]:

"Bada AG has been manufacturing high quality technical thermoplastics and thermoplastic elastomers for a diverse spectrum of sectors including the automobile, electronic, sport and leisure, construction, furniture-making, medical technology and household goods industries since 1998.

We are well-known as an innovative compounding specialist and flexible solution provider for our internationally established customers: Backed by the latest production technology in efficient processes, our highly qualified, dynamic team develops compounds with precisely the qualities required for our customers' applications and of key importance to their function. We supply tailored solutions in consistently outstanding quality - and with our extensive sales network, the shortest paths across the globe." [Bada – Web Start-page]

Focusing on related opportunities, correspondingly, between 1985 and 2000 there was much global activity and dynamics in the plastics area with regard the appearance of new technology ventures or firms existing already in the plastics field to turn to compounds, leading to the compounding industry.

Foundation of polyMaterials [Runge 2016] was based on the fact that industry challenges shape business opportunities.

For instance, the US firm M.A. Hanna even completed the company's dramatic transformation from essentially a major mining company into polymers in the mid-1980s and then into compounding and distributing. Soon after that it acquired Theodor Bergmann GmbH & Co. Kunststoffwerk KG (Gaggenau, Germany), the largest independent thermoplastics compounder in Germany and also one of the largest producers of specialty compounds in Europe [Encyclopedia 2007] (cf. Competition chapter).

Main challenges of the plastics industry between 1990 and early 2000s were that demand for new materials would no longer be satisfied by new polymers due to high development cost, time to market and fast cycle-times for products determined by the end-users of other customer industries as well as the re-engineering of the R&D and innovation process.

To summarize, as a response the main focus was no longer on totally new plastics, but development by combinations using the vast amount of existing polymers – new blends (mixing polymers, formulations, recipes) or getting plastic materials with various properties by compounding, processing a basic plastic with additives and modifiers in very small amounts.

Therefore, for instance, polyMaterials [Runge 2016] could assume service providers to play an increasingly important role in the customer- or application-specific development of compounds and market-ready products that big suppliers shy away from developing themselves.

Correspondingly, as its major business polyMaterials operates as a service organization for the plastics segment, but also other industries needing high-performance materials (for automotive, electrical & electronic, medical technology, etc.).

For a compounder serving a broad spectrum of industries with materials and with an international orientation complexity occurs due to the fact that compliance with legal regulations as well as industry and application standards on the national level is required which means masses of (expensive) testing and paperwork.

Awards and Publicity

In March 2013 Bada was listed as “Compounder of the Month” by the internationally renowned magazine “Compounding World” [Compounding World 2013].

But Bada already gained publicity and recognition before this.

Its Spanish subsidiary Bada Hispanaplast had been nominated in 2009 as one of the leading companies in the Spanish region Aragon. The company award “Premio Empresa Huesca” honors innovative corporate concepts as well as committed and responsible action in the economic environment [Bada 2009a].

Moving to a new location in close vicinity to the old one a new production hall with the adjacent administration building of Bada was awarded for “its pleasant contribution to the industrial built environment” at the competition of “Exemplary Building 1998-2008” by the Architectural Association of Baden-Württemberg.

Designed by the architect’s office Wurm+Wurm (Bühl), the complex includes the production hall for compounding of raw polymers, the appurtenant storage area, community rooms and the bordering administration building.

Linked coherently to the material flow of the thermoplastic manufacturing and *designed to support internal communication*, the structure of the building complex combines architectural elegance and functional aspects synergistically. Consistent with the sustainable corporate philosophy of Bada, the building possesses an exemplary energy saving concept [Bada 2009b].

The building received a further award, the “Hugo-Häring-Auszeichnung 2011” (by the German Association of Architects, BDA Baden-Baden). Building owner was Bada Grundstückverwaltungs GmbH [Competitiononline 2011].

After the audit of the new facilities in 2007 by the Technical Inspection Agency (“TÜV”), the conformity with the standards of ISO 14001 and EMAS (The European Eco-Management and Audit Scheme) had been confirmed every year after the first audit until 2016.

With this certification Bada was pursuing and implementing a future-oriented strategy: “Economics and ecology are the same sides of a coin” said Chairman of the Board Andreas Schettler. “An enduring company’s business success can only be achieved with an enduring economic activity.” Owing to an intensive preparation by a critical control of the flow of substances and energy in the plant in Bühl the result was positive [Bada 2009c].

The management system optimized to the issues of preservation of resources is able to recognize deviations in the environmental area quickly and the staff can react target-orientated. “Not only the environment but also Bada as company benefits from this certification” explained Schettler [Bada 2009c].

On December 2011 the German Federal Environment Minister awarded Bada AG a certificate for its exemplary operational environmental management. Bada was among 25 German companies that have implemented the environmental management system according to the EMAS European Environmental Audit Regulation and applied for the EMAS Award 2011 [Bada 2012a].

The employers’ association “Chemie Baden-Württemberg e.V.” honored Bada AG with the certificate “Apprenticing Company of the Chemical Industry” in January 2011. It was appreciated that the company takes its responsibility in terms of social policy seriously. For instance, Bada AG was training one student with the course of studying “Business Studies – International Business Administration” (IBA) at the university DHBW at the moment.

Andreas Schettler expressed an optimistic view on training in general. “We need qualified and motivated employees – and we can train them best by ourselves.” Training is an important and strategic task for him, developing future employees [Bada 2011c].

In 2012 Bada also earned this award and again in 2013 and 2014 Bada was honored by the employers‘ association “Chemie Baden-Württemberg e. V.” with the certificate “Apprenticing Company of the Chemical Industry”.

The Entrepreneurs

According to the (German) Commercial Register [Handelsregister] and various Commercial Register abstracts (“Handelsregisterauszüge”) [Moneyhouse] Bada Plast GmbH & Co. KG was founded in Bühl in September 1997 by five (natural) persons: S.K.H. Max Markgraf von Baden, Salem (Margrave/Prince of Baden); Reiner Becker, Karlsbad; Michael Schmidt, Ettlingen; Wiltrud Walter-Strobel, Baden-Baden and Oswin Weiser, Baden-Baden.

The first site of Bada (Plast GmbH & Co. KG) in Bühl was at Industriestraße 9 where also the related Bada Plast Verwaltungs GmbH was located.

In 2003 Bada Plast GmbH & Co. KG was subjected to a legal form changing conversion into Bada AG and in 2005 the associated Bada Plast Verwaltungs GmbH became Bada Holding GmbH [Handelsregister; Moneyhouse].

Concerning the key persons for the foundation of Bada one reads “at the official opening of Bada’s Spanish subsidiary, the five shareholders in the company and several of the members

of the Board of Directors of Bada AG attended"; Oswin Weiser was characterized as a "shareholder and initiator of the creation of the Bada Group" [Interempresas Media 2007].

But obviously, in addition to O. Weiser, also Wiltrud Walter-Strobel played a key role. They were characterized as: "Oswin Weiser y Wiltrud Strobel, impulsores de la creación del Grupo BADA" (Google Translations: Oswin Weiser and Wiltrud Strobel, drivers of the creation of the Group BADA – Oswin Weiser und Wiltrud Strobel, Treiber der Erstellung des Konzerns BADA) [IZ@RO 2013].

The firm's GmbH & Co. KG [2] structure is a special legal form (in Germany and Austria) which is partially comparable with a Limited Liability Company (LLC – GmbH) in the US. In fact it resembles two companies. This legal form of company unites the tax advantages and company law advantages of a corporation and a personal company. The GmbH functions as the general partner of the KG (Kommanditgesellschaft).

For the KG a further founder was listed: the company Bada Plast Verwaltungs GmbH, Bühl which appeared as a "legal person". It acts as a so-called "Komplementär" in the particular legal form. The complementary ("Komplementär") is the personally liable partner of a limited partnership.

The other shareholders (limited partners, "Kommanditisten"), with their capital investment, have only a partial share in outside obligations of the KG. The GmbH functions as the general partner of the KG, which leads to a factually limited outside liability of the entire company unit. The above five founders represent five so-called "Kommanditisten".

The limited partners are only liable with their capital contributions to the company. The limited partner participates in the KG but are only partially liable: The level of its liability is limited to the amount of their share investment.

Management is regularly taken over by the GmbH as the general partner of the KG, which for its part is represented by its own manager. The natural person appointed as the GmbH manager generally also manages the business of the KG.

Bada's basis of foundation concerning polymers and plastics was quite different from that of polyMaterials [Runge 2016], but also different from the majority of new technology ventures.

It relates to a type of founding technology ventures when the founders had already broad industrial experiences in the particular business, had management experiences and were known to customers or even may could keep solid customer relationships (Exiting a Firm to Start in the Same Business) [Runge:306].

Particular cases comprise (experienced) employees who leave a firm because they were unsatisfied with their career development (such as PURPLAN GmbH [Runge:672-673]).

Entrepreneurship by knowledgeable, skilled and experienced employers of a firm may also take the form of a management buyout (MBO), a form of acquisition where a company's existing managers acquire an existing product line or particular business or even the whole company. MBO often refers to a large firm and a management team buys out the business it is managing, as observed for Aluplast GmbH [Runge:309,1196].

Sometimes people also leave a firm and start their own firm because they identified an unexploited opportunity in the field of their corporate activities or simply thought "I can do that better" [Runge:265-266].

In Bada's case a group of people from management left the firm PolyOne Th. Bergmann GmbH located in Gaggenau/Germany rather close to Bühl. It occurred (maybe voluntarily and probably with mutual agreement or unwillingly being forced to leave) after the firm Theodor Bergmann GmbH & Co. Kunststoffwerk KG, Gaggenau, was taken over by the US firm PolyOne Corp. (or

PolyOne Deutschland GmbH, respectively) in 1994 to become PolyOne Th. Bergmann GmbH (for more details cf. also the Competition chapter).

As described later (chapter Competition) the emergence of the US PolyOne Corp. with global reach between 1994 and 2000 did not proceed with company internal frictions.

It is not clear (to the author) whether there were (are) explicit or implicit non-compete covenants between Bada and PolyOne Th. Bergmann GmbH.

Basically, Bada's foundation process corresponds to a "management walk out" (MWO) and, in fact, is a form to start up – perhaps like "running a (computer) startup" executing predefined settings and operations – but the complications and possible legal implications should not be underestimated. For the firm which loses key people it is often hard to deliver when the key team (management or technical) has gone.

The to-be entrepreneurs or innovators proceed directly to exploiting the given (known) opportunity based on a particular personal conviction, intention and decision reflected often by an "*antagonistic attitude*" in terms of "I can do that better, cheaper, simpler, more specific, … differently (substitutive), … also (me-too)."

This means, for the opportunity there is a knowledge base that is available or can be accessed and used and a market as the basis for the decision to found a firm. This leads usually to competitive antagonism, originally called "competitive aggressiveness" [Runge:264-266,1030].

A rather recent MWO was related to the US firm HP [Kobie 2012]. In 2011 HP bought the British software firm Autonomy for $10 billion. When HP announced it was slashing 27,000 jobs globally it included that of Autonomy CEO Mike Lynch. His departure was not the first among Autonomy's senior management, with CFO Steve Chamberlain, president and head of sales, Sushovan Hussein, CTO, Pete Menell, COO, Andy Kanter, CMO, Nicole Eagan and Martina King, the head of the virtual reality project Aurasma. All leaving was within a few weeks. The firm's head of legal and several regional sales chiefs also departed. It was said that the departures are borne out of frustration with the new parent company, saying it was "exceedingly difficult to get anything done" with HP. It appeared it was "HP bureaucracy that caused most of the management team and many of the top developers to walk in the last few months."

S.K.H. Max Markgraf von Baden, Salem (Prince/Margrave of Baden) (H.R.H. – His Royal Highness) seems to be exceptional from the other Bada founders. All other founders have a business administration (BA) degree or in businesses were active in BA-oriented functions; no one has a technical education or degree (Table 1).

According to (the German) Wikipedia Maximilian Andreas Markgraf von Baden, also called Max von Baden (born Jul. 3, 1933 in Salem) was a German entrepreneur and since 1963 Head of the House Baden (the Dynasty of Baden). He was also owner of the wineries of the Margrave ("Markgrafschaft").

Since 1998 his son Prince Bernhard became plenipotentiary ("Generalbevollmächtigter") of his father (Max Margrave of Baden) and also Head of the business of the House Baden [WiWo].

As Prince Max of Baden was deeply in debt he started in 1994 to sell his art treasures and art collections, company branches and giving up castles [SDR 1995; WiWo]. In this context, to pay off debts, Prince Max sold his plastics company Theodor Bergmann at Gaggenau – according to statements of Oswin Weiser, then CEO of Theodor Bergmann [SDR 1995].

The firm being located in Gaggenau at the Northern Black Forest ("Schwarzwald") and originally focusing on "wood businesses" was acquired in 1926 by the industrialist Theodor Bergmann who sold it in 1937 to the Princes of Baden. A switch from wood (essentially matchstick fabrication) to producing plastics started in the 1960s, essentially as a contract manufacturer [BNN 2016].

In 1994 they sold the company to the globally operating US firm M.A. Hanna (which through a merger with Geon became PolyOne Corp. in Avon Lake, Ohio). PolyOne had ca. 7,000 employees and made €3.8 billion in 2014 [BNN 2016] (cf. the Competition chapter).

In the context of competitive antagonism it is notable that Margrave Max obviously used part of the capital obtained by the sales of the firm Theodor Bergmann GmbH & Co. Kunststoffwerk KG, Gaggenau to infuse capital into the foundation of the nearby located Bada Plast GmbH & Co. KG. Though maybe accidental it is striking to see that the same legal form (GmbH & Co. KG) was used for the startup Bada Plast.

Reiner Becker (Karlsbad/Germany) was characterized as a banker ("Bankkaufmann") or bank manager ("Bankdirektor") in official documents (of the Amtsgericht Mannheim) or online Moneyhouse documents. Reiner Becker was affiliated with the Volksbank Baden-Baden Rastatt eG (a cooperative bank) since November 1995 (attribute executive director – Geschäftsführer) and before with the actionade Immobilien & Versicherungen GmbH which was (is?) related to the Volksbank [Moneyhouse – Becker].

Characteristics of the three remaining founders of Bada are given in Table 1 together with data concerning their MWO from Theodor Bergmann GmbH & Co. Kunststoffwerk KG. Additionally also information on Andreas Schettler is shown who later also left Polyone Th. Bergmann GmbH to take over a leading position in Bada AG.

Actually the development of Bada until the end of 2004 looks like a "phased MWO": Andreas Schettler occupied a leading position ("Prokura") in Polyone Th. Bergmann GmbH to take over ultimately the CEO position in Bada.

Bada's leadership/management team was rather stable since 2005 including founders and just adding Andreas Schettler by the end of 2004. The leadership team was already rather old on foundation. And now nineteen years after foundation they are still active and in charge. This is also true for the Supervisory Board.

The current management of Bada AG is given by the Firmenwissen database as follows:

Oswin Weiser	Prof. Dr. Franz Brandstetter	Heinz Brachten	Andreas Schettler	Michael Schmidt
Chairman of the Supervisory Board	Supervisory Board	Supervisory Board	Chairman of the Board of Executive Directors, CEO	Prokurist
		Further affiliations:	Bada Grundstückverwaltungs GmbH, Bada Holding GmbH	Bada Grundstückverwaltungs GmbH

The average age of technology entrepreneurs in the US and Germany is 40 years, often meaning that they served several years as employees with other companies. A specific reflection of this situation is seen in the biofuels fields where the notion of "veteran technology entrepreneur" was introduced to characterize entrepreneurs or a "veteran management team" having members with 45+ years of age and with 15+ years of experience in relevant industry [Runge:298].

Table 1: Characteristics of three (of five) founders of Bada Plast GmbH and its current CEO, their residence, birthday or year of birth, and education/academic degree [Moneyhouse; Handelsregister] *).

Affiliations and Functions or Roles	Oswin Weiser (born 1937) Baden-Baden; Academic degree: Dipl.-Kfm. – BA	Wiltrud Walter-Strobel (born Oct. 15, 1940) Baden-Baden; Academic or educational degree: described as "Kauffrau" – businesswoman [3]	Michael Schmidt (born Nov. 1, 1959) Ettlingen; Academic degree: ?; Acts currently as Leader BWL (BA) of Bada AG	Andreas Schettler (born Nov. 22, 1960), Bühl; Academic degree: Dipl.-Betriebswirt (FH) – BA
Theodor Bergmann GmbH & Co. Kunststoffwerk KG	Before 1994 Executive Director [SDR 1995; Moneyhouse]	Jun. 1991: Authorized Officer, Jointly held Prokura NOTE 4, (Gesamtprokurist), Jan. 1995 individual Prokura, (Einzelprokurist)	Jan. 1995 Authorized Officer, individual Prokura, (Einzelprokurist)	
Hanna Deutschland GmbH → PolyOne Deutschland GmbH	Dec. 1994 Executive Director with Henry Garth, Cleveland, Ohio,			
Theodor Bergmann Kunststoffwerk GmbH → PolyOne Th. Bergmann GmbH	Jan. 1995 till Jan. 1998 Executive Director of PolyOne Deutschland GmbH (previously Hanna Deutschland GmbH)	Jan. 1995 individual Prokura (Einzelprokura) Jan. 1998 individual Prokura canceled	Jan. 1995 individual Prokura Jan. 1998 Prokura canceled	May 2002 – Nov. 2004 Authorized Officer, individual Prokura (Einzelprokurist); Dec. 2004 Prokura cancelled
Bada Plast GmbH & Co. KG	Sep. 1997	Sep. 1997: Authorized Officer, individual Prokura	Sep. 1997	
Bada Plast Verwaltungs GmbH → Bada Holding GmbH		Jul. 2005 Executive Director (Jun. 2005 Executive Director Bada Grundstückverwaltungs GmbH)	Jul. 2005 no longer Executive Director (Jun. 2005 Executive Director Bada Grundstückverwaltungs GmbH)	Jul. 2005 Executive Director (Jun. 2005 Executive Director Bada Grundstückverwaltungs GmbH)
Bada AG	May 2003 Executive Director, Chairman of the Supervisory Board	May 2003 Board of Executive Directors	May 2003 Board of Executive Directors	Nov. 2004 member of the Board of Executive Directors, Chairman of the Board, CEO

*) For more details cf. Competition chapter.

Remarks Concerning Corporate Culture

Compound development is still largely an empirical process. Hence, it is essentially associated with the employees running research and development of compounds and experiential knowledge ("Erfahrungswissen") and tacit knowledge. Sharing these is the important basis for problem-solving and development of a firm. This requires implementing and keeping the related corporate culture which motivates the employees to stay with the company.

Often satisfactory solutions with reasonable effort can be found as long as the new requirements are within the limits of existing experience. Expanding into new areas outside prior experience requires a huge number of experiments, if done in a systematic way. Examples are adjusting the properties of an existing compound for a new application or replacing a component because of regulatory issues, or integrating new materials, such as biogenic polymers because of customer demand.

As a response to such issues by polyMaterials AG a high throughput screening, combinatorial experimentation and mathematical Design of Experiments (DoE) for planning and development of polymer compounds and blends emerged as polyMaterials' "X-Plorator® Technology". Very complex experimental plans can be handled with it, and often predictive mathematical models can be created for systems of thermoplastic compounds and blends [Runge 2016].

Corporate policy of a company is interwoven with features of corporate culture as it also specifies required personal features and personalities and employees' interactions to achieve the firm's goals. Therefore, we extracted some characteristics related to corporate culture from Bada's corporate policy document [Bada – Corporate Policy].

Fundamental for Bada's operation as a service organization and its employees is *customer-orientation* and *quality-orientation* (cf. customer-driven *versus* customer-oriented [Runge:450]).

The future of the company is predominantly determined by its ability to *understand customer requirements*, to fulfil them completely and to be a predictable partner. This translates into *communication skills* of Bada's employees with the developers and design engineers of *customers* and *end users*.

Communication skills are also needed to provide advice, consulting and instructions as services. Concerning application technology for customers at home and abroad, materials are usually developed in local facilities specifically according to customer requirements. Technical characteristics are tested and Bada's engineers and developers further advise customers technically on the telephone or on the spot, visit customers, carry out material analyses, etc.

Challenging applications and the use of customized special compounds require intensive preconsulting and continuous interactions.

The diverse requirements of Bada's cross-sector customers are challenges which are to be addressed using individual in-depth know-how of Bada's employees as well as their communication to achieve together problem-solving.

A cooperative partnership with *suppliers* is also an essential success factor in a world of constantly changing raw materials conditions. Therefore, the development of supplier relationships (communication!) and the optimal selection of raw materials is a crucial competitive advantage Bada intends to benefit from.

Bada's aim is to provide its customers with the best possible support and the optimal product in combination with the most *flexible supply chain*.

For all business activities and behavior environmental awareness and protection, the prevention of ecological damage and the conservation of resources, are to be striven for.

"The prerequisite to reach these ambitious goals is *competent and motivated staff*. We want to *provide our employees with a save business environment that leaves room for development* for the benefit of the company. In our opinion, long-term commitment and an *open, communicative* working environment are synonymous with *innovative thinking and action*. We intend to advance our company with the help of our employees' numerous good ideas."

Regular discussions with employees establish effective relationships with supervisors and can form the basis of employee development (and career) [Your Chemistry Career].

It is a key element of company policy to *protect company know-how and personal data* of the customers, employees and business partners as well as protecting related data/information from unauthorized access and illegal use or falsification, which is documented by Bada's external data protection.

"*Continuous improvement*" for all activities and production is (should be) the mindset of the all the employees: "Continuous development of our products, know-how, processes, and organization based on methods for steady improvement guarantees our future success. It is the company that is ready for improvements and willing to improve that can seize the chances offered by *ever more rapidly changing markets*."

To look into (Internet) reports of assessing Bada as an employer one finds just one reference [Kununu 2016] and this has to be used very cautiously. It provides at best a rough indication concerning corporate culture if one refers to opinions of just three (previous?) employees. These provided an average assessment of 3.90 (of 5.00) for the firm. Below are listed features with the highest scores. And there is one summarizing statement: "Short distances, fast decision-making and implementation possibilities, innovative products, good operating climate."

Working		**Career**	
Cohesion of colleagues	4,00	Dealing with Colleagues	4.33
Interesting Tasks	4.33	Career / Continuous learning	4.00
Working atmosphere	4.33	Salary and fringes	4.00
Communication	4.00	Environmental and social awareness	3.67

Overall this seems to corroborate what is seen by management as relevant for Bada's corporate culture; employees seem to have internalized the corporate culture.

A particular positive comment about Bada's corporate culture was made by visitors at the FAKUMA 2012 fair: Andreas Schettler was especially pleased about the particular statement on the firm that "you can feel that people enjoy working for Bada." [Bada 2012b].

"Our customer's high expectations and an increasingly complex market environment require maximum flexibility with regard to the development of highly customized solutions as well as product development, delivery service, and customer support. Reliability to our customers is our highest priority in times of a continually changing business environment."

Business Idea, Foundation and Product and Service Developments

The present chapter covers the first twelve years of Bada's existence (until the end of 2009) which is a (rather formal) threshold of regarding Bada as an NTBF (New Technology-Based Firm) [Runge:16] before becoming a small or medium-sized enterprise (SME) [Runge:19]. This time period covers the Dot-Com Recession (March 2001–Nov 2001 in the US) and the Great Recession (Dec 2007 – June 2009 in the US) and, hence, covers also that and how Bada "survived" these economic crises to then enter into its very successful further development path (chapter on Vision/Mission …).

Bada's basis of foundation concerning polymers and plastics was quite different from that of polyMaterials [Runge 2016], but also different from the majority of new technology ventures.

As described above Bada's foundation in Bühl corresponds to a "management walk out" (MWO) – when a group of people from management left the firm PolyOne Th. Bergmann GmbH located in Gaggenau/Germany rather close to Bühl. It is based on "activity- and subject-related experiences" of the founder team and characteristics of "start over entrepreneurs" [Runge:306].

Functionally rather similar and famous is the "William Shockley case" (Physics Nobel Prize Winner) when eight employees, the "Traitorous Eight", left the firm Shockley Semiconductor and later some of them played a key role in the foundation of Intel Corp. This was a "*knowledge walk out*" of six or more persons leaving an existing firm to generate a new independent business based primarily on scientific and technical knowledge and experience [Runge:632].

Figure 1 (cf. also Table 1) outlines the structural relationships between Bada Plast's founders and other relevant persons and involved organizational units established during the firm's development until 2005.

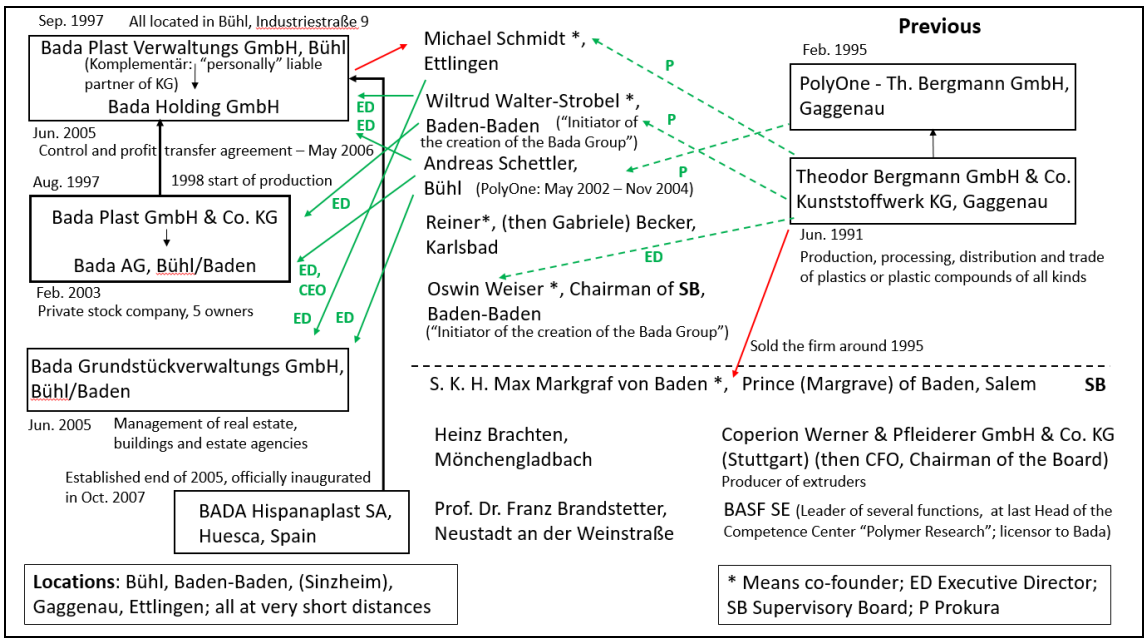

Figure 1: Bada's foundation and company and management structure (until early 2007) by a network of people knowing each other and exiting a firm to start in the same business by MWO (Red: out of a firm or function; solid green: into a function in Bada, dashed green: affiliation and function with PolyOne).

Why there was an MWO from PolyOne Th. Bergmann GmbH to found Bada Plast is not obvious to the author – voluntarily or inunwillingly.

After foundation Bada Plast entered the market immediately with a relatively high level of production. It started production in 1998 announced as an engineering materials and TPE (thermoplastic elastomers) compounder with a just-in-time capability for special grades. Production capacity was around 9,000 tons per year [British Plastics & Rubber On-Line 1998].

The range of products included [British Plastics & Rubber On-Line 1998]:

- Polyamides PA 6, PA 66 and co-polyamides PA 66/6, under the Badamid® brand name
- Polybutylene terephthalate (PBT) as Badadur®;
- SEBS and SBS thermoplastic elastomers (TPEs as Badaflex® (SEBS – Styrene-Ethylbutylene-Styrene, SBS – Styrene-Butadiene-Styrene)
- Badaform® consisting of thermoplastic construction materials based on the polyoxymethylene (POM) copolymer.

Structures and nomenclature for aliphatic and aromatic polyamides (PAs) are outlined by Runge [2016:61,Figure 36].

This products' portfolio was very similar to that offered by PolyOne Th. Bergmann GmbH and its Spanish sister company Polibasa Poliamidas Barbastro SA (in the Huesca province). Later (in 2006/2007) Bada established also its foreign subsidiary in the Spanish province Huesca (Bada Hispanaplast SA).

Between Bada and PolyOne Th. Bergmann GmbH brands of products there were (are) also close correspondencies: Badamid® – Bergamid® (PA), Badadur® – Bergadur® (PBT), Badaform® – Bergaform® (POM) [Kompass].

All this looks like distinct *competitive antagonism* ("competitive aggressiveness") of Bada [Runge:507,264-266].

Bada Plast's development seemed to proceed positively. An indication is that the founders, four of them except Michael Schmidt, increased their shares in the company considerably in January 1999 [Moneyhouse] (cf. sub-chapter on Financing).

In 2000 Bada Plast organized its product distribution, for instance, via the firm WOBATEK Kunststoffvertriebs GmbH which was founded in July 2000 in Sinzheim/Germany, close to Baden-Baden and Bühl. WOBATEK became an official trade representative in *direct sales* for Bada in the area of compounds. It is still distributing Bada products. It simultaneously also acted as a distribution partner for Huntsman TPUs (thermoplastic polyurethanes) [WOBATEK].

Furthermore, Bada Plast (as also PolyOne) utilized rather early an electronic market place as a marketing tool to offer their products, to gain visibility and to support e-procurement via the Internet for their customers. Many of these online stores (e-commerce platforms) entered the scene during the period 1998-2001, such as Omnexus. One of these platforms was Polymerce which had also a German user interface (founded in April 2000, being online in October 2000 addressing the European plastics industry) [Canic 2001].

In October 2001 BASF's business unit Engineering Plastics Europe formed a production and marketing alliance with the thermoplastics and elastomers company Bada Plast for BASF's specialty grades of Ultramid® (PA) and Ultradur® (PBT) thermoplastic engineering resins [Ong 2001; Maschinenmarkt 2001; Chemie.de 2001].

Accordingly Bada would independently market small-volume specialties as licensed products of BASF in Europe [Chemie.de 2001].

Bada gained the right to market specialty grades to non-bulk purchasers. The license included existing approvals and existing listings (for instance, UL – Underwriters Laboratories) to continuously remain valid. This provided for Bada constantly a potential for new applications and customer acquisitions. BASF said that this alliance will enable it to maintain its strong presence in the low-volume, specialties segment of the market [Ong 2001; Maschinenmarkt 2001; Chemie.de 2001].

This may have shown Bada rather early *serving the low-volume part of a market segment* to provide a business opportunity.

UL provides safety-related certification, validation, testing, inspection, auditing, advising and training services to a wide range of clients, including manufacturers, retailers, policymakers, regulators, service companies, and consumers. [5]

For instance, before electrical products in North America (USA/Canada) may be introduced into the market, they must be checked for possible hazards in terms of flammability, the electric shock and some equipment on electromagnetic compatibility and must have been specifically allowed: They need certifications. Therefore, application, dielectric strength, upper limit temperature and flame resistance are the essential elements of the UL approvals.

In particular the license with BASF referred to Badamid®L specialties for production and sales in Europe differentiating, for instance,

- Badamid LA
- Badamid LB
- Badamid LC.

At the same time, both companies would respect the adjustment of colors for polyamide (PA) and polybutylene terephthalate (PBT) and work more closely together. Through this cooperation, BASF can offer specific solutions to customers in small quantities and also special colors. Ultramid (PA) and Ultradur (PBT) were (are) the two largest volume representatives of BASF's engineering plastics [Ong 2001; Chemie.de 2001].

They are used for example in automotive engineering and electrical engineering, where high-strength materials are required, in addition to excellent mechanical properties, also heat resistance, chemical resistance and high dimensional stability – in the case of PBT [Chemie.de 2001].

Despite the probable competitive situation with PolyOne Th. Bergmann GmbH Bada Plast was developing obviously smoothly into a stable state in the clandestine, meaning that there are very few data and information about this period publicly available.

For its first years of existence one can speculate that Bada Plast may had another relationship with BASF via the firm Dr. Wolman GmbH in Sinzheim next to Bühl (founded in 1911 by wood preservation pioneer Dr. Karl Heinrich Wolman), one of the world's leading companies in the wood preservation industry including fire protection. It was taken over by BASF in 1980 and in 2014 it was renamed to "BASF Wolman GmbH". It belongs to the BASF business "Building and Construction" unit and has ca. 130 employees [BASF 2014].

Bada's relation to BASF Wolman may be reflected by Bada's diverse spectrum of served sectors including the automobile, electronics, sport and leisure, *construction, furniture-making*, medical technology and household goods industries since 1998.

BASF Wolman GmbH produces and distributes high-performance wood preservatives for industrial use to protect wood against wood-destroying fungi and insects. The product portfolio focuses on wood preservation solutions for the impregnation of external timber (such as boards, pylons), timber, and the temporary protection of cut wood (for instance, pallets) [BASF 2014].

Related contract reworking ("Lohnumarbeitung") for BASF appears to provide a rather constant source of revenue. But it is not known to what extent this contract reworking contributed to the overall revenue of the firm.

There may have been a further aspect for Bada Plast to be interested in BASF. BASF is among leading suppliers, manufacturers and innovation partners of plastic additives – used for compounds.

In Figure 2 the early established relationships of Bada with BASF are displayed. In addition to the licensing deal Prof. Brandstetter of BASF to become a member of the supervisory board of Bada AG in 2003 was important – the relationships to BASF Wolman GmbH in Sinzheim are speculative.

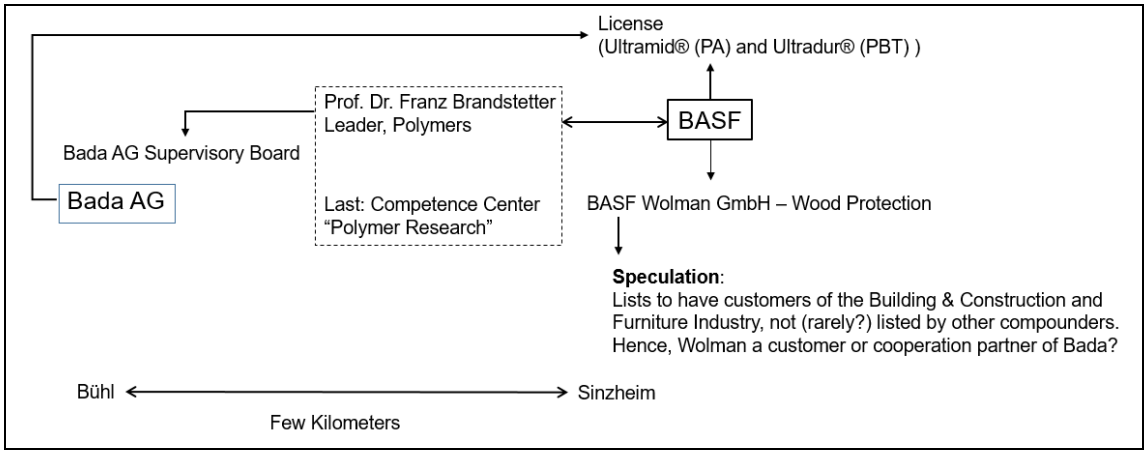

Figure 2: The role of BASF for the development of Bada Plast/Bada AG.

Apart from unknown effects of the global Dot-Com Recession (March 2001–Nov 2001 in the US), at least after 2002 (Table 5) Bada Plast could utilize economically favorable conditions until 2007/2008, until the worldwide Great Recession (Dec 2007 – June 2009 in the US).

In 2009 Bada existed for twelve years keeping its founders. Existing for twelve years is used as a (more or less formal) criterion to limit a firm to be called an NTBF (New Technology-Based Firm) [Runge:16,588].

For Bada Plast/Bada AG there was a seemingly rather regular growth in terms of production capacity. In ten years of its existence Bada doubled its production capacity in Bühl to 18,000 tons per year in 2007 running six extrusion lines with partly mega-compound equipment [Bada Web – 2006].

On the other hand, after change of its legal status from Bada Plast GmbH & Co KG to a private stock company Bada AG in 2003 regular information on the firm appeared in the public.

> In November 2004 Andreas Schettler left a leading position ("Prokura") in PolyOne Th. Bergmann GmbH which he held since May 2002 (Table 1) to hire at Bada AG and joined the Board of Executive Directors and later took the role of Chairman of the Board, which means CEO [Moneyhouse; Handelsregister].

With the establishment of Andreas Schettler in December 2004 as Bada's CEO, responsible also for Marketing and Distribution, some significant changes with Bada AG occurred. It was Andreas Schettler, still Bada's CEO in 2016, who emerged as a leader shaping successfully the subsequent development of the firm.

In June 2005 Bada Plast Verwaltungs GmbH (founded in September 1997) became "Bada Holding GmbH" with a share capital ("Stammkapital") of €1,222,450.00. Wiltrud Walter-Strobel and Andreas Schettler became Executive Directors. In July 2005 Michael Schmidt gave up his job as Executive Director of Bada Plast Verwaltungs GmbH [Moneyhouse; Handelsregister].

In May 2005 Bada Grundstückverwaltungs GmbH (Bühl, Industriestr. 9) was established with Michael Schmidt and Andreas Schettler acting as executive directors. The purpose of the company is to hold and manage real estate and provide rental and leasing service (letting). [Moneyhouse; Handelsregister] – particularly vis-à-vis Bada AG (Table 1).

A *groundbreaking future strategy for further development* of the Company was adopted in spring of 2005. Accordingly the decision was made to set up a completely new plant at its headquarters in Bühl – the new location (Bühl, Untere Strut 1) was in the vicinity of the old one. Building owner was Bada Grundstückverwaltungs GmbH [Competitiononline 2011].

Within the next two years the company would build new production facilities and an administrative block on a green field site in the Bussmatten industrial area, with a property covering

approx. 21,000 m² and sufficient space for the future company expansion. Besides the building structure, the machine park would also be upgraded to state-of-the-art standard [Bada 2005a].

The official inauguration celebration of the new Bada building in Bühl was on 20 July 2007, marking the company's 10 year anniversary.

In 2007 Bada realized the complete new plant with administration and production. The centerpiece is a new system for feeding the extruders and for bottling the granules. An optimal infrastructure, efficient processes, latest process technologies and the ability to expand the supply of materials at any time – these were the requirements for the system designer [Sonntag 2008].

For the new factory it was logical that then both proven and newly modelled processes be subjected to critical examination. As early as April, the Rhineland Technical Inspectorate (TÜV Rheinland) gave its OK. The management system of Bada AG also fulfiled all requirements of ISO/TS 16949 in the new environment [Bada 2007b].

In October 2007 Adrian Zanki joined Bada's management team as a Technical Director. He had a jointly held Prokura ("Gesamtprokura") and later received an individual Prokura. Mr. Zanki left Bada in May 2011 [Moneyhouse; Handelsregister].

Improvements in productivity and further optimization of the entire process sequences determined decisively the year 2008 [EB 2008].

> Basically, according to Michael Schmidt [PWC 2007], Bada was not interested in acquisitions, but would *develop through organic growth* [Runge:681-682].

In November 2005 a *foreign subsidiary located in Spain* in the province Huesca was founded as Bada Hispanaplast SA. This mirrors the constellation of PolyOne Th. Bergmann GmbH which also has a sister company in Spain in Huesca (Polibasa Poliamidas Barbastro SA).

Polibasa Poliamidas Barbastro SA serves the Spanish, Portuguese and North African markets, as well as the specialties required by customers of the German PolyOne firm. Another reason for the capacity expansion was the continuing buoyant demand by the Spanish automobile industry for customer-specified engineering plastics grades [Plasteurope 1996].

Following the Bühl headquarters' decision to embark on the building of a completely new factory, the foundation of Bada Hispanaplast represented the next decisive stage in Bada's strategic planning [Bada 2005b].

The Iberian Peninsula as the fourth largest market for engineering plastics in Europe and the excellent location of the site for the development and expansion of market presence were the basis to be active here. Initially, it acted as a pure distribution and sales company of products which were produced centrally in the main factory in Bühl [Bada 2005b]. After about one and a half year (end of 2007) the production of compounds could start in Spain.

Bada Hispanaplast SA, with a planned capacity of 9,000 t/a. was officially inaugurated in October 2007. The same standards as for the German factory apply to the production facilities in Spain: The plant fulfils the highest technological requirements. Here, too, a laboratory with advanced equipment permits the flexible, innovative realization of all required customer applications utilizing an area of 2,700 m^2. Bada Hispanaplast's proximity to the French border brings further valuable benefits to the export business [Bada 2007a].

Bada Hispanaplast was dedicated to the production and marketing of thermoplastics. In the Huesca factory, Bada will produce the same products as in Germany (with some exceptions) but also will serve as a center of production and distribution for Southern Europe, North Africa and in the future, to South America [Interempresas Media 2007] and other regions, such as China and India [IZ@RO 2013].

For the creation of Bada Hispanaplast in Huesca €4 million had originally been invested. It employed 30 workers in 2007. By the end of the year, the company planned to produce 3,000 tons [Interempresas Media 2007].

In 2007 there was the move into the new Bada plant in Bühl. And in 2007 the Bada Group put two of the most modern compounding works in the world into operation and had a production capacity of around 24,000 t/y. In 2009 it generated net sales of approximately €40.8 million, in 2010 it generated net sales of approximately €62 million [Bada Company].

Scalability of Bada's business covers several dimensions, essentially ("standard" and customized) compounds, but also blends and services:

- Volume/mass (increasing level of production)
- Increasing performance of existing products and/or adding color (for given customers)
- General and specific colorization of compounds (for instance, industry-specific for medical technology or release of automotive paint including Daimler, BMW and SEAT, provide comprehensive color approvals [Bada 2012j]
- Increasing the number of customers for existing products and markets
- New applications of existing products; new customers from different markets or industries
- New types of compounds; new brands
- Providing UL lists for standard products or organizing these for customized products.

Bada followed a *strategy of continuously developing new offerings* for their customers. In 2005 it succeeded in expanding its product range by two branded product families. Novelties in the product range were colored and modified ABS specialties, which are marketed under the brand name "Badalac® ABS", as well as thermoplastic elastomers based on EPDM/PP-blend under the brand name "Badaprene® TPV" [Bada 2005c; K-Zeitung 2007].

At the FAKUMA 2005 (Internationale Fachmesse für Kunststoffverarbeitung, Friedrichshafen/ Germany; International Trade Fair for Plastics Processing) Bada was presenting a wide range of tailor-made specialties based on its Badamid® brands (PA 6, PA 66, PA 66/6), Badadur® (PBT) and Badaflex® (TPE-S) and through BASF licensing Ultramid® specialties [Bada 2005c]. Thermoplastic elastomers (TPE) were based on styrene-block-copolymers (SEBS, SBS) [Bada 2005c].

During the FAKUMA 2006 as a novelty the technically interesting high-temperature polyamide Badamid® T was presented. It is a specialty based on a polyamide PA 6/6T (partially with aromatic constituents), which is particularly characterized by a high melting point (295 °C) and high mechanical properties.

The special advantage of Badamid® T lies in the fact that the mechanical properties remain constant even after moisture absorption up to 60 °C, whereby the processing is as good as polyamide 6 or 66. Badamid® T can be prepared with various modifications, for instance, flame retarding, dyed/colored and provided with various reinforcing materials [Bada 2006].

Badamid® T has excellent heat resistance. Therefore, this plastic resin is the perfect material for high strained components in the automobile and electrical & electronic industries [Bada 2008a].

The launch of "Badalac® ABS" and "Badaprene® TPV" based on polypropylene/ethylene-propylene-diene-monomer (PP/EPDM) rubber was in advance of the K 2007 Fair (Düsseldorf, Germany). EPDM rubber is a terpolymer of ethylene, propylene, and a diene-component.

In 2007, for the first time in the history of the company, Bada participated at the international exhibition event in the plastics industry K 2007 (in Düsseldorf/Germany), being confronted with a wide trade public from all over the world. The outcome at the end of the day was extremely

positive. In particular, international contacts to existing customers and new potential customers from all over the world promised further expansion in export activities which so far were top of 30 percent [Bada 2007c].

During the first ten years of its existence to a certain degree Bada's development exhibited a kind of *path-tracking*, the path being an analogy to operations of PolyOne Th. Bergman.

In 2008 there were various high-performance and high-temperature compounds in the development phase for a large number of very technical applications. The highly temperature-resistant PA 6/6T (Badamid® T) had already successfully completed its market launch [EB 2008].

In 2008 Bada introduced Badatron® PPS (polyphenylene sulfide) as its latest high quality thermoplastic resin. Its outstanding combination of thermal, mechanical and chemical durability offers this material a wide range of applications. Bada offered this material in high quality, modified individually to every customer's demand [Bada 2008e].

Bada attended the FAKUMA Fair 2008 for the seventh time and presented some interesting news. These included among others blends based on diversified polymers, such as PC/ABS-, PC/PBT-, PBT/ASA-, PBT/SAN and PA/ASA-blends. All these blends can be modified and colored according to customers' individual specification [Bada 2008b].

And concerning the Spanish subsidiary Bada Hispanaplast participated at the plastics specialist fair Equiplast 2008 in Barcelona, Equiplast– International Plastics & Rubber Exhibition. It took the opportunity to introduce itself to the international public on a big platform [Bada 2008c].

"The FUKAMA 2008 was a great success for our company. We were able to meet lots of interesting new business partners and started numerous promising projects." [Bada 2008d].

However, as also observed for polyMaterials, the impacts of the Great Recession (Dec 2007 – June 2009 in the US) started to emerge: 2008 showed a cyclical development in the economy as a whole, which was characterized by a booming start of the year over a steady weakening of demand in the course of the year and an abrupt decline in demand in the domestic and export business in the last quarter [EB 2008].

The beginning of the year 2009 was marked by an extreme weakness in demand in all sectors and markets. Due to a very high inventory level among most customers, the normalization period continued into the summer. Overall, a decline in business in the range of 20 to 30 percent was observed relative to the pre-crisis level in mid-2008 [EB 2009].

In the first half of the year, by strict cost control and flexible production conditions, order cutbacks could be neutralized. By deliberately refraining from short-time work or similar instruments, production readiness and short-term response to customer demand were possible, which generated some additional business. In addition, especially by export, orders' volume was obtained in some markets, which were responsible for the relief and a constant good liquidity [EB 2009].

In the second half of the year, the situation improved notably through the positive effect of many new customers and projects which had developed and were sampled in previous years [EB 2009].

However, as a result of the global economic crisis, in the year as a whole Bada recorded a drop in sales of just under 20 percent due to orders received (Table 4, Table 6) [EB 2009].

Despite economic tough conditions Bada kept on expanding its successful product line Badaprene® TPV. Badaprene® TPV as a thermoplastic vulcanized rubber combines the benefits of traditional elastomers with the excellent processability of thermoplastics [Bada 2009f].

In particular, Bada developed a technique to colorize Badaprene® TPV in every possible shade and also to produce it as a two-component-type. “We achieved a maximum of process and quality reliability, in order to fulfill our customers individual demands”, said Chairman of the Board Andreas Schettler.

Its outstanding qualities assure Badaprene® TPV a wide range of applications in the automobile, engineering, electronics, building and leisure industries.

Despite the economic crisis in 2009 there was investing in a further production line which supports the goal of a highly efficient and flexible production [EB 2009].

New types of TPEs had been added to the successful product line Badaflex®. Bada offered TPEs also on the basis of polyester and polyether. These high quality materials go by the name Badaflex® TPE-E and combine the positive properties of rubber with the easy processability of thermoplastics [Bada 2009g].

Badaflex® TPE-E offers outstanding qualities for a wide range of applications, especially in the automobile, engineering and equipment manufacturing industries, for instance, for surface treatment of metals for noise reduction. Bada developed a technique to provide this resin tailored individually to the customers’ demands, quickly and flexibly.

Bada introduced also Badaflex® TPU which is a thermoplastic elastomer based on urethane copolymers. Laser marking ability, individual coloration and viscosity are just a few of the possible modifications that were produced by the modern compounding systems of Bada [Bada 2009h].

Badaflex compounds reflect lucidly, how product development of Bada over years strives to cover a type of compounds by filling gaps or unmet needs concerning applications and particular properties [Bada 2014d].

As flexible as rubber and still processible like a thermoplastic: This is what thermoplastic elastomers are generally known for. Badaflex TPE, however, has much more to offer, because the Badaflex product line provides the adequate solution for nearly every demand in the field of soft plastics. For instance, one encounters over time

- A Badaflex TPE-S dyed in any color, for instance, used for handles or gaskets, or a Badaflex TPU for highly abrasive applications.
- Badaprene TPV as the best option for prefabricated components with extremely favorable compression sets at higher temperatures.
- Badaflex TPE-E used for high-temperature applications up to 135 °C (sometimes even more) in fields where other soft plastics cannot be applied. In addition, it is the option for parts with alternating bending load.
- Material types with a very smooth surface structure particularly for extrusion applications.
- Both TPEs reduce odor; Badaflex TPE-S types for applications in passenger compartments and V-O flame retardant injection molding types with UL listing (all colors) are available in many color shades.

Flame (also called fire) retardancy as a property of materials represents a typical case for the complexity of development constraint by regulations. Electrical and electronic (E&E) applications – including housings, wire and cable, and internals such as connectors – are the largest market for flame retardants (FR) in plastics globally [EU 2013].

Flame retardant plastics is also an interpart of railroad traffic. Unlike the electrical industry, rail transport has its own, usually much more complex, standards. In addition to fire showing up and progress there are also evaluated the quantity and quality of the produced gas. A train is separated into hazard classes [Bada 2012l]. For instance, a standard EN 45545-2 classifies the different railway applications and areas according to so-called hazard levels focusing on to

what extent a passenger is prevented from leaving the train by gas, smoke and spreading flames [Bada 2015g].

Thus a supplier to the railroad serving the German market needs other approvals than for a product which is delivered to France, England or Italy. Therefore, it is desirable to obtain product approvals for several markets.

Classic flame retardants contained halogen or red phosphorus. And reduced halogen and halogen- and phosphorus-free flame retardants determined in many areas further developments. Halogen-free flame-retardant PA 12 with glass fiber reinforcement was possible [Bada 2010b; 2012h].

But there are still very many applications which only function as halogen-containing flame retardants. In addition, commercial aspects are added which make the use of halogen-containing flame retardant systems necessary. Therefore, Bada developed a new flame retardant package which significantly reduces the usual amounts of halogen-containing flame retardants [2012m].

Financing and Organization

According to Bada [Bada – Corporate policy]:

- Bada is constantly facing fierce international competition.
- A secure financial basis and a profit-oriented strategy are the prerequisites for the investments required for a sound future growth.
- Furthermore, Bada's development will proceed through organic growth [PWC 2007].
- The variety of principles and values of Bada requires a well-structured, flexible and successful organization [Bada – Corporate policy].

Financing

Foundation of the firm Bada Plast GmbH & Co. KG and its financing are closely interrelated as the foundation was established by the five founders (natural persons) listed in the chapter on Entrepreneurs, whereas the KG part was occupied by the *legal person* Bada Plast Verwaltungs-GmbH as an organizational mean.

For the startup of the venture in August 1997 each one of the five founders ("Kommanditisten") contributed the same amount of share capital, DM300,000 (2 DM ≈ 1 Euro). This was enhanced in January 1999 to DM500,000 by four founders (except Michael Schmidt).

Finally, after the change from the Deutschmark (DM) currency to the Euro and further small amounts of added money the following amounts of share capital ("Stammkapital") by the founders were as given below. [Moneyhouse, Handelsregister]:

S.K.M. Max von Baden	€255,750.00
Reiner Becker	€255,750.00
Wiltrud Walter-Strobel	€255,750.00
Oswin Weiser	€255,750.00
Michael Schmidt	€153,450.00

Wiltrud Walter-Strobel was given individual Prokura for the company.

It is not clear for the author in how far for Bada's foundation the founders used only their own capital and/or utilized (also) external financial sources. Reiner Becker, characterized as a bank manager, could have played a role in this regard.

In February 2003 Reiner Becker left the firm, but, by special law of succession, Gabriele Maria Becker (born Weihrauch) took over the position of Reiner Becker.

In September 1997 Bada Plast Verwaltungs GmbH was registered. Its purpose was running the administration of other firms, in particular taking over the function of the "Komplementär" of Bada Plast GmbH & Co. KG. Share capital for this GmbH (LLC) was DM50,000 and its executive director was Michael Schmidt with an individual Prokura. Due to the change of the DM currency to Euro in December 2001 the capital was slightly modified to €26,450.00 [Moneyhouse; Handelsregister].

In July 2005 Bada Plast Verwaltungs GmbH became Bada Holding GmbH. The purpose of the company remained to hold and manage participations in other trading companies, but included activities as the parent company of a jointly managed company group. It may set up branches and participate in similar firms or similar undertakings. Bada's subsidiary in Spain, Bada Hispanaplast SA, founded in 2005, was the first example of Bada Holding's anticipated activities.

Already in May 2003 Bada Plast GmbH & Co. KG was transformed into a stock company, Bada AG. The share capital (€1,196,000) was divided into 1,196,000 no-par value shares. Wiltrud Walter-Strobel and Michael Schmidt became executive directors [Moneyhouse].

Oswin Weiser became the Chairman of the Supervisory Board. Additional members were Prof. Dr. Franz Brandstetter (graduated chemist, Neustadt an der Weinstraße) and Heinz Brachten (Dipl.-Betriebswirt, BA, Mönchengladbach).

For many years Professor Dr. Franz Brandstetter worked in senior positions at BASF, most recently as Head of the BASF Competence Center Polymer Research [Plastverarbeiter 2008]. After his corporate career over the last years he worked as a technology consultant [LinkedIn]. The very broad competencies of Prof. Brandstetter cover, for instance [LinkedIn]:

Strategic realignment of business areas including

- Optimizing processes (research, development, production, logistics, marketing)
- Organization and structure of R&D
- Project management
- Development and implementation of research strategies
- Portfolio Management (R&D projects, assortments, markets)
- Process and product development of polymers
- Nanotechnology [Plastverarbeiter 2008].

Previously Heinz Brachten was active for the firm Coperion Werner & Pfleiderer Beteiligungs-GmbH. He was executive director of Krupp Werner & Pfleiderer from October 1996 till March 2001 and since April 2001 till November 2008 executive director of Coperion Waeschle GmbH & Co. KG [Moneyhouse].

In 2002 Heinz Brachten expressed, in accordance with his personal plans, the desire to give up his mandate as CEO of Coperion Werner & Pfleiderer in Stuttgart [Kunststoff Forum 2002]. During the official opening of the operations of Bada' s Spanish subsidiary Bada Hispanaplast with presence of a number of key representatives of Bada AG Heinz Brachten was introduced as Chief Financial Officer of Coperion Werner & Pfleiderer [Interempresas Media 2007].

In November 2008 Coperion Werner & Pfleiderer, Coperion Waeschle, Coperion Keya and Coperion Hartmann became Coperion GmbH (Stuttgart) as a Group. As of December 1, 2012 Coperion is a full member of the US firm Hillenbrand, Inc. It is currently (2015) a company with 2,500 employees. Revenue of Coperion in 2012 was €518 million [Coperion; Gupta].

Coperion is an international market and technology leader in compounding systems, feeding technology, bulk materials' handling systems and services – as well as being a partner for global corporations and small to medium-sized enterprises in the plastics, chemicals, food and aluminum industries.

Specifically, Coperion is the worldwide market and technology leader in compounding and extrusion, materials handling and service. With continuous extruders, Werner & Pfleiderer has a worldwide market share of ca. 30 percent [Wer zu Wem].

Not surprisingly, new high-performance compounding systems for the new Bada works were acquired from Coperion Werner & Pfleiderer.

Since (at least) 2006 S.K.H. Bernhard Prinz von Baden (Kaufmann – Businessman) is listed as a substitute member of the Supervisory Board of Bada AG [EB - 2006].

The Supervisory Board is rather small, but seems to be actively and successfully involved in managing Bada and in strategy and decision-making.

Among its members there is a broad knowledge of polymer chemistry, compounding plastics and compounding business in the company (Weiser and the other founders given in Table 1) complemented by a Supervisory Board concerning science, technology and technology management (Brandstetter) and process engineering (Heinz Brachten) who both also provide origins for networking.

In November 2004 Andreas Schettler (formerly PolyOne ...) became a member of the Board of Executive Directors of Bada. Wiltrud Walter-Strobel and Michael Schmidt left the Board, but Michael Schmidt got Prokura.

After the establishment of Andreas Schettler as Chairman of the Board, CEO of Bada AG and responsible also for Marketing and Distribution, the structure, management, activities and attributed responsibilities of the “Bada Group” were changed.

In June 2005 Bada Grundstückverwaltungs GmbH, Bühl (Industriestr. 9) was established with a share capital of €25,000 and Michael Schmidt and Andreas Schettler acting as executive directors. The purpose of the company is to hold and manage real estate and provide rental and leasing service (letting) [Moneyhouse; Handelsregister] – particularly vis-à-vis Bada AG. And this function materialized immediately by founding Bada Hispanaplast.

Concerning liabilities of Bada Grundstückverwaltungs there is a joint and several liability of Bada AG, Bühl and Bada Holding GmbH, Bühl.

For establishing Bada’s Spanish subsidiary in 2005 it was reported that €4 million were invested [Interempresas Media 2007]. And in the annual report 2006 of Bada Grundstückverwaltungs GmbH [EB 2006] exactly that sum occurs as a loan as “Liabilities against credit institutions” in Table 2.

Table 2: The maturity and the collateral provided for the individual liabilities through the so-called liability level of Bada AG in 2006.

		Remaining Time			
Type of liability	**Total (€)**	**Up to 1 Year (€)**	**More than 1, up to 5 Years (€)**	**More than 5 Years (€)**	**Secured Amounts (€)**
Liabilities against credit institutions	4,000,000	125,000.00	1,411,810.00	2,463,190.00	4,000,000.00
Liabilities from goods and services	597,130.52	597,130.52	0.00	0.00	0.00
Liabilities to affiliated companies	597,646.33	597,646.33	0.00	0.00	0.00
	5.194,776.85	1.319,776.85	1,411,810.00	2,463,190.00	4,000,000.00

In the Fixed Assets part of the 2006 balance of Bada one finds the following entry:

Land, land equivalent rights and buildings including buildings on foreign land, €4,924,977.77, particularly plants under construction €4,924,977.77.

For further developments it was obvious for Bada to focus on using for its manufacturing always state-of-the art technolology and for the organization have an appropriate management system:

"Further investments in a new and universal product line and an in Europe for comparable companies unique integrated management system, which unites quality, environment protection and innovation, are the basis for a flexible reaction to the changing markets." [Bada 2009i]

Organization

In July 2005 Bada Plast Verwaltungs GmbH became Bada Holding GmbH. Michael Schmidt was no longer executive director. Wiltrud Walter-Strobel and Andreas Schettler became executive directors of the holding. The original share capital of Bada Holding of €1,196,000 was changed to finally €1,222,450 [Moneyhouse; Handelsregister].

> In May 2006 Bada Holding GmbH closed a control (domination) and profit transfer agreement with Bada AG (Figure 1) [Moneyhouse; Handelsregister].

In July 2005 Bada AG's Board was restructured with Andreas Schettler, who became Chairman of the Board of Executive Directors (CEO). Michael Schmidt had jointly held Prokura. But Mr. Schettler became simultaneously executive director of Bada Holding GmbH and Bada Grundstückverwaltungs GmbH.

The business situation in 2006 was characterized by a growing market demand for more specialized compound products which continued for the following two years until the Great Recession.

The continuously broadened product range was delivered to much diversified application areas and end customer markets. This mainly covered technically demanding applications in the fields of electrical and electronics, E&E), automotive, construction, furniture, household, medical technology, leisure and sports [EB 2007].

Bada presents itself to have a *slim hierarchical organization* and a highly customer-oriented corporate structure which makes Bada extremely flexible, innovative as well as quality- and service-oriented in all areas [EB 2007].

In Figure 3 a tentative organizational sketch is displayed which is derived from the typical components of a technology venture's value chain (functions, activities) [Runge:60], citations of various departments in Bada's literature and roles and jobs of Bada's employees in LinkeIn or Xing.

Disregarding management the outline of the figure is essentially arranged according to three blocks, administration, marketing and development/process engineering and production (cf. MAE in Table 4). Vertically arranged functions reflect extensions of their activities across several units. This refers to the development, production and quality functions, whereas the information and other systems extend over most of the firm's functions.

In particular, the sketch also intends to visually reflect by proximities Bada's important *interfaces between marketing, distribution and sales and development/engineering and production*.

It is not clear whether field sales also includes technical sales and after-sales service plus market development.

For the early development phases of Bada the notion "Laboratory" might essentially cover measuring properties and testing products. But most recently, as described in the next chapter, it may also include research and development. Bada participates successfully in R&D projects publicly financed by the German Federal Government or the European Union ("*external resource management*" by collaborative R&D [Runge 2006:650,687,707,716]).

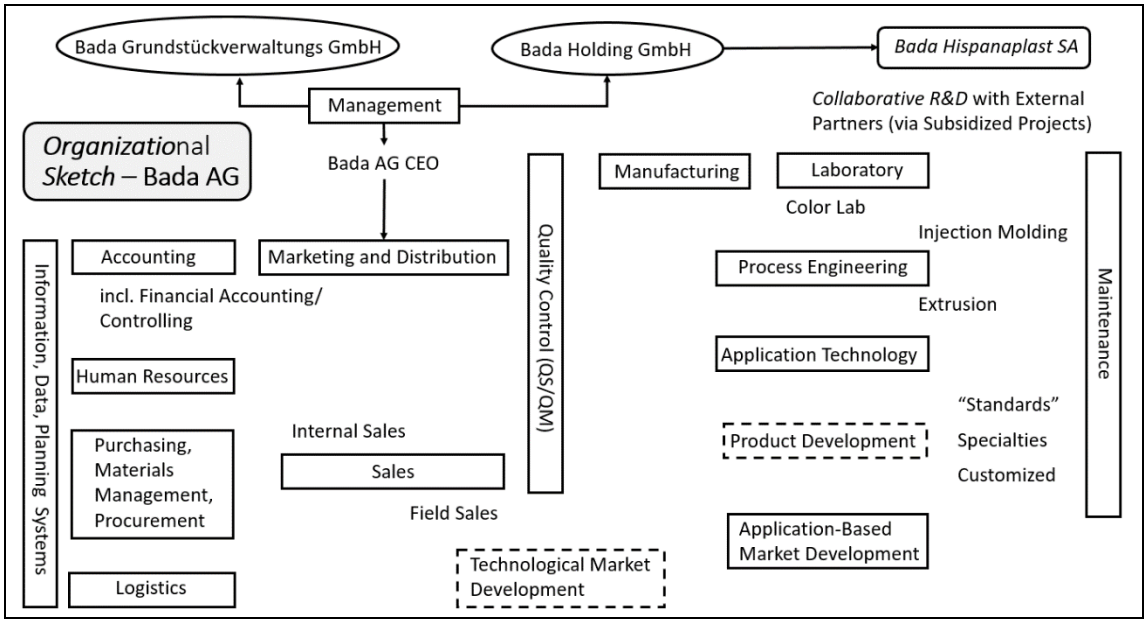

Figure 3: A tentative sketch of organizational features of Bada AG.

The development of application-focused special compounds is one of Bada's *core competencies*.

In 2013~~,~~ to expand its business activity with tailor-made special compounds, Bada added workforce capacity to bridge a gap existing so far through a new application-based market development unit. This completed a missing link between its customers, its internal sales representatives and its field sales force. The related application-based market development will assist in the development of a customized product, no matter if it is intended for the automotive or E&E industry, mechanical engineering, medical or food engineering, construction, sports or leisure activities, or agriculture [Bada 2013e].

The unit will create tailor-made solutions and individual modifications. It is about advising and supporting mainly end customers in the implementation of challenging new projects and development projects to the point of release for series production.

Bada offers service which often starts right at the point of product development. A Technical Marketing department will assist and advise customers from the idea to the start of production [Bada 2013i].

Networking and Cooperation

The *core competencies* of Bada are the development of customer- or application-oriented product solutions, particularly application-focused special compounds. Product base and compounding know-how also make Bada a partner for *collaborative research and development* projects, particular production research activities, *process research* [Bada – Technology].

By regularly participating in publicly supported research projects and a tight network, Bada ensures that customers will continue to be supplied with *innovative product solutions* in the future [Your Chemistry Career].

> Bada has been successfully demonstrating that being a medium-sized enterprise does not contradict commitment to basic research to its advantage.

An appropriate cooperation was seen to provide Bada the possibility to enter the field of nanotechnology, specifically compounds based on suspensions of nanoscale fillers.

It may well be that the member of Bada's Supervisory Board, Prof. Brandstetter, directed Bada's orientation towards *nanocomposites* as he described already in 2004 that the addition of a

nanoscale additive led to a significant improvement of a particular property of PBT (cf. Badadur based on PBT) [Brandstetter 2004]. Additionally, later, Prof. Brandstetter provided an assessment of the development of nanotechnology and a very attractive outlook for the chemical industry – “cooperation and networks as a must in nanotechnology” [Plastverarbeiter 2008:79].

Within the framework of a project NanoDirekt funded by the German Federal Ministry of Education and Research (BMBF), Bada started in 2007 to intensively deal with the incorporation of nanoparticles into thermoplastic matrices in the coming years. For this area the BMBF had established a consortium, in which renowned partners, such as the Fraunhofer Institute for Chemical Technology (ICT), Coperion Werner & Pfleiderer, Hosokawa Alpine, Viscotec, Evonik and Bayer MaterialScience (now Covestro), were involved. Bada took over project leadership together with the Fraunhofer ICT institute (Institut für Chemische Technologie) [Bada 2007d]:

> NanoDirekt – Direktprozess zur Herstellung von Nanosuspensionen und Zudosierung in thermoplastische Matrices zur Produktion von Nanocomposites (Direct Process for the production of nano-suspensions and dosing into thermoplastic matrices for the production of nanocomposites).

Incorporating nanoparticles leads to certain special compound properties like, for instance, electrical conductivity, impact resistance, UV- resistance, barrier behavior which are so significantly well that they either do not or are difficult to reach with conventional ingredients. These properties can only be achieved if the nano-particles are as possible finely and consistently dispersed in the polymer matrix. But the biggest problem lies herein [Bada 2010a].

So far, the production of nanocomposites in which no agglomerates are present was predominantly on the laboratory scale because the technical limitations, such as the dosing, dispersing and stabilizing of nanoparticles, are a major problem for a large number of industrial applications. As long as nanocomposite production is not carried out on a large scale, many such products cannot be placed on the market for reasons of cost. For this purpose, however, the solution must be fundamentally altered in the processing of the nano-particulate raw materials and their introduction [Bada 2007d; VDI 2007:6].

Therefore, the aim of this project was the related consortium to develop an economically and technically interesting direct process for the production of nano-suspensions and to incorporate them into polymer matrices.

Specifically a demonstration plant for the production of thermoplastic nanocomposites with in-line dispersion and addition of the nanofillers into the extruder was built up. New, innovative processes were being developed in the areas of dispersal and short-term stabilization, as well as conveying and compounding technology [VDI 2007:6].

Fine particles, especially nanoparticles, tend to agglomeration which aggravates the further processing. The “NanoDirekt”-procedure shows precisely here its strengths. Agglomerates are broken up selectively and effectively and can be introduced as dispersed as possible in the polymer matrix. A further decisive factor is the health aspect. During the entire production process operations will only proceed with bounded nanoparticles. The contact with single and free particles is therefore excluded [Bada 2010a].

Through targeted developments following the project the demonstrator was to be further developed into a turnkey plant unit. In addition to the free marketing of the main components grinding, dosing and extrusion by the respective project partners, the consortium also wanted to distribute the complete system in cooperation [VDI 2007:6]. Bada together with a number of well-known project-partners applied for a patent for the production technology due its efficiency [Bada 2010a].

The results of the project NanoDirekt were immediately exploited by Bada [Bada 2010a]. Bada can produce nanocompounds process-safe in larger quantities based on various polymer systems. Nanoparticles such as carbon nanotubes (CNTs), nanoclays, pyrogenic silica and other nanoscale particles can be used.

“The fact, that the step out of the theoretical future technology to the realization on a production scale has succeeded, is very groundbreaking for the future of Bada. We can develop now tailor-made nanocompounds and produce with a process-safe and innovative technology.” [Bada 2010a]

For almost five years Bada had been working on the future-oriented nanotechnology to come up with tailor-made nanocompounds for new, innovative applications that could not only be developed, but also mass produced. “We would particularly like to stress the high innovative potential offered by the specific and process-safe use of nanoscale ingredients in compounds,” said Adrian Zanki, technical director at Bada [Bada 2011a].

Excellent properties of Bada's nanocompounds was convincingly demonstrated in conjunction with Framas GmbH. Framas is a development partner for high-quality sports shoes made by renowned sports equipment manufacturers, such as Adidas.

Exceptional mechanical properties were achieved with a compound on PA 12 basis with 2 percent carbon nanotubes (CNTs).

FRAMAS was founded in Germany in 1948 and develops and manufactures high-tech components for the shoe and sports sector, such as outsoles, shoe lasts, heelcounters, shanks, insoles, shoe systems and other injection molding components in one or multiple color/density technologies.

Framas has a global presence in all locations where customers are actively developing and manufacturing. With its own in-house development centers and high-end mold-making facilities at each location, Framas is providing customers with the best possible support.

Using the sole of the football boot of the WM 1978 World Cup, Framas tested a Badamid PA 12 compound that was selected as the base material in both the fiberglass reinforcement and carbon fiber reinforcement. In the basic formulation, the compounds had an elongation at break of 7 percent. The use of 2 percent carbon nanotubes (CNTs) increased the elongation at break to 16 percent in conventional incorporation used on the market [Bada 2011a].

“What these carbon nanotubes are really capable of was only revealed through the incorporation of 2% CNT using our special procedure,” said Zanki and cited several properties whose performance was impressively increased by CNTs [Bada 2011a].

The conclusion of Bada’s CEO Andreas Schettler was: “For more than half a decade now, we have been working on nanotechnology. Our success, and the opportunity to find excellent technical innovations, have reinforced our decision to continue to work intensively with new technologies in the future.” [Bada 2011a]

The project “NanoDirekt”, aiming at the production of carbon-nanotube-polymer nanocomposites, was terminated in 2011. It resulted in a joint European patent application (EP 2501746; Table 9) by members of the consortium that ensures and regularizes the future utilization of the results.

As an element of plastic compounds, nano-scale fillers offer huge potential. Due to their very small particle size, they have an extremely large surface, which can interact with the polymer matrix [Bada 2011l].

In comparison to conventional fillers, a small quantity is often sufficient, which has a positive impact on mechanical properties, among other things. Applications for these nanocomposites include, for instance, electrically conductive plastics (carbon nanotubes), plastics with better

mechanical and barrier properties (phyllosilicates) and higher scratch resistance (pyrogenic or precipitated silica) [Bada 2011l].

Above mentioned issues and problems of processing can be solved with the help of the "NanoDirekt process.

Bada continuously expanded its running Badamid PA development activities, sometimes with partners, but also concerning long-chain polyamides, such as PA 12 and PA 10.

For instance, for 20 years, NRC Nordmann Rassmann GmbH and UBE Engineering Plastics SA were cooperating in the marketing of UBESTA®-PA12 as a partnership. This successful connection was supplemented in 2009 by special compounds based on PA 12 [Plasticker 2009].

In cooperation with Bada formulations were developed together with the customer, which NRC has not yet been able to offer from the UBESTA® portfolio. Particularly interesting applications were injection molding qualities in special colors, with certain fillers (glass fibers (GFs), glass spheres, conductive fluxes, molybdenum disulfide, etc.) and special filling levels.

Even in the extrusion area, polyamide 12 can be adapted in selected flame retardant finishes and additives. NRC distributes the entire polyamide 12 range in Germany, Austria and the Central and Eastern European countries.

NRC is part of the Georg Nordmann Holding AG affiliation of companies, an independent, 100-year-old family enterprise, active mainly in the manufacturing and service industries. It ranks among the world's leading sales and marketing organizations in chemical distribution (with an annual turnover of ca. €450 million and 330 employees). It sees itself as strategic partner for customers and suppliers (according to Wikipedia and its Web).

Bada also began to enter another area of plastics. Polymers based on *sustainable raw materials* are growing in importance as fossil resources become scarcer. In the specialties area, Bada, for instance, developed various formulations as Badamid PA 10T, which is based on sustainable raw materials (castor oil) up to 50 percent [Bada 2011l].

After the introduction of PA 12 types Badamid PA 612 and Badamid PA 610 followed. Badamide PA 612 has a melting point higher than that of PA 12 by 30 °C with nearly identical other properties. Possible applications are media-carrying cables, quick connectors, chemically loaded housings in plant construction and plain bearings [Kunststoff Web 2012].

The product line Badamid PA 610 offers similar properties as PA 612. Melting point and strength are somewhat higher than in the PA 612 family. But PA 610 provides an *entry into biobased chemistry*. It is based on sebacic acid ($(HOOC)(CH2)_8(COOH)$) from renewable raw materials.

Combined with an extensive market experience and the existing material competencies, Bada guarantees its customers always solutions on high technical level. C*ontinuous collaboration in research projects* ensures Bada to have access to the latest know-how from the plastics world. Furthermore, the contacts generated in projects can be used to participate in further research projects. "We see the cooperation in such projects as an important innovation driver. They help us to respond to ever-increasing customer requirements," said Andreas Schettler [Bada 2012d].

Another program on the EU level addressing the nanoscale Bada participated in was PHOENIX (Project period: 2013-01-01 till 2016-12-31) [EU 2013]:

> Synergic combination of high performance flame retardant based on nano-layered hybrid particles as real alternative to halogen based flame retardant additives.

PHOENIX covers fifteen partners including the coordinator from Spain. From Germany the participants covered Bada AG, A&E – Applikation und Entwicklung Produktionstechnik GmbH, the Technische Universität Darmstadt and the Fraunhofer Society (FhG).

Total cost of the project was €6,981,368, EU-contribution was €5,099,936. The EU-contribution to Bada was €370,580.

The objectives of PHOENIX addressed electrical and electronic (E&E) applications including housings, wire and cable, and internals such as connectors which are the largest market for flame retardants (FR) in plastics globally. The need for flame retardancy is increasing due to electronics miniaturization and higher temperatures in both processing and use.

(i) A new concept of FR nanostructured materials, based on *new non-halogenated flame-retardants* applying nanotechnology to replace hazardous chemicals to produce sustainable FR additives based on *nanolayered structures* and *modified lignins*, produced with innovative and *green chemical routes*, for thermoplastic and thermoset applications.

(ii) Innovative processing routes finding a true cost-effective and sustainable alternative to existing non-environmentally friendly FR, which allows simultaneously a significant improvement of mechanical properties and processability for compounding, extrusion and injection molding processes. New *compounding techniques such as the NanoDirekt process*, and high innovative systems, such as ultrasound mixing systems coupled to extrusion and injection equipment, shall assure high nanoparticles dispersion in the polymer nanocomposites and in the final pieces.

(iii) Simulation and modelling of compounding processes for the preparation of optimal nanocomposites, avoiding aggregates and achieving the best dispersion of the nanoparticles in the polymer matrix.

In a project supported by the “Central Innovation Program for Medium-Sized Enterprises” (SME) (“Zentrales Innovationsprogramm Mittelstand” of the Federal Ministry of Economics and Energy, BMWi), Bada and the Technical University of Clausthal developed a halogen-free flame retardant compound reinforced with natural fibers on the basis of technical polymers. As the compounds are partially made of renewable raw materials and do not contain halogens, Bada is strengthening with this project its contribution to sustainability [Bada 2015a].

The task, together with the Institute for Polymer Materials and Polymer Technology of the TU Clausthal, was to use natural fibers as filler and to modify with flame retardants at the same time, despite of the rather high processing temperatures of PA and PBT.

By means of combination of appropriate process technology and formulation a stable process has been achieved and the natural fibers have been largely protected against thermal damage. Therefore, flame retardant polyamide compounds with a reinforcement of up to 20 percent natural fibers could be produced with excellent processability on conventional injection molding machines.

Possible applications for these products are, for example, housings and they cover also the E&E industry. In view of the growing demand for sustainable products the compound is also very interesting for applications in the automotive sector.

Using natural fibers as fillers by several German compounders has been described by Runge [2016].

Bada had been participating in R&D cooperation for many years demonstrating successfully that being a medium-sized enterprise does not have to contradict commitment in fundamental research. It has proven innovative power in the *production research* for the future.

Organizational Processes: Production and Management

Drivers for Bada's new building were the optimization and efficiency improvement of Bada's development and production processes using most advanced process technology for tailor-made solutions – flexible and expandable for the future [Bada – Technology]. Corresponding technical processes will cover entities in the right part of Figure 3.

In 2006 Bada had six extrusion lines with partly mega-compound equipment and a capacity of approximately 18.000 t/a. One extrusion line was equipped with a state-of-the-art underwater head granulation for pearl shaped granules [Bada Web Home page 2006].

In the development department it was working with four molding machines. Additionally it had Werner & Pfleiderer extruders at the development department, especially for color elaboration and testing new modifications.

Since May 2004 the quality standard was the certificate according to ISO/TS16949:2002. This standard combines the essential requirements of the ISO 9001, QS 9000, EAQS, AVSQ and VDA regulations. The main focus of the standard is the orientation to the process, the continuous improvement and the optimization of the processes.

After having moved into the new factory buildings at the end of 2006, the year 2007 was marked by the commissioning of new production facilities in the new production hall and the corresponding adjustments of the process sequences to the new environment [EB 2007].

The main *technical aspects* were described by Chemietechnik [2007] as follows.

Bada realized a complete new plant with administration and production. Centerpiece is a new line for feeding the extruders and filling the granules. Optimal infrastructure, efficient workflows, the latest process technologies and the possibility to expand the supply of materials at any time, these were the requirements of plant planners.

The optimization and efficiency improvement of the process sequences was the main reason for the new building at the company location in Bühl. Meanwhile, the company together with the Spanish sister company Bada Hispanaplast earned around €40 million annual turnover (Table 6).

The batch sizes were between 1,000 and 20,000 kg, with small batches between 2,000 and 4,000 kg making up the lion's share.

Requirement: High plant availability, low cleaning effort.

In order to be able to *produce economically* high throughput, high plant availability and low cleaning costs are required. As far as possible, identical systems with a corresponding line structure are necessary.

Decisive are

- interchangeability of individual components
- lower capital commitment for wear and replacement parts (maintenance)
- a simple production planning
- uniform plant operation by the employees.

The compounding system, including its feeding, must be suitable for a wide range of materials, and also ensure a high compounding quality, a high recipe accuracy and a high color accuracy In addition, from the beginning, an expansion of the product portfolio with ABS special compounds and compounds of thermoplastic elastomers based on PP/EPDM had to be provided.

Above all, three *operating aspects* were decisive: Flexibility, process safety and future security. "We process the recipes up to twelve times a day. Hence the feeding systems have to be easily accessible and easy to clean," said Markus Fiedler, production manager at Bada. "Several

extrusion lines are dependent on the feed; therefore we cannot afford a failure and need very high availability."

CEO Andreas Schettler was particularly interested in the *expansion capability of the system*: "We demanded a universal plant engineering that can be expanded flexibly and modularly, since we do not yet know exactly for which product families to be expanded we will be looking for in the next few years."

Reduce cleaning effort

With the *frequent recipe changes* "the cleaning effort is crucial in order to be able to *carry out the frequent recipe changes economically,*" said Markus Fiedler. Weighing and dosing have effects on cleaning. A special process arrangement guarantees very high *weighing and dosing accuracies*.

There are three plant areas: The *large quantities* of the polymer raw materials are available in external silos, or they are fed to the mixer from octabins (octabin is a pallet-size box used for storage and shipping of bulk quantities) or big bags via the suction weighing systems. For the additives, the colors and the other modifiers, there are user-operated weighing stations available for each line.

Small quantities, such as paints, additives, modifiers and similar substances, are weighed on each line at weighing stations and then manually poured into the respective mixer. As a result of this measure, only the mixer is contaminated and the remaining conveyor system does not have to be cleaned for product changeover.

After the mixing process, the homogeneous charge is ultimately transferred to the extrusion process. "As continuous feed processes are never allowed to be interrupted by material supply, process safety is the number one criterion for us in this area," emphasized Schettler.

Charges traced back without gaps

With the help of the new process control and visualization system, the recipe change and cleaning frequency can be optimally planned and controlled.

The products weighed at the user-operated manual weighing stations are also precisely registered and documented. This makes it possible to carry out charge traceability without any problem and to provide the proof of composition of the produced granules at any time.

Bada equipped the new plant in Bühl with new compounding lines from Coperion Werner & Pfleiderer GmbH & Co. KG, Stuttgart. For the lines, installed at the end of 2006, the company opted for three identical ZSK MEGAcompounder PLUS. This made it possible to produce high-quality products of higher quality, with an output of up to 30 percent higher than before [Plasticker 2007].

"Despite a generally *difficult economic environment*, Bada has relied on proven virtues. At a time *when many market stakeholders stop any investment*, we have been able to strengthen our plant by acquiring a very universal production line. This gives us the opportunity to develop new developments in a highly effective manner and to produce small-volume specialties flexibly. We look forward to Fakuma 2009, where we want to take advantage of the opportunity to convince our customers and new prospective customers of the performance of Bada," said Mr. Schettler [K-Zeitung 2009].

In 2009 a new production line started, which was also suitable for smaller batches. In this way Bada expanded its options within product engineering and simultaneously increased its flexibility [Bada 2009j].

The *future-oriented investment* complemented the current production capacities perfectly – the compounding machine replaced the former laboratory extruder and paved the way to the *manufacturing of samples similar to mass-production*. Additionally, smaller customer orders can be manufactured with the familiar maximum quality.

“Especially today, *promptitude and flexibility* are two of the most important skills we have. In this respect we are now perfectly set”, said Andreas Schettler [Bada 2009j].

> And the importance of the strategy to rely on highly developed technology and highly specialized products became obvious.

By the end of 2008, Bada AG was awarded with the EMAS-certificate for environment-conscious management. The European Eco-Management and Audit Scheme (EMAS) is a voluntary management tool for companies and other organizations to evaluate, improve and report their environmental performance [EMAS 2010].

For the new factory it was logical that then both proven and newly modelled processes be subjected to critical examination. As early as April, the Rhineland Technical Inspectorate (TÜV Rheinland) gave its ok. The management system of Bada fulfilled all requirements of ISO/TS 16949 in the new environment [Bada 2007b].

Later the locations in Germany and Spain were certified according to ISO/TS 16949:2009 and in Germany an additional ISO 14001 and EMAS had been added since 2008 [Nanovalley 2015; Bada – Quality].

Complying with standards and norms is no time for relaxing.

> Instead, *continuous improvement* is the main idea in order to remain one of the leading compounding companies within Europe and to keep up the quality of the products [Bada 2009e].

These certificates reflect a *quality-dominated mindset* of the firm’s employees. This particular style of efficient quality management allows Bada not only to eliminate faults in the production process but to avoid them from the beginning. CEO Schettler pointed out: “Our employees did a great job checking the flow of substances and energy in the plant in Bühl critically and revealed hidden potentials.” [Bada 2009d]

Finally, Bada paved the way to an integrated *management system, where environmental as well as quality aspects play a significant role*. Schettler said: “Our new management system and the subsequent increase in efficiency within all parts of our business are another great step for Bada to become the most innovative and modern plastic compounder in Europe.” [Bada 2009d]

“It is indispensable to continuously improve our standards as well as our attitude towards our environment”, said Andreas Schettler in 2013 and continued that it is essential to include environmental protection, the prevention of pollution and the *better management of natural resources* into Bada’s behavior.” [Bada 2013a]

In 2012-2016 the ISO 14001 and EMAS certificates were always renewed. Such a result can only be attained if all staff makes every effort to fulfill the corresponding aims and norms throughout the whole year [Bada 2013a].

In 2013 Bada Hispanaplast was the first manufacturer of technical plastics in Spain to be certified according to ISO/TS 16949:2009 (especially for automotive suppliers). The certification sets Bada Hispanaplast apart from other companies in the Spanish plastics industry. This is due to the existing control and quality standards with respect to the production processes, as well as to the end product [Bada 2013b].

> Bada's investment in technology which usually is accompanied with addition of necessary personnel follows its principle of "*investing after demand*". Furthermore, with regard to the timing Bada follows also an *anti-cyclical approach*: In an economic recession, when all are cutting back, it invests to be ready to immediately exploit new opportunities when demand and a new boom starts and in this way it obtains a competitive advantage.

For instance, in 2012 Bada AG was expanding its capacities at the German location as well as in Huesca, Spain. "The step was absolutely necessary because of the constantly growing demand," said Andreas Schettler. "Thanks to the new production lines, Bada is now able to meet the demanding requirements of its customers with "state-of-the-art extrusion technology". As a result of the capacity expansion, Bada has retained flexibility and speed when processing customer requests [Bada 2012e; K-Zeitung; Bada 2013d]. This documents again Bada's principle of investing after demand.

The new lines were designed so flexibly that the process parameters "can be adapted to a modified product within a very short time." This is also important in order to be able to continue to produce specific compounds which are exactly tailored to the respective application of the customer and require their own special driving method during production. ŧBada 2012e; K-Zeitung 2012]. As a result of capacity expansion new jobs will also be created

"In addition, we are confronted every day with new, technically even more demanding requirements from our customers. These can only be realized with state-of-the-art extrusion technology and our many years of know-how," said Andreas Schettler [Bada 2012e].

Not much later the plant expansion of Bada Hispanaplast took place. The Spanish affiliate nearly doubled its plant areal and introduced a new production line. It did not mean only increasing the production volume but also being more flexible with respect to the composition of the formulations [Bada 2013c].

Expansion of manufacturing does not only mean focusing on capacities or technical facilities. It can also mean a different kind of output from facilities. For instance, in 2012 Bada had produced a small extrusion line for the production and additional quality control of flat films. The complex is divided into two units, one for plasticizing extrusion materials, the other one to clearly define the film width or sheet thickness [Bada 2012i].

Another aspect that must be kept in mind is analogy between Bada's different production line sizes. For instance, laboratory equipment should be compatable with that in production so that scale-up is easy possible or tasks whereby sample quantities of 25 kg up to several 100 kg are needed if tailor-made solutions for the customers are to be run [Bada 2014a].

Re-engineering its *business processes* corresponding to the implementation of the SAP-ERP (Enterprise Resource Planning) system occurred in 2013/2014 [Kopte 2014; ITP Verlag 2014]. Corresponding business processes covered also entities in the left part of Figure 3.

In 2013 an outdated IT system and new requirements of the market required a complete reorientation of the entire IT landscape at Bada. With the introduction of the ERP (Enterprise Resource Planning) solution based on SAP Business All-in-One, the company should be optimally positioned for future developments [Kopte 2014; ITP Verlag 2014].

As a partner for introducing the new system Bada opted for SYCOR GmbH and had already had its first talks at the plastics fair FAKUMA 2012.

In the course of the development of the company and the market, the software solution used so far was no longer able to meet the requirements for fast and efficient production. "Our old solution was at its end. Too many manual activities, too many interfaces between the transfer of information from incoming orders to invoicing," explained Andreas Schettler [Kopte 2014; ITP Verlag 2014].

The requirements for the new system were quickly formulated: Production, sales and logistics should also be reflected in the new integrated system, such as purchasing, financial accounting and controlling. The SAP ERP solution as a core should not only replace the central system, but also *improve and optimize processes*.

The implementation/introduction of the system was complex and covered with additional modules.

The company Sycor GmbH took over the implementation of the ERP total solution with the SAP modules Sales (SD), Materials Management (MM), Production Planning and Control (PP), Financial Accounting (FI), Controlling (CO) and the Project System (PS). In addition, an integration with the AZO mixing system for granulate production had to be carried out. "With the SAP standard for Bada AG, we have created *an individual solution* that is very flexible and represents the business processes highly integrated.

Thanks to the *comprehensive improvement of the processes*, Bada was also optimally positioned for the future development of the company. This provides a competitive advantage, as information can be accessed more quickly and in a more targeted way. "The change from our old system to SAP ERP brings us significant advantages. Many work steps can now be done more effectively than before."

"In addition to the processes related to production, the company also improved the manageability and controllability of the company," explained Schettler. For this purpose, it is easier to manage various customer orders and to control the material and product flows [Kopte 2014; ITP Verlag 2014].

A later rollout of the ERP system for the Spanish subsidiary was planned.

Recalling attitudes, behavior, activities, strategies, etc. presented so far for Bada characterize its execution of *technology management* (TM). There is no generally accepted definition of TM. Therefore, we shall emphasize two notions of TM which fit essentially what has been described so far for Bada.

Technology Management (TM) represents *a holistic technology and innovation management system*, which integrates a firm's *internal and external aspects* on the *normative, operational and strategic* management level [Runge:630]. This means particularly, it is a *set of activities associated with bringing technology products to the marketplace* – based on *adequate organizational structures* as well as the *mindset and behavior of associated people*. The focus is on *new offerings' development* (products, services, applications) and *commercialization*.

According to the US National Research Council in Washington, DC management of technology (MOT) is linking "engineering, science, and management disciplines *to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization* [Encyclopedia of Management]. TM as a specification is embedded in corporate strategy.

Key Metrics

There are several indicators to reflect development or growth, respectively, of firms – each one with its special merits and shortcomings [Runge:638-640]. As Bada originated by an MWO out of PolyOne Th. Bergmann GmbH a comparison between both firms when Bada Plast started production will characterize the competitive situation after foundation.

When Bada started in 1998 with a production capacity of 9,000 tons/year Theodor Bergmann Kunststoffwerk GmbH/PolyOne Th. Bergmann GmbH and its Spanish subsidiary Polibasa Poliamidas Barbastro SA had already estimated sales of €60-70. In 1995 total turnover of DM96

million (now €48 million) was achieved with 180 employees (65 of whom are based in Spain). Capacity in Spain in 1995 was 17,500 t/a and in Germany 23,000 t/a [Plasteurope 1996].

The further development of Bada's production capacities is shown in Table 3. It took Bada AG ca. ten years to double its capacity on starting.

Table 3: Development of Bada's production capacities (tons/year) of Bada.

Year	Bada AG (DE)	Bada Spain (ES)	References
1998	9,000		[British Plastics & Rubber 1998]
2007	18,000 (? 2006) ca. 20,000	2,800; 3,000	[PWC 2007; Bada Web – 2006] [K-Zeitung 2007] Spain (ES): [IZ@RO 2013]; [Interempresas Media 2007]
2009	24,000		[Bada – Company]
2010	28,000	ca. 9,000	[Nanovalley 2015] Spain (ES): [Bada 2007a]
2011	28.500		[Compounding World 2012]
2013	30,000	10,000	[Bada 2013d] Spain (ES): [Europapress 2013]
2015		12,000	[AutoRevista 2015; Sereno 2015]

After the global Dot-Com Recession (March 2001–Nov 2001 in the US) the years 2002 and 2003 provided an unfavorable economic environment for the plastics industry. However, Bada could improve its local and foreign market position. This was attributed to re-organizing the management of procurement, addition of employees for application technology, quality management, process control and a focus on foreign markets (according to the paper-based 2003 annual report).

In Table 4 the development of Bada AG's employees 2002-2015 is listed differentiating those of Management, Administration and the Engineering Department (MAE) and plant operation. This is visualized in Figure 4. It shows the distinct impact of the Great Recession by the distinct trough at 2009 in terms of the significant decrease in the number of employees.

Assuming the changes in the MA part to exhibit only small changes over time the development of the MAE values will essentially reflect the development of the engineering and R&D parts of Bada. Figure 4 shows for 2010-2014 that the increase of MAE people is much lower than that of the industrial workers, which demonstrates an increase in performance of the firm.

Table 4: Development of Bada's personnel and its profit transfer to Bada Holding GmbH after 2004 [EB].

Year	Number of Employees 1)	Revenue 2) (€ million)	Profit 3) (€ million)
2002	63 – 15 white-collar workers, 47 wage earners	15.623,119	1.218,984
2003	66 – 17 white-collar workers, 49 wage earners	19.380,575	1.305,600
2004	68 – 17 white-collar workers, 51 wage earners	23.813,025	1.585,815
2005	63 – 17 MAE, 46 industrial workers	26.010,202	1.209,249
2006	68 – 18 MAE, 50 industrial workers	33.342,249	0.00 {2.293}
2007	67 – 22 MAE, 45 industrial workers		0.00 {2.252}
2008	70 – 23 MAE, 47 industrial workers		0.00 {2.900}
2009	60 – 18 MAE, 42 industrial workers		0.00 {3.027}
2010	64 – 23 MAE, 41 industrial workers		0.00 {4.910}
2011	68 – 23 MAE, 45 industrial workers		0.00 {4.321}
2012	71 – 22 MAE, 49 industrial workers		0.00 {5.835}
2013	79 – 25 MAE, 54 industrial workers		0.00 {6.467}
2014	84 – 27 MAE, 57 industrial workers		0.00 {8.710}
2015	88 – 28 MAE, 60 industrial workers		0.00 {8.462}

1) MAE: Management, administration and engineering department, white-collar workers – Angestellte – wage earners – gewerbliche Arbeitnehmer; 2) Revenue data for 2002-2004 from paper copies of annual reporting delivered from the relevant agency, otherwise from [EB]; 3) Values in braces result from the profit transfer and control agreement with Bada Holding AG and describes essentially the yearly profit. [EB].

Developments of number of employees and profit in Table 4 show a significant dip in 2005.

Bada's profit increased almost continuously from 2005 until 2014 with the exception of a small decrease from 2006 to 2007. During the 2005-2007 period, however, Bada was about to invest heavily in its new building and founding its Spanish subsidiary.

The year 2007 was essentially determined by launching the new production facilities in the new manufacturing hall and the related adaption of processing to the new environment. Furthermore, during the course of the year some organizational changes and re-assignments of responsibilities must be implemented which must fit the new requirements. Movement into the new building occurred by the end of 2007 [EB 2007].

This probably led to a reduction in production volume or efficiency of production, respectively, and related diminished sales and also profit – and number of employees.

The small dip in 2007 may probably be generated by a real effect: the German economy had to cope with a strong VAT increase in 2007.

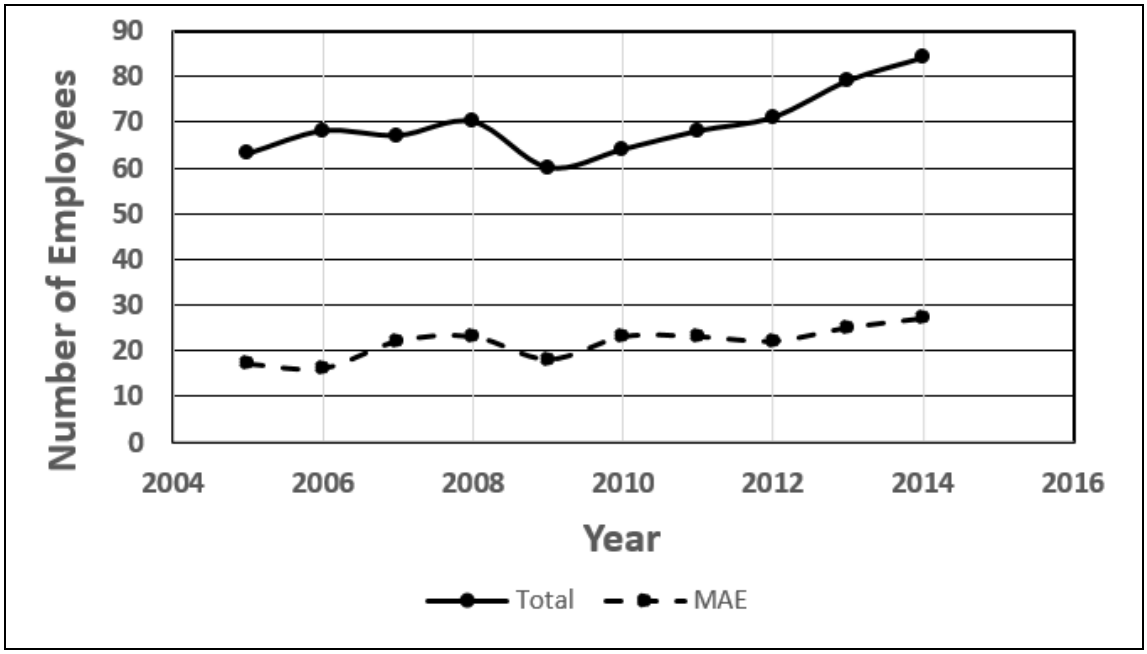

Figure 4: Development of the number of Bada AG's employees 2005-2014 [Table 4].

On the other hand, the 2008/2009 data are notable: Bada's profit before transfer to Bada Holding in 2009 exceeded that of the year 2008 by more than 4 percent (€3,026,579 *versus* €2,900,005) whereas the total number of employees decreased dramatically.

Due to the global recession in 2009 Bada had a decrease of orders which led to a dramatic reduction of revenues by about 20 percent [EB 2009].

The beginning of the year was characterized by an extreme weakness in demand in all industries and markets. Due to a very high inventory level among most customers the time for the normalization period continued into the summer. In the remaining part of the year demand regarding the core business and some new business significantly increased notably levelling off losses so far.

During the first half of 2009 strict cost control and flexible conditions of production were executed which counteracted the reduction of orders [EB 2009].

There were continuous readiness for production and short-term reactions to requests by customers which provided some additional business. Additionally, through export the volume of orders in some markets could be achieved which provided some relief and constantly good liquidity [EB 2009].

During the second half of 2009 the situation became better and better by a positive effect of many new customers and projects of products which were developed and sampled during the previous years.

Apart from the years 2005 and 2006 in the year end reports Bada AG reported its financial indicators in the income statement no longer in terms of revenues ("Umsatzerlöse") but in terms of gross profit ("Rohergebnis"). Gross profit is the company's total revenue (equivalent to total sales) minus the cost of goods sold, the costs associated with making and selling its products or providing its services.

According to law in Germany small and medium-sized stock companies may start the Profit and Loss (P&L) Statement with gross profit. Gross profit can be calculated essentially with the formula

Gross Profit = Revenue – Expenses for Materials (materials, auxiliaries, operational materials etc.).

Basically the gross profit may better represent the actual performance of the company if the material and product use fluctuates strongly. Furthermore, with this measure, a company can compare itself to other companies in its industry in order to see whether competitors achieve their output with less cost for material.

In Table 5 for selected years related items are listed together with some derived indicators, such as the Gross Profit Ratio (R/U) and Materials' Expenses/Gross Profit (A/R) in time periods of smooth growth.

Table 5: Financial items characterizing Bada AG for different time periods: Revenues, gross profit, expenses for materials and personnel and some proportions of items relative to each other (in € million) [EB].

Year	**Umsatzerlöse (Revenue) - U**	**Rohergebnis (Gross Profit) - R**	**Aufwendungen Roh-, Hilfs-, Betriebsstoffe usw. - A**	**Expenses for Personnel; Number**	**Proportions R/U; A/R**
			Expenses for raw materials, auxiliaries, operational materials etc.		
2002	15.623	7.056	8.665	2.479	45.16%; 1.22
2003	19.380	8.837	11.254	2.910	45.60%; 1.27
2004	23.813	10.017	14.569	3.360	42.06%; 1.45
2005	26.010	9.310	16.316	3.416; 63	35.80%; 1.75
2006	33.342	11.382	22.049	3.187; 68	34.13%; 1.94
(**R/U**): Rohertragsquote = Rohergebnis/Umsatzerlöse (Gross Profit Ratio = Gross Profit/Revenues)					
2012	48.4 1)	15.785		4.026; 71 2)	32.59% 3)
2013	50.5 1)	17.702		4.515; 79 2)	35.04% 3)
2014	56.1 1)	21.183		5.191; 84 2)	37.73% 3)
2015	55.5 4)	21.085		5.590; 88	ca. 38% 4)

1) Estimated values using R/U, 2) From Table 4, 3) From the Firmenwissen database, 4) Taking the Gross Profit Ratio of estimated 38% for 2014 gives an estimated value of the Bada AG revenue for 2015.

Gross profit of Bada increases continuously during the two considered time spans and the estimated revenues of Bada AG for 2012-2015 correspond to those reported in the literature (Table 6). The transition from 2013 to 2014 is associated with a jump in revenue and gross profit which is significant larger than the previous one.

For 2014 to 2015 revenues and gross profit remained almost constant. This may be related to increased cost for raw materials etc. in 2015.

The productivity (revenue/number of employees) of Bada AG for the two time periods was distinctly higher in recent times. From 2002 to 2006 it increased regularly to double to ca. €530,000. For 2012-2015 it remained at about €650,000 per employee for the whole period.

- 2002: €244,111; 2003: €293,645; 2004: 350,192; 2005: €382,502; 2006: €529,242 (per employee)
- 2012: €681,690; 2013: €639,240; 2014: €667,860; 2015: €639,680 (per employee).

In Table 6 metrics of the Bada Group, Bada AG and Bada Hispanaplast, are considered referring to the number of employees and revenues.

Here it turns out that based, on avalilable data, Bada Hispaniaplast contributes with a proportion of ca. 0.31 to the revenue of the Bada Group. The ratio is 0.36 if the distribution of employees for the years 2012-2014 is used. Its average productivity for 2013-2015 is €545,000 per employee, distinctly lower than that of Bada AG. Correspondingly for 2013-2015 the average productivity of the Bada Group is €610,000.

But it is to be noted that the productivity of Bada Hispanaplast continuously increased from 2013 to 2015 from €530,454 to €568,775.

Table 6: Total numbers of employees and revenues of the Bada Group, Bada AG and Bada Hispanaplast [EB].

Year	Number of Employees 1)	Total Revenue (€ million)	ES Revenues (€ million)	References and Remarks
2002	63	15.62		Paper copies annual reports
2003	66	19.38		Paper copies annual reports
2004	68	23.81		Paper copies annual reports
2005	68	26.01		[EB]
2006	63	33.34		[EB]
2007	67 {30} 1)	ca. 40	12.4 2)	[EB]; [Interempresas Media [2007], [Sonntag 2007]
2008	70	ca. 50		[EB]; estimate: revenue 2009 was ca. 20% compared with 2008 [EB 2009]
2009	60	40.8		[EB]; [Packmeeting 2010]
2010	64	ca. 62		[EB]; [Observatorio del Plastico 2010]
2011	68 {40}			[EB]; [Ranking empresas 2016]
2012	71 {41} Total ca. 120	ca 70		[EB]; Compounding Word 2013]; [Ranking empresas 2016]

Table 6, continued.

2013	79, {44}	73.8 (ca. 80 ?)	23.34	[EB]; [IZ@RO 2013], [Ranking empresas 2016]
2014	84, {47}	81.4	25.27	[EB]; [Ranking empresas 2016]
2015	88, {49} {60 ?}, Total 145	85	27.87	[EB; IHK 2016]; [Ranking empresas 2016], [Nanovalley 2015]

1) Values in braces for Spanish (ES) subsidiary, 2) Estimated value using the ratios of employees for Bada AG and Bada Hispanaplast for 2013-2015 (ca. 0.31) to derive it from the total of €40 million.

The export rate of Bada AG increased continuously over the years and reached 40 percent in 2013. It served seventy countries in 2015 (Table 7).

In 2015 Bada Hispanaplast exported 38 percent of its output to 30 countries [Sereno 2015].

Table 7: The development of Bada AG's export rate and number of countries served.

Year	Export Rate (%)	Number of Countries	References or Remarks
2003	21.1		Copy from paper-based annual report
2004	23.6		Copy from paper-based annual report
2006	Almost 30		[Plasticker 2007; K-Zeitung 2007]
2007	30.4		[EB 2007], [K-Zeitung 2007], [PWC 2007]
2008	32.5		[EB 2008]
2010		50	[Observatorio del Plastico 2010], [Bada – Company]
2013	40	60	[IZ@RO 2013]
2015		70	[Nanovalley]

Vision/Mission, Further Developments, Business Model and Risks

Industries across the board are intensifying their demand for high-performing materials with tunable properties. This surge in the uptake of new materials will disrupt existing business models, encouraging collaborations among original equipment manufacturers (OEMs) and material developers. Companies and the academia are also signing long-term research agreements for applied research to prove the feasibility of commercial-scale product development.

By the end of 2009 Bada AG with CEO Andreas Schettler achieved a state which was characterized by successful strategy development according to changed external conditions, customers' needs and opportunities and subsequent execution in terms of

- *Corporate culture* with employees having internalized attitudes, mindset and behavior according to explicit expectations, guidelines and continuous self-enforcement as well as deeply ingrained *customer-orientation*.
- Demonstrating *quality standards* by pursuing continuously quality standard certificates
- Having established *core competencies* centering on compounding providing additionally colorization of products and delivering products also in small quantities, not just only large or very large quantities.
- *Investment and innovation persistence* as a self-reinforcing process [Runge:681-682]
- Innovation, often as *incremental innovation*, concerning *performance of the existing product and service spectrum* as well as addressing new types of compounds, for instance, focusing on gaps when a particular market segment is left by other firms
- *Always extending the range of products (and services*). Customers do not necessarily have to choose from Bada's comprehensive range of products, they can also be provided with individually *customized materials*
- Having established *basic research in the firm in terms of collaborative R&D* in multipartner projects which are funded by public agencies, but also by individual partnerships with other firms
- A principle of *continuous improvement* concerning technical processes and manufacturing technology but also work and business processes covering new production facilities/lines or updating existing ones (continuous development and improvement of equipment and products).

This state was a solid basis for the further developments in and after 2010 when Bada is to be considered a *midsize company*.

Bada's fundamental operational principle is customer-orientation, "all that counts is that Bada customers will always find what they are looking for." [Bada 2013f]

It serves *much diversified application areas and end customer markets*. One of the key strategies is the development of customer-oriented product solutions for these areas.

And there is close cooperation with the customer, "the customer as the innovator".

Bada's *vast experience* is reflected by its wide product spectrum: Versatile product groups include compounds with highly specialized properties that, from the outset, satisfy individual customer requirements. They also form the best possible foundation for one of Bada's innovations developed with and for customers at their special request [Bada – Customized solutions]: Bespoke solutions wrought from advanced process technology.

> In 2013 *Bada's product portfolio* consisted of customized engineering plastic compounds optimized to suit a variety of applications ever since the company was founded. Bada still offers individually customized materials solutions, contrary to the common trend to restrict the product variety in favor of the production of higher quantities [Bada 2013f].

Bada is convinced that there is a high potential for tailor-made special compounds, due to the fact that technical requirements for plastics and products made of plastics are steadily increasing and plastics are being used for an ever increasing number of materials and applications [Bada 2013f].

"Our customers are still demanding us with new projects and new ideas," said Mr. Schettler with respect to the wide product portfolio. "Our success does confirm our strategy to answer flexible and fast to customers' requirements. We are anxious to optimize the excellent customer service to be a reliable partner for future-oriented compounds." [Bada 2008b]

"Your special compound within a short period of time." [Bada 2011f]

Bada's *mission* is embedded in a statement of CEO Schettler. "Our new management system and the subsequent increase in efficiency within all parts of our business are another great step for *Bada to become the most innovative and modern plastic compounder in Europe*." [Bada 2009d] And it is further specified by factors and aspects.

"Our varied *core competencies* make it possible for us to *offer an absolute added value to our clients at reasonable and competitive costs* with a high level of service and the corresponding *reliability in the execution*," Andreas Schettler summarized the advantages of Bada AG [Bada 2011d].

Core competencies of the company are the development of application- or customer-oriented product solutions. Its broad product base and compounding know-how also make Bada a partner for research and development projects. An example was the BMBF-funded project "NanoDirekt", in which various project partners, especially Fraunhofer ICT, Pfinztal developed compounds based on suspensions of nanoscale fillers [Nanovalley 2015].

Colored, customer-specific products are another core competence. Bada provides, for instance, color matches in TPE-S, TPU, TPE-E and TPV quickly based on available organic dyes or inorganic pigments. Color matches and color productions are constantly monitored both visually and using colorimeters. In conjunction with peripheral components such as mixers and homogenizing devices, even the tightest color tolerances can be met. Thanks to many years of experience, Bada AG's expertise covers various NCS, RAL, Pantone and automotive colors.

Flexibility in *individual color matching* makes it possible to serve many markets that would otherwise be forced to use standard colors or to carry out coloring themselves [Bada 2011g]. This system also enables another polymer (hard component, for instance, PA 6 or ABS) to be delivered on request that is perfectly matched to a soft plastic.

Bada is convinced that *there is a high potential for tailor-made special compounds*, due to the fact that technical requirements for plastics and products made of plastics are steadily increasing and plastics are being used for an ever increasing number of applications [Bada 2013f].

Since 2011 many Bada AG customers were adhering to the philosophy of *procuring everything from a single source* (a "*one-stop-shop*"), an approach that is particularly warranted in the area of colored plastics. As a result, a variety of *different polymers can be supplied by Bada in one and the same color*. The use of the same or similar dyes in all polymers leads to a high degree of uniformity in the appearance of plastics used together. And this is ultimately the aim of such an assembly: a uniform appearance without (unwanted) rough edges [Bada 2011j].

The release of an automotive paint is nowadays project work for a compounder and means a lot of effort. However, the customers of the compounder (injection molders) can benefit from such a release and reduce release times. In recent years, Bada performed development work in this area and has now been able to provide comprehensive color approvals.

The Bada concept "everything from a single source" means the ability to supply automotive interiors not limited to a polymer class, but to polymers for the whole assembly. In addition to releases in the area of polyamide, ABS and TPE-S, there were also releases in bulk plastics such as PP [Bada 2011j].

An assembly produced in this way is able to meet even the most stringent requirements with regard to overall impression and inspires every automotive colorist. Some automobile firms for which Bada got release of an automotive paint include Daimler, BMW and SEAT [Bada 2011j].

Bada's *success factors* are innovation, flexibility, reliability, highest quality standards, and customer-oriented service [Bada – Company Policy].

The *customer's high expectations* and an *increasingly complex market environment* require maximum flexibility with regard to the development of highly customized solutions as well as

product development, delivery service, and customer support. *Reliability* to the customers is the highest priority in times of a continually changing business environment.

For this purpose, Bada invested in sustainable technical sales and distribution structures and enhanced communication with the customers.

Bada's *philosophy* and *vision* emphasizes success factors, technology, workflows and infrastructure, quality and customer service as well as goals for the future [Bada – Customized solutions; Your Chemistry Career]:

Innovative strength and flexibility are the key success factors of the company. As they are not only decisive in the development and manufacture of the products, they also shape activities and actions in every respect.

Central for all individual behavior and the firm's operations is striving for *continuous improvement*: "We work daily to further optimize and rationalize our *technology, workflows and infrastructure* and make them more efficient.

The *vision* is [Your Chemistry Career]: "Combined with individual, customer-oriented service and the highest demands on the *quality* of our work, *in the future we want to reach market leadership as an innovative special compounder and increase the added value for our customers even more noticeably*."

Bada's innovation strategy for existing core product types targets (Table 8)

- Properties/performance improvements including nano-scale components (new grades)
- New applications (other markets, industries)
- Replace components (additives, fillers) by biobased equivalents.

For the transition ("cross-over" strategy) *from petro-oil based additives and polymers to bio-based plastics* a typical approach is DuPont's Sorona® 3GT [Runge 2016:62; Runge:112-113; Runge 2006:583]).

Concerning customers Bada proceeds with a strategy of *exploiting a whole market segment*, including also the fringes. Here, for instance, due to its technical infrastructure, Bada is in the position to not only provide its products also with requested coloration in *very large quantities, but also in medium and even small quantities*.

Another approach is *finding the gap* if in a market segment manufacturers with few products are trying to serve the entire market. Bada is taking a different path here and is particularly *targeting the applications beyond the standards*.

In addition to liquid softened flame retardants or ready-to-dye compounds, Bada also offers special solutions for injection molding as well as combinations of other functional additives.

Bada's highly flexible, liquid-softened compounds are highly flexible as elastomers and at the same time chemically resistant as high-performance thermoplastic tubing for hydraulic fluids, fuels or coolants. In order to meet these requirements, Bada has introduced the product group FM into the program. FM stands for "fluid modified" [Bada 2012k].

In addition to the tried-and-tested chemically plasticized plastics, this is a product group characterized by almost unchanged chemical resistance and E-modules. As a result, these products open up a market segment in which Bada AG has not yet been present.

The following description (Table 8) illustrates Bada's approach to product type extension focusing on Badamid (PA) types. Bada's first few years reflected orientation of developments on extending its Badamid offerings by structural variations of polyamide "6 types". Bada sees itself as the specialist in the development and compounding of polyamide compounds [Bada 2012f].

After 2010 two orientations emerged: lightweight materials and metal replacement,

Table 8: A timeline of Bada's product developments of Badamid polyamide types.

Year	Badamid Products –Polyamide (PA) Types	Ref. 1)
1998	Badamid A, B, C; PA 6	Text
2001	Production and marketing alliance and licensing agreement with Bada Plast for BASF's specialty grades of Ultramid® (PA) (and Ultradur® (PBT). Badamid L licensed products	Text
2005	FAKUMA 2005: Bada was presenting a wide range of tailor-made specialties based on its Badamid® brands (PA 6, PA 66, PA 66/6), Badadur® (PBT)) and through BASF licensing Ultramid® specialties	2005c
2006	FAKUMA: high-temperature polyamide Badamid® T was presented – PA 6/6T (partially with aromatic constituents) characterized by a high melting point; various modifications possible, e.g. flame retarding, dyed/colored and various reinforcing materials; for automotive, E&E	Bada 2006
2007	Established new location in Bühl and subsidiary Bada Hispanaplast SA	Text
2008	PA/ASA-blends. All can be modified and colored according to customers' individual specification	2008a
2009	The Great Recession	
2010	Halogen-free flame-retardant PA 12, with glass fiber reinforcement; good resistance to chemicals, high impact strength and low water absorption; customer-specific coloring and glass fiber content possible	2010b
	PA12 glass bead types in medical colors; for medical housings, a new chemically-optimized and shrinkage-optimized PA 12, resistant to all conventional cleaning agents; glass bead content freely definable; with NCS color scale typical in the medical sector	2010c
2011	Bada launched a new series, the Badamid PPA product series, specially developed for high-temperature applications on the basis of polyphthalamide (PPA), offers improved processability.	2011b
	FAKUMA 2011: New developments for Badamid T (based on PA 6/6T), Badamid PA10T (based on PA 10T), Badamid PA12 (based on PA 12); developed a constant color from batch to batch over the whole "lifetime" of the product, e.g. for PA 6	2011d
	Increasing demands on more and more high-performance materials placed by the automotive sector: A new product range Badamid PPA HT was established, based on polyphthalamide. In addition to high strength over the entire temperature curve it offers improved processability. Both flame-proof, halogen-free types and glass/carbon fiber or impact-modified compounds are possible, also coloring in line with the RAL or NCS colour series	2011f
	In automotive sector e.g. plasticised PA 12 grades with liquid plasticizers problems cannot be avoided, but migration always must be taken into account (a limit); Bada developed PA12 SM-Z grade for tube applications by use of only non-toxic elastomer plasticizers	2011i

Table 8, continued.

	Use of high-performance polymers usually fail due to trivial things like the non-existence of oil temperature control. Badamid T closes this gap, can be run on every conventional injection molding machine with water-cooled dies – even if highest demands are placed on the finished part	2011k
	Bada produced nanocomposites. A compound on PA 12 basis achieved exceptional mechanical properties with 2 % carbon nanotubes (CNTs). Bada developed various formulations as Badamid PA10T, which is based up to 50% on sustainable (biobased) raw materials (castor oil).	2011l
2012	PA 610 provides also an entry into biobased chemistry. It is based on sebacic acid ((HOOC)(CH2)8(COOH)) from *renewable raw materials*.	2)
	FAKUMA 2012: Badamid PA12 and PA1212 for medical applications; highly flexible compounds containing liquid plasticizer; flame retardant grades that contain even less halogen or exceptionally high reductions in density for the *lightweight construction* were some of the new developments to be offered for every kind of application and market	2012b
	Bada completes its polyamide portfolio by PA 612 and PA 610. Badamid PA612 suitable for many applications, for which Badamid PA12 cannot be used due to lower melting point	2012c
	Badamid expanded its Badamid PA12 and PA1212 for medical applications by “hydrolysis types”. In particular for use in hospitals material can be sterilized by hot steam. Furthermore coloration is possible.	2012g
	Lightweight construction and the associated weight reduction of materials plays an important role in many applications with ever-increasing raw material and energy costs. Bada was able to integrate specially modified hollow glass balls into the polymer matrix Thus, it could achieve material densities below the densities of unreinforced polymers. A solution of this kind is particularly lucrative in connection with cost-sensitive high-performance polymers (such as PA 12, PA 612, PA 1212, PA 46, PPA).	2012o
2013	*Low weight material*: Bada’s carbon fiber reinforced compounds are the material of choice, if components with maximal strength and low weight and excellent antistatic properties (carbon vs. glass fibers) are needed. Badamid® A70 CF20 HHC black, a heat-stabilized PA 66 containing 20% carbon fiber, up to 30% possible	2013k
2014	*Substitute metal* for plastics components? Good capabilities for molding, lower production costs, weight savings needed. Highest demands of strength and heat resistance; Badamid A70 GF60 based on PA 66 and reinforced with 60% glass fiber does so, also the semi-aromatic Badamid T70 GF60 HH, being processable with water-cooled machines	2014b
	If the heat distortion temperature and tensile strength of Badamid PA 12 are not sufficient, the use of Badamid PA 612 should be considered; has also high resistance against saline solutions and cleaning agents, suitable for medical technology; also flame retardant types exist	2014g

Table 8, continued.

	A product line Badamid UL A703 GF20-35 FR HF was developed particularly for electrical applications, especially for outdoor applications that are exposed to water and UV radiation. Glass fiber content is within a range of 20 to a maximum of 35%; for content of 25 or 30% it can be produced in any color thus keeping its UL-f1 listing	2014h
	Portfolio of carbon-fiber reinforced compounds for *the substitution of metal* and structural components expanded: a PA 6 with a carbon-fiber (CF) filling of 35% was developed; important for applications in the *lightweight construction*. If, nevertheless, a PA 66 is required the proven Badamid® A70 CF20 HHC black, a heat-stabilized PA 66 with a carbon-fiber content of 20%, is available	2014i
2015	In view of the growing demand for *sustainable products* Bada developed natural fiber reinforced, halogen-free flame retardant technical compounds (project PHOENIX and with TU Clausthal). A stable process was achieved; applications are e.g. housings and cover the E&E industry	2015a
	Maximum stiffness and strength of compounds are mandatory for many applications, often with high requirements on the surface quality. Bada expanded its portfolio by highly rigid compounds with high surface quality, Badamid B70 CF35 black S1. As a *metal substitute*, this material does not only have technical, but also commercial advantages	2015d
	EN 45545-2 classifies the different railway applications and areas according to so-called hazard levels focusing on to what extent a passenger is prevented from leaving the train, by gas, smoke and spreading flames. Here Bada developed Badamid BA 70 FR HF HH, a non-halogen, flame retardant blend made from PA 66 and PA 6 and set a mark for European rail traffic. Listing with UL had already been commissioned, listing also with the German VDE is striven for.	2015g
	Summary of Badamid product types: Badamid A Badamid B Badamid C Badamid T Badamid L Badamid PA12 Badamid PA612 Badamid PA610 Badamid PPA Badamid PA10T Badamid PA46	

1) Reference give only the year component rather than [Bada Year], 2) [Kunststoff Web 2012].

Badamid A and Badamid B are PA6-based with different melting points, Badamid C covers co-polyamides with different properties according to their basic polymer composition. PA 46 is a partially crystalline high temperature material with a melting point just below 300 °C. In addition to its high heat distortion temperature, it stands out for its tribological properties and high impact resistance.

Bada has listed a so-called glass fiber range type with UL. This makes Bada one of the first compounders to offer such a flexible type. This material is referred to as Badamid UL A703 GF20 FR HF (GF25, 30, 35). Bada has listed a halogen-free, flame retardant polyamide 66. This type's glass fiber content may range between 20 and 35 percent. This type is particularly suitable for electrical and electronic applications. It has already been successfully used for series production in this field [2013h].

In the context of reinforced polyamides, low weight and nanocomposites it is interesting to note that Halloysite, an aluminosilicate clay, occurs naturally as small cylinders which average 30 nm in diameter with lengths between 0.5 and 10 µm, Halloysite nanotubes (HNT). Due to its structure, it can be used as a filler in either natural or modified forms in nanocomposites [Fernández et al. 2013].

Polyamide 12 nanocomposites based on HNTs are promising candidates for structural applications. On the other hand, Fernández et al. [2013] of the University de Zaragoza, Spain reported on characterization and processing at the industry scale of nanocomposites based on thermoplastic PA 6 polymeric matrix and Halloysite nanotubes (HNT) as nano-scaled reinforcement.

Three raw materials were used: PA 6 Badamid from Bada Hispanaplast, raw milled Halloysite nanotubes from Naturalnano, Inc, and Pleximer-PA, a masterbatch of PA 6 up to 30 percent weight content of Halloysite nanotubes also from Naturalnano.

Envisioned applications referred to the newest requirements for *lightweight automotive materials* to embrace improved security performance (high impact energy absorption), lower weight (equivalent mechanical properties with lower density) and improved functional specifications (higher flame retardancy and restricted volatile emission). The new hybrid and electric vehicles (HEV) require the key factors indicated to reduce the weight of existing parts to accommodate and new components as the battery pack; all with at least the same security and the greatest possible autonomy [Fernández et al. 2013].

Table 8 and the following text show in detail Bada's approach and marketing efforts:

- Addressing essential physical properties (performance) and associated services
- Applications and met requirements (concerning need, related regulatory compliance or industry standards, market interests/demands)
- Provide alternative Bada products or offering customization
- Make advanced colorizations of compounds a standard offering
- Offering regulatory certifications for products like UK listings as a standard service or as a service on demand.

Bada continued to be active also with regard to blends. For instance, it developed Badalac ABS/PA *as a response to great market interest* in colored and customer-specific ABS/PA and ASA/PA. It further improved these products to surpass by far the current products on the market (flowability, impact strength). They perfectly combine the properties of the two product groups PA and ABS [Bada 2013j].

Such blends are adjusted to the customer's wishes within just a few weeks and can even be delivered in batch sizes smaller than one ton.

The polymer blend group ABS/PA is attractive by matt surface, very good dimensional stability under heat and high impact resistance values. Often, challenging colorings are demanded, especially for passenger compartments. If further characteristics are required like different flowabilities, the product group Badalac ABS/PA offers solutions.

Due to the adjustable flow behavior, the desired matt and homogenous surface can be achieved even for fine structures. The wide fields of applications include small components like sliding elements for air outlets as well as extensive and fine grid structures of loudspeaker grilles up to compact thick-walled cooling unit covers for trucks, passenger compartments and housings [Bada 2015e].

In the context of related complicated regulations Bada developed a non-halogen flame retardant blend made from PA 66 and PA 6 to set a mark for (European) rail traffic [Bada 2015g]. Topping rail traffic the aircraft industry has the highest demands on safety worldwide. Compounds delivered in this area consequently have to comply with these immense requirements.

A standard measures and qualifies, for instance, afterflame times, burning distance and the fact whether the material produces burning droplets.

The fire class is an essential factor, in addition to an excellent surface and mechanical stability. And the new Badalac ABS 30 FR perfectly combines all these qualities. The product complied with the safety values. And, furthermore, had been listed with UL94 V-0 for all colors [Bada 2016a].

The Airbus family A320 and Boeing 737-800 of the international Russian S7 Airlines and Globus Airlines were equipped with parts made of Badalac ABS 30 FR for seat panels and luggage compartments. The parts are produced by Sibir Technics LLC in Novosibirsk/Russia which is allowed to produce plastic parts for the above mentioned aircraft. Actually, this was achieved by a development partnership between Sibir Technics LLC and Bada [Bada 2016a].

> The history of Bada with CEO Andreas Schettler has demonstrated that the firm executed successfully strategy and plans.

After having overcome the Great Recession in 2010 Bada AG *has also* set itself sophisticated *growth targets* in the domain of *thermoplastic elastomers for the coming years*. The list containing already available and developed products with diverse properties is long and can be realized individually or in combination within the product families Badaflex as TPE-S, TPU or TPE-E and Badaprene as TPV respectively.

The Badaflex range of different thermoplastic elastomers differ basically by their underlying polymers or polymer blends: TPE-S (SBS / SEBS-based elastomers), Badaflex TPU (polyurethane elastomers) and Badaflex TPE-E (copolyester elastomers).

The industries and applications into which Badaflex products flow are as diverse as the products themselves. For instance, in 2010 Bada presented flame-retardant TPE-S and Badaprene TPV extrusion and injection molding types in special colors [Bada 2010d; 2011g].

Thermoplastic elastomers now have become well-established in numerous applications in which rubber was previously used. The car interior, under the car bonnet, white goods and electrical applications are just a few segments in which TPE is now used.

Using an electrically conductive filler, Bada developed new grades with antistatic and conductive properties that are suitable for ATEX applications (EU directives to protect employees from explosion risk in areas with an explosive atmosphere, derived from an earlier French title directive entiteled Appareils destinés à être utilisés en ATmosphères EXplosibles).

A car's ventilation system also contains a few soft plastics that need to meet the highest standards with regard to odor. Bada supplies a Badaprene TPV grade specially developed for sealing cups in the air-conditioning system.

In 2013 a flame retardant Badaflex TPE-S (based on SEBS) became also available free of halogen, for allications like cable conduits and seals in the electrical sector where fire risk may occur in case of damage when plastics come into contact with voltage – carrying parts [2013g].

Most recent developments in 2014 of Badaprene TPV were described previously (in the chapter on Business Idea, …) [Bada 2014d).

It was general known that a dynamically cross-linked PP/EPDM, or TPV for short, is a thermoplastic elastomer with excellent mechanical properties for high-temperature applications. However, Bada could show that its TPV product range can be supplied fully colored to customer requirements with no restrictions. Masterbatches were not used at all, and coloring used only organic dyes and inorganic pigments. Flawless colors are the result. [Bada 2011j].

> This was a further example that many Bada customers were about to adhere to the philosophy of procuring everything from a single source, that is particularly warranted in the area of colored plastics.

Around 2011 Bada introduced two new polymers into its product portfolio, when stability is needed. Polyphenylene sulfide (PPS) is the choice when low water absorption, chemical resistance, dimensional stability, a *substitute for metal* and high temperature resistance are required. Notably, PPS was already market-ready in the mid seventies [Bada 2011h].

Being an alternative to metallic materials, engineering plastics with high stability and heat distortion temperatures form an integral part of material science.

The high-performance plastic PPS was considered when two of the aforementioned properties were required in an application. The Badatron PPS product series was developed on a purely customer-specific basis.

The product range in the area of Badatron PPS was very limited. However, Bada closed a gap concerning its offering of customer-specific solutions – even for small sizes of 1 ton or less. Modifications with carbon fiber/PTFE fillers achieved increasing impact strength or conductive grades.

However, the creation of variants of familiar grades was also in demand. Requirements' specifications often contain properties that are not yet achieved by "off-the-shelf" products. These properties only become possible through a (slight) modification of the original product.

Carbon fibers (CF) are additives of choice for reinforced compounds, if components with maximal strength and low weight at the same time as well as excellent antistatic properties are required. The density of carbon fibers is about 30 percent lower compared to glass fibers (GF) [Bada 2013k].

In 2013 Bada launched, for instance, Badatron® PPS CF20 black for parts exposed to severe thermal loads which are used, for instance, in the electrical engineering and automobile industry. While the high melting temperature of PPS (about 295 °C) guarantees highest heat distortion temperatures, the carbon fiber (CF) reinforcement confers high stiffness and antistatic properties.

Compounds with high glass fiber contents are often used for high-tensile parts. However, the processor has to cope with bad surface quality, which usually is the price for additional strength properties to the material. Replacing 10 percent glass fibers by carbon fibers provides very good antistatic properties to the compound [Bada 2013k].

Bada presents its portfolio of highly reinforced compounds also for the substitution of metal. For parts which are permanently exposed to temperatures beyond 150 °C, Bada offered Badatron PPS GF40. PPS is inherently flame resistant and provides highest shape stability for components due to the negligible water absorption [Bada 2014b].

Bada had expanded its portfolio by polyphenylene sulfide (PPS) compounds specifically for applications where even high-temperature polyamides reach their limits. As opposed to polyamide, outstanding properties of PPS are acid and base resistance, high dimensional accuracy of the parts due to its extremely low hygroscipicity, as well as heat distortion temperatures above 250 °C for glass fiber reinforced materials. In addition, these compounds are inherently flame resistant.

Badatron PPS is available either with glass fiber, glass bead or mineral filling to achieve reinforced types or types with shrinkage optimization. Badatron PPS CF20, a carbon fiber reinforced material, has been developed for compounds with extremely high rigidity and electric conductivity [Bada 2014f].

At the FAKUMA 2011 fair Bada introduced its new product range involving polyphthalamide (PPA), Badamid PPA HT, that especially stands out by its high heat resistance, by excellent mechanical properties and by an unsurpassed price/performance ratio [Bada 2011m].

Only one month after the Fakuma, Bada Hispanaplast presented itself at the 16th Equiplast fair in Barcelona. And both José Ramón Lanceta, managing director of Bada Hispanaplast and Andreas Schettler pointed out: “6 years after the foundation, we established ourselves as a reliable and flexible partner for our clients and business partners despite difficult market conditions.” [Bada 2011n]

Due to its low hygroscopicity, Badamid PPA generally offers good dimensional stability and shows minimal warpage and its other properties will not be impaired. Bada offers a wide range of compounds based on its Badamid PPA types. Due to their high melting temperatures Badamid PPA-HAT and Badamid PPA-HP types have ideal thermal properties [Bada 2014c].

As mentioned above compounds with high glass fiber contents often provide issues for the processor, meaning to cope with bad surface quality. Bada detected a possibility to sustainably enhance the surface quality of highly filled, black-colored glass fiber compounds. Based on the development of the polyphtalamide compound Badamid PPA-HP GF60 H S3 Bada AG has succeeded to apply this technology to further products, such as polyamides (e.g. PA 66, PA 6, PA 66/6, PA12, PA 612) [Bada 2015f].

> Bada does not only has to differentiate its products according to requirements of the various targeted industries but also its services.

Due to market requirements for electric and electronic parts and medical devices, a certification in the form of a UL listing is very likely to become indispensable. In addition to tailor-made raw materials solutions for customer applications, Bada offers a UL 64 listing service. Thus, the customer benefits from a UL certification after a successful joint development of the compound that offers the opportunity to expand sales to the US or Canadian markets [2013i].

Bada has an extensive portfolio of plastic types listed with UL. Here, Bada focusses on flexibility. Most of the types listed with UL are available in all colors within their respective listing. Some types are listed as glass fiber range, meaning that all adjustments between the limiting samples tested by UL are listed as well.

If a customer cannot find the desired type after all, Bada will offer a “custom UL Listing”, meaning that it will have the properties of the customized type listed for the customer and provide the UL card for further usage.

Furthermore, for electrical or electronic applications special norms and standards are defined also by the (German) VDE. [6]

Particularly for the electrical industry, VDE approved products are an indispensable requirement for many markets and applications. VDE has been testing individual compounds for Bada for many years to show the VDE certification mark. Unannounced in-shop testing and testing of individual, selected requirements and products once a year ensure the maintenance of the certification.

According to CEO Andreas Schettler “VDE certified products are a strong pillar of our steadily growing product range and a solid base for our customers‘ products. Our new developments always reflect our customers‘ requirements and the latest developments of the market. Thus, we can continue to offer timely provision of tailor-made solutions for our customers’ requirements and products.”[Bada 2016b]

Thanks to Bada’s tight distribution network, the products are currently exported to more than 70 countries (Table 7) in the shortest possible time. The customer base extends from the core area of Europe to Asia, America and Africa [Your Chemistry Career]. Recently, in 2014, Bada

started planning to expand its worldwide distribution network in the CIS states (Confederation of Independent States – Gemeinschaft Unabhängiger Staaten, GUS). It intended to introduce its individual solutions in Russia, Belarus and Ukraine to acquire new customers [Bada 2014j].

Efforts of Bada described so far targeting *marketing and customer relationships* comprise:

Gaining visibility:

- The Web (home page, etc.)
- Presence in technical journals (such as "Compounder of the Month" in the Compounding World magazine [Compounding World 2013])
- Broader public attention exclusively in the business world is achieved by participating in related industry's fairs, exhibitions and conferences
- Attention among researchers from public research organizations and industry may be gained by participation in competence networks and related events of the network
- Reviews in scientific and technical journals; an article on Bada, for instance, in a journal
- Winning various awards and prizes alone or with cooperation partners.

The Bada Web is remarkable as it combines business and related information together with detailed information of applications and numerical data of properties within the "News". Usually these property data are found on technology ventures' Webs under the heading "Products" or "Product Sheets" (Material Safety Data Sheets – MSDS and "Technical Data Sheets") separated from the news.

Detailed reporting of new standard products or *products under development* on its Web and targeted applications and also *envisioned other industrial application fields* is an interesting marketing instrument.

Establishing *relationships with customers* may cover *intentional or opportunistic* aspects. Setting up recently the newly division for application-based market development ("Anwendungstechnische Marktentwicklung", Figure 3) is an example of the first aspect. Organizationally it completed the so-far missing link between its customers, its internal sales representatives and its field sales force. Since May 2013, the division was advising and supporting mainly end customers in the implementation of challenging new projects and development projects to the point of release for series production [Bada 2013e].

Based on the customer's specification, the division will assist in the development of a customized product, no matter whether it is for the automotive or E&E industry, mechanical engineering, medical or food engineering, construction, sports, leisure activities or agriculture. The resulting product will stand out from other provider's standard products, because of its dedicated properties, for instance, mechanical, electrical, fire protection, tribological, haptic and optic properties.

The "strategy, which includes to acting flexibly and rapidly at the request of the customer, is encouraging us to extend our customer service," explained CEO Schettler his visions of the future [Bada 2009i].

And there is more about *Customer Relationships*:

"Customer development" or continuously broadening the customer base requires essentially three actions [Runge:623]:

- Find Them (they also should find you – how? – via the above means to gain visibility)
- Attract Them (by various kinds of value; service, flexibility, speed of development; ... convert first-time customers into customers coming back)
- Bind Them (trustworthiness; reliability, customization, switching cost, … *customer loyalty*).

For technology push situations or disruptive innovations there is a further action partly blended with the above first step:

- Create Them (inform, teach and help them).

Finding customers does not only mean responding to a demand, a product or a problem-solution, but also promoting products and technologies to firms looking for a means of rekindling their growth.

"*The customer as the innovator*" may play an important role in collobarative efforts with various kinds of contacts and interactions.

According to José Ramón Lanceta (managing director Bada Hispanaplast) "innovative thinking and acting and the direct contact to the customer are important growth factors. "We have to consider the technological innovation as well as the process of product development in equal measure and to realize this development together with the customer." [Bada 2013c].

Customer Contacts:

- Sales and after-sales services by highly qualified scientific/technical and sales personnel
- Customer visits; expose many employees to customer contacts
- Individual customization of products
- Test measurements for customers
- Common projects (also addressing potential customers in publicly funded R&D projects, collaborative R&D).

On the other hand, attending fairs represent opportunistic aspects concerning customer relationships, for instance, an opportunity for Bada AG (or its Spanish subsidiary) to capture orders. In Germany the FAKUMA fair, which Bada attended regularly since 2002, plays a key role. Here Bada presents the whole range of new and coming developments to a wide professional audience.

Attending fairs means keeping existing customer relations by communication and discussions, listening, presenting novelties and addressing potential customers by informing on offerings.

- According to Schettler: "We were able to meet lots of interesting new business partners and started numerous promising projects." [Bada 2008b].
- The industry fair can be used "to exchange ideas with regular customers and interested new customers." "An intensive dialogue with the customers is indispensable especially in economically difficult times." [Bada 2009i]
- "We would like to take on new challenges of our customers and develop corporately with them individual solutions for their applications." [Bada 2009i]

In the context of the fairs FAKUMA 2008 and the and Equiplast 2008 in Barcelona and that "the FUKAMA 2008 was a great success for our company" [Bada 2008d] Bada felt already where to position itself on further development: "This combination is the optimal condition to *position ourselves as leading compounder in the field of technical plastics on the market*." [Bada 2008c]

Bada's *risks* are depending on macro developments and on the company level; they concern competitors and finding/hiring and keeping employees and talents, respectively.

Risks are essentially the general economic development and the price of raw materials which depends mostly on the oil price. This means *cyclicality*, the usual ups and downs of the economy. Specifically, this is accompanied by a great uncertainty about the further development of the euro, the state debt crisis in Europe, crises in Eastern Europe involving the Ukraine and Russia as well as recently the Brexit, the UK being about to leave the EU.

Generally, to partly offset the partial cyclical downswing demand in its core business Bada looked to start-up some projects with new customers or new projects with regular customers.

A considerable risk for the future remains the *sufficient supply of raw materials* and the distinct price increases of raw materials. The main main challenge here is the difficult task to pass on corresponding cost increases to the customer.

Bada's answer to this issue: Through a forward-looking inventory management and a stable and well-established supplier and purchasing policy, the supply of the regular customers was almost guaranteed with few restrictions, yet still strategically important new business could be served.

Megatrends were shaping the polymers and plastics industry, specifically [Runge 2016:3]:

- Scientific and technical know-how is globally distributable; a "war for talent has started".
- Competition has intensified, particularly by new players from Asia and South America.

Andreas Schettler response is training in general. "We need qualified and motivated employees – and we can train them best by ourselves." Training is an important and strategic task for him, developing future employees [Bada 2011c].

Bada was honored almost yearly by the employers' association "Chemie Baden-Württemberg e. V." with the certificate "Apprenticing Company of the Chemical Industry".

The above description of the business model of Bada AG is complemented by a structural *business model* in the Appendix (Table 15).

When looking into what made *Bada AG a successful mid-size company* one can refer to success factors which emerged for the German class of companies called "Hidden Champions" [Runge:575-582]. But there are also two dedicated investigations dealing with Success Factors of (German) Mid-Sized Enterprises [Runge:784-786].

Out of the list of (enumerated) critical success factors (CSFs) listed for Hidden Champions the following ones are also observed for Bada:

1. Extremely ambitious aspirations and goals – Market leadership and growth; consequently executing towards achievement of the goals (Best Quality, Best Value, Best Service!).

2. Leadership and Employees – (Led often by personalities with determination, risk taking, persistence and inspiring abilities, who "walk as they talk", have high credibility and act as examples; continuity of leadership; employees work in a high-performance-oriented corporate culture).

3. Offerings are characterized by focus and "deepness" – (Deepness is in terms of a total solution customers seek).

4. Internationalization – (Specialization of products and know how is associated with worldwide marketing and distribution. This means a continuous multiplication of market magnitude: a €2-5 million niche market in Germany translates into a €20-50 million "super-niche" worldwide market).

6. Customers and Competition – (A very narrowly focused niche strategy with a deep understanding of business and customer problems is associated with consistent top service; achieving competitive advantage by product and service quality, delivery flexibility, punctuality, reliability, closeness to customers).

Other investigations added some aspects not listed above. A more general study from 2008 reported on an investigation of 1,300 German mid-sized firms, usually family-controlled, and comparisons with the 180 firms showing the strongest growth revealed, for instance, as its number 4:

4. Manufacturing and networking, bundling product and associated service; cooperate with universities and public research institutes and develop products together with customers or firms of other branches

A study of Ernst & Young (2011) inquired into 68 mainly technically oriented (German) mid-sized and large firms, actually finalists of the “Entrepreneur of the Year” contest, which showed above average growth over a series of years.

The Ernst & Young study emphasized sustainable growth to rely on permanent innovations including internal processes and high appreciation of the firm by its employees and customers and the following success factors:

3. Innovation and investment persistence [Runge:625,627,682]

4. Continuously improve not only offerings, but also organizational processes.

5. Inform and motivate employees – (Firms can trust that their employees are committed to the plans and new developments)

6. Plan ahead – (The firms prepare for possible uncertainties and issues in their business, in particular on those, which they can influence even in the worst case).

Intellectual Properties

With currently relatively little activities in basic research it is not surprising that so far Bada occurs on just one patent as co-owner with further German partners (obtained from the German DEPATISnet patent database of DPMA – Deutsches Patent- und Markenamt).

In Table 9 two members of the patent family with six members of the patent (application) of Bada together with the partners of the project NanoDirekt are given.

Table 9: Bada as a co-owner of a patent resulting from the NanoDirekt project.

Patent Publication Number	**Patent Assignee/Owner**	**Title**
EP000002501746B1	Bada AG; Bayer MaterialScience AG; Byk Chemie GmbH; Coperion GmbH; Fraunhofer Gesellschaft Forschung	[DE] Verfahren zur Herstellung von Kompositmaterialien auf Basis von Polymeren und Kohlenstoffnano-röhren (CNTs) und auf diese Weise hergestellte Kompositmaterialien sowie deren Verwendung
Application Date		
2010-02-08		
Patent Publication Number	**Patent Assignee/Owner**	**Title**
AU002010321303A1	Bada AG; Bayer Materialscience AG; Byk Chemie GmbH; Coperion GmbH; Fraunhofer Gesellschaft Forschung	[EN] Method for producing compo-site materials based on polymers and carbon nanotubes (cnts), and composite materials produced in this manner and the use thereof
Application Date		
2010-02-08		
2010-02-08		

On the other hand referring to its relatively large product portfolio Bada is focused on branding as intellectual property and owns currently ten trademarks on the ®-level (registered trademark) officially registered usually with a patent and trademark office by its owner.

Trade names:

Badamid	Badaflex	Badaprene
Badadur	Badaform	Badatech HT
Badalac	Badalon	Badatron
		Badaprop

Competition

Bada is aware of its competitive situation: “We are constantly facing fierce international competition.” [Bada – Corporate policy] But competition does not only provide threats. Looking into the strength of competitors and how they are doing particular things may be used as examples and for learning how to improve its own operations.

The strong competitive pressure can primarily be sustained by those companies that succeed in strengthening their market position in comparison to the competition through *innovative products* and *efficient production processes*. This requires *continuous investments* in efficient and modern production lines as well as in new and further development of the products.

There are some approaches to respond to competitive threats:

- Catch up with the (products’ properties of the) market and try to provide a *cost advantage* or/and *value advantage* (essentially service)
- Be superior (to the products’ properties of the) market – also by using other product types with corresponding properties (“countertypes”)
- Find a gap in the market to occupy a niche left by competitors due to there inability to respond to an existing demand or intentionally giving up to serve this market segment due to own technical or cost issues, for instance, to produce very small quantities cost efficiently.

Furthermore, with regard to materials’ specification and demand it may be advantageous to not focus on just one or two requested properties of the product (compound) and corresponding performance, but simultaneously on three or more properties opening further applications.

Bada shows strong self-confidence in its strength in relation to competition, and also economic issues. In spite of the upcoming financial crisis in 2008/2009, Bada drew a positive conclusion after FAKUMA 19. “Due to our corporate philosophy, we can often be one step ahead of our competitors, especially regarding the perfect combination of customer fulfillment, flexibility and high quality products,” said Andreas Schettler [Bada 2008b].

In the context of competitors of polyMaterials AG [Runge 2016] a number of firms were discussed which may also exhibit competitive features from Bada’s point of view.

Referring to the spatial distance of few kilometers between Bada AG in Bühl and PolyOne Th. Bergmann GmbH in Gaggenau (and production locations in Huesca, Spain) and Bada’s foundation process originating in PolyOne Th. Bergmann GmbH it is obvious that both firms may be special competitors.

In particular, PolyOne with several European facilities and a strong position in its US home market appears to stand out as *the* international competitor.

Competition may not only exist on the technical and business level, but also with regard to employees. Looking into Xing/LinkedIn profiles of professionals at Bada one sometime detects earlier affiliation with PolyOne. For instance, LinkedIn shows for Christian Attig:

- *Current*: Application-technological market development at Bada AG (Aktuell: Anwendungstechnische Marktentwicklung bei Bada AG)
- *Previously*: Application technology / Sales at PTS Plastic-Technologie-Service, Marketing und Vertriebs GmbH; *Technical Support at PolyOne Th. Bergmann* (Früher: Anwendungstechnik/Vertrieb bei PTS Plastic-Technologie- Service, Marketing und Vertriebs GmbH, Technical Support bei PolyOne Th. Bergmann)

PolyOne Th. Bergmann GmbH

Not only concerning competition, but also with regard to the history of founding Bada it is worthwhile to have a more detailed look at PolyOne Th. Bergmann GmbH.

The PolyOne Corporation was formed in August 2000 from the merger of two in the US Cleveland-area well established firms, M.A. Hanna Company and The Geon Company. For the current entrepreneurship case and competitive situation the focus will be on M.A. Hanna [Encyclopedia 2007]. Hanna's development reflects essentially the developments of the polymers and plastics industry after 1990 as described in the polyMaterials case [Runge 2016].

In 1991 Martin D. Walker, Hanna's chairman and CEO envisioned Hanna to become "less a subcontractor and more a proprietary company" in the last decade of the 20th century. The decision to refocus came on the heels of an early 1990s recession that highlighted Hanna's dependence on contract work that distanced the company from the end users of its products and services. In 1992 the company divested a number of its interest in firms regarded to be no longer relevant for the targeted business [Encyclopedia 2007].

M.A. Hanna completed several more acquisitions in the mid-1990s to both strengthen its US operations and make further inroads into overseas markets. In June 1993, for example, the firm acquired Cookson America Inc.'s *engineered materials* division, which included *Monmouth Plastics Company*, a leading producer of *flame retardant polyolefins* and *Texapol Corporation*, a major producer of *engineered thermoplastic compounds*, including nylon, acetal, and polycarbonate. Then in July 1994 Hanna purchased Theodor Bergmann GmbH & Co. Kunststoffwerk KG, one of Germany's largest producers of specialty and reinforced thermoplastic compounds from H.R.H. Maximilian Markgraf von Baden, the primary shareholder [Encyclopedia 2007; PR Newswire 1994].

Theodor Bergmann reported 1993 sales of more than $40 million (DM65 million, now €32 million). The company had two processing facilities, one at the headquarters and the second at Barbastro, Spain. The Spanish business, Poliamidas Barbastro SA, operates as Polibasa. With 138 total employees – 90 in Germany and 48 in Spain. Bergmann was also one of the largest producers of specialty compounds in Europe [PR Newswire 1994].

According to Martin D. Walker, Hanna's CEO "Bergmann was the top candidate on Hanna's list of potential plastics compounding acquisitions for two reasons. First, "we saw that Bergmann could help us expand our presence in high performance materials and, second, we saw the company as the most technically proficient in Europe." The company supplied specialty compounds, primarily based in nylon 6 and nylon 66, to the automotive and electronics end markets, where Bergmann had key relationships with German-based, global manufacturers. Bergmann also has capabilities to produce compounds based in polybutylene terephthalate (PBT), polypropylene (PP), cellulose acetate and thermoplastic elastomers (TPEs) for a cross section of markets [PR Newswire 1994].

"Bergmann provides substantial advantages to Hanna to improve our compounding technology and expand our market reach," Walker said. He also noted that significant investments were made in 1993 and 1994 to purchase a series of extrusion lines, laboratory instrumentation and sophisticated materials handling equipment.

The acquisition meant raising technology. Concerning Bergmann's fit with M.A. Hanna's US-based businesses, Walker pointed out complementing technologies including high performance compounds and flame retardant materials. Two US-headquartered businesses of M.A. Hanna were leading producers of compounds based on engineering resins and flame retardant materials. Texapol Corporation, Bethlehem, Pa., was a leader in compounding nylon and Monmouth Plastics, Freehold, N.J. a major producer of flame retardant materials. Walker said. "This will save us two or three years and significant costs in developing formulations and getting approvals for the U.S. market. Bergmann also will benefit from the technology and market position of our U.S. compounding operations. Therefore, we will be better able to serve key customers on a worldwide basis." [PR Newswire 1994]

"Bergmann provides Hanna with an engineering plastics foundation which adds to our already strong European presence in the production of specialty colorants for the plastics industry," Walker said.

> "Theodor Bergmann will serve as the nucleus of a M.A. Hanna European compounding business, and *M.A. Hanna will retain the Bergmann management team"* [PR Newswire 1994].

M.A. Hanna acquired Synthecolor, France in 1990 and Wilson Color -- with operations in Belgium, France, Germany, Sweden and the United States – in 1992. Color and additive concentrates are produced at all five European facilities. "We are building a stronger base in Europe to market specialty materials, ranging from specialty colorants to compounds based on engineering resins," Walker observed.

In December 1994 a share/investment company MEDUSA Beteiligungsverwaltungsgesellschaft Nr. 6 GmbH, was established at the location of Bergmann (Gaggenau), led by Oswin Weiser (Baden-Baden) and Henry Garth (Cleveland, Ohio) which later became Hanna Deutschland GmbH, and then PolyOne Deutschland GmbH/Gaggenau and finally relocated to Melle in Germany. Between Bergmann as controlled company and the company "Hanna Germany GmbH" in Gaggenau a profit transfer and control agreement ("Ergebnisabführungs- und Beherrschungsvertrag") had been completed in December 1994 [Moneyhouse].

The Spanish subsidiary Polibasa Poliamidas Barbastro SA (in the Huesca province) and its sister company were subsidiaries of M.A. Hanna Deutschland GmbH, Gaggenau. And Oswin Weiser was manager of M.A. Hanna Deutschland and Bergmann. According to Weiser the amount of material available from Polibasa was no longer sufficient to supply the requirements of the Spanish, Portuguese and North African markets, as well as the specialties required by customers of the German subsidiary. Correspondingly, new PA and TPE compounding capacity was built in Spain due to the growing demand from the auto industry [Plasteurope 1996].

With the new compounding plant Polibasa was able to produce 10,000 t/y of compounds as well as 3,500 t/y of TPEs. Its PA manufacturing capacity of 4,000 t/y was unchanged. In addition Bergmann had 23,000 t/y of compounding capacity at its Gaggenau plant. In 1995 Bergmann and Polibasa achieved a total turnover of DM 96 million (now €48 million) with 180 employees (65 of whom were based in Spain) [Plasteurope 1996].

Megalibro specified Polibasa to produce polyamides PA 6 (60 percent), PA 66 (5 percent) and Bergaflex (35 percent) [Megalibro].

M.A. Hanna Company had become a leading international specialty chemicals company focused on the plastics and rubber industry. It reported 1993 sales of $1.5 billion or DM2.4 billion (now €1.2 billion). Primary businesses of M.A. Hanna were plastics and rubber compounding, color and additive concentrates, resin distribution and polymer products [PR Newswire 1994].

In a stock-swap deal announced in May 2000 and completed that September, M.A. Hanna and Geon merged to form the PolyOne Corporation: Hanna + Geon = PolyOne. The combination

created the world's largest polymer company, with a range of operations consisting of polymer compounds, color and additive systems, specialty resins, rubber compounds, engineered films, and polymer distribution. PolyOne began with a workforce of around 9,000 and 80 manufacturing sites around the world. On a pro forma basis, combined revenues exceeded $3 billion. The firm was initially headquartered in Cleveland, but later moved to the nearby city of Avon Lake, where Geon had been based [Encyclopedia 2007].

In 1996 Geon promoted Thomas Waltermire to chief operating officer, placing him in charge of day-to-day operations. On the management front, Phillip Ashkettle, who had headed Hanna, had been slated to serve as chairman and CEO of PolyOne, but he abruptly resigned from Hanna just before the merger was consummated. As a result, Waltermire took control as PolyOne's first chairman, president, and CEO [Encyclopedia 2007] – one year before Bada's foundation.

Ashkettle served as President and Chief Executive Officer of M.A. Hanna Company from June 14, 1999 to August 2000 [Encyclopedia 2007]. Ashkettle would have filled the top position at PolyOne and Waltermire would have been president and chief operating officer of the new company. Waltermire would have succeeded to the CEO position in 2002, and to the chairmanship in 2004 [PRNewswire 2000].

Timothy Gerdeman, who followed Hanna for Lehman Brothers, said the move "reflects the board's frustration with the company's languishing stock price" since the merger was announced, and it should allow the deal to proceed more smoothly. Hanna's shares have dropped more than 30 percent since May 8. "The financial community as a whole tended to deem Geon as a better managed company than Hanna," Gerdeman noted [Paton 2000].

Products of PolyOne Th. Bergmann GmbH included [Kunststoff Web; Kompany]:

Plastic raw materials, auxiliaries/intermediates and chemicals, specifically the products,

- PA - Bergamid®
- PBT/Bergadur®
- PP - Maxxam®
- POM - Bergaform® (polyoxymethylene)
- TPE-V Onflex (networked –"vernetzt")
- TPE-S Onflex S/Bergaflex®
- TPE-O Onflex
- TPE-U Onflex
- PET Petal®
- PC, ABS, PC/ABS-Blend-Edgetek®

By 2006 PolyOne put an emphasis on TPEs and developed a new process for TPEs. According to PolyOne production of TPEs had experienced an annual growth rate of 6 to 12 percent in the last decade. While the market for thermoplastic elastomers was growing constantly, the demand grew for the networked types disproportionately. In the last three years the compounder increased its production capacity of TPE from about 4,500 tons to around 7,000 tons per year [Rehmet 2006].

PolyOne claims to be the world's largest polymer services company, providing customers with a single source for polymer, colorant, and additive products. With its products and complete range of support and technical services, it defines its mission as follows: We help people work wonders with polymers! [Chemnet].

In 2011 PolyOne announced the opening of an "Innovation Center" in Gaggenau. This facility will support application development for the specialty platform by providing customers with capabilities for development, testing, process optimization and color matching. PolyOne said it has invested over €1 million ($1.2 million) in the center [Kunststoff Web 2011].

"The ability to replicate manufacturing conditions will facilitate faster and more efficient product launches for our customers, thereby reducing their time to market, risk and design costs," said Jean-Marc Verhaeghe, global marketing director, PolyOne Global Engineered Materials. "This new facility demonstrates our firm commitment to delivering specialized service and material solutions that create value for customers and help them bridge the gap between concept and commercialization. By streamlining the design process, customers can slash development time while optimizing efficiency – two keys for a major competitive advantage." [Kunststoff Web 2011]

The Gaggenau Innovation Center features an advanced testing laboratory that includes a spectrum of processing and color matching equipment as well as computer simulation software. Testing can be conducted for mechanical properties, such as modulus, ductility, strength and physical properties, such as density, electrical resistance, and creep as well as rheological and flammability behaviors.

Production-grade processing includes twin-screw extrusion lines for TPEs and engineering materials, a profile extrusion line for quality assessment of TPEs, and injection molding machines (one and two component) for sample geometries and prototypes [Kunststoff Web 2011].

PolyOne Th. Bergmann GmbH has currently about 160 employees in Gaggenau [BNN 2016] and is focused on highly specialized plastics, mainly for the automotive and electrical and electronics (E&E) industry [BNN 2016]. In 1996 it had 115 employees [Plasteurope 1996] and 145 in 2014 [EB]. Its revenues were €61.7 million (2014) and €60.1 million in 2013 [Statista].

The competitive scene for Bada does not only comprise firms developing, producing and distributing compounds and blends for further processing and application by third parties but also firms operating like compounders, but focusing on product design and manufacturing components and parts for end-use.

During Bada's development until ca. 2013 LS Kunststofftechnologie was such a venture (LS = Lösungen und Systeme, Solutions and Systems). In 2013 the French firm Saint-Gobain purchased the company and finalized the acquisition in 2014 [Saint-Gobain 2014]. The company now operates with the name Saint-Gobain Performance Plastics L+S GmbH.

LS Kunststofftechnologie GmbH – Saint-Gobain Performance Plastics L+S GmbH.

LS co-develops tailor-made solutions in response to its customers' specific requirements and has cutting-edge expertise in design, tooling, testing and the processing of high-temperature polymers. The addition of LS to Saint-Gobain Performance Plastics and the Seals group will help boost international sales of its polymer products.

The acquisition of LS Kunststofftechnologie GmbH provided Saint-Gobain Seals with the knowledge and long standing *experience in polyamide-imide (PAI) compounds*, which strengthened their polymer solution portfolio, especially in the automotive market [Woodward 2014].

LS Kunststofftechnologie was a medium-sized company specializing in the processing of high-performance polymers to produce components and parts. The related injection molded parts are used primarily in the automotive industry and in medical technology. The company viewed itself as the leader in this field.

Originally LS Kunststofftechnologie produced numerous injection molded parts. The product portfolio consists of plain bearings, precision parts, multi-component parts, high-performance polymers and disposable medical products. The company had its own compounding plant, a material testing laboratory, the research and development department and a tool manufacturing department ("Werkzeugbau") [Wer zu Wem 2014]. This means, in-house capability covers the entire process from initial design and thorough testing to high quality production.

In 2013 the company had two production sites, one in Wertheim-Bettingen (Federal State of Baden-Württemberg) and the other in Neuhaus, near Erfurt, in Thuringia and more than 220 employees. In 2014 the firm had more than 240 employees in both locations and ca. 130 in Wertheim [Riffenach 2014]. Major markets were automotive, mechanical engineering and medical technology [Saint-Gobain 2014].

Saint-Gobain Performance Plastics L+S GmbH views itself as a leading processor of high performance polymers.

Almost all the plastics which are processed are high-performance polymers. The focus is on:

- Seal rings and thrust washers in gear boxes and drives
- Highly wear-resistant components subject to sliding and other forms of friction
- Maintenance-free and low maintenance plain bearings
- Precision parts and multi-component applications.

Their seal rings, thrust washers and precision components reduce friction, leakage, wear and noise and contribute significantly to more energy efficient designs.

Specifically, LS Kunststofftechnologie offers gear shifters, rectangle sealing rings, straight or helical gear wheels, ball bearings and ball cages. The range is supplemented by pump components and pressure pieces (“Druckstücke”) [Wer zu Wem 2014].

In Figure 5 for LS Kunststofftechnologie the chronological sequence of major events and involved partially intermediate companies is displayed.

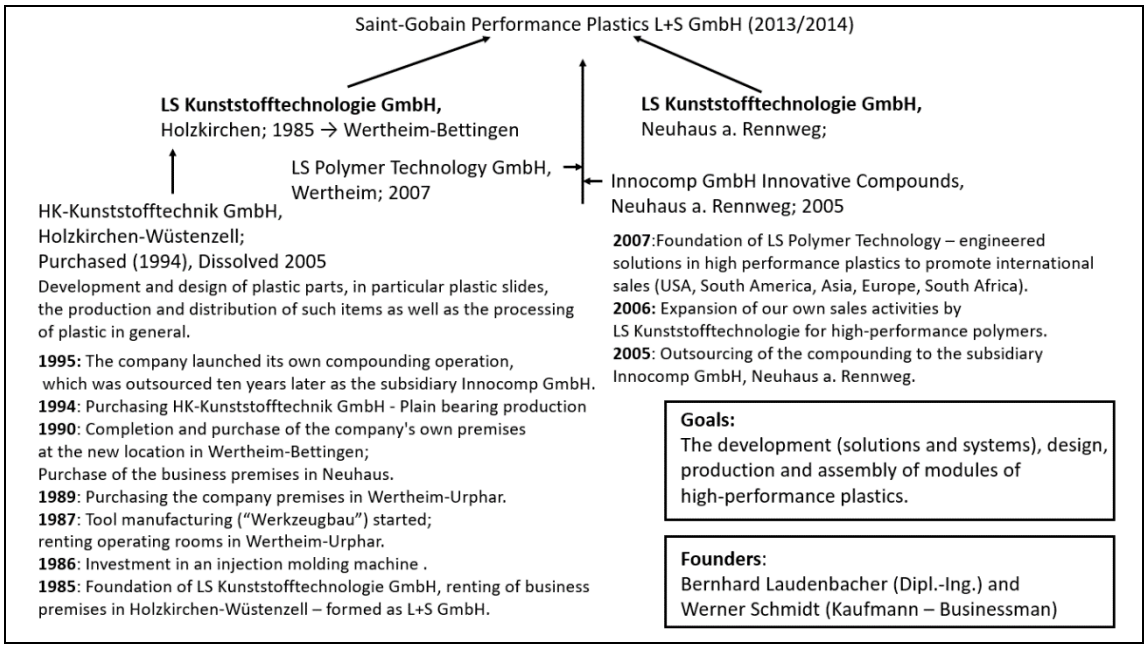

Figure 5: The foundation development of LS Kunststofftechnik into Saint-Gobain Performance Plastics L+S GmbH and involved and intermediate companies [Wer-zu-Wem 2014; Saint-Gobain; Handelsregister].

For instance, key activities of Innocomp GmbH Innovative Compounds and LS Polymer Technology GmbH were as follows:

The application-specific modification of plastics, in particular the procurement of the base polymers, fillers, reinforcing materials, fibers, modifiers, lubricants, additives and the like. Activities included also the corresponding formulation development and the development of the necessary process engineering [Moneyhouse – Innocomp].

Goals were the development and distribution of plastic parts made of high-performance polymers and tribologically stressed components made of special polymer materials. [Handelsregister – LS Polymer].

A major task of the company as a part of Saint-Gobain is the production of seals for rotating components. They are mainly used for gears with step automation ("Stufenautomatik"), CVT (Continuously Variable Transmission) and double clutch transmission ("Doppelkupplungsgetriebe"). It runs specific manufacturing cells for sealing rings [Wer zu Wem 2014].

With many years of technical experience in material selection and compounding for injection molding the venture focuses on high performance components in tribological applications that, due to certain mechanical and thermal demands, cannot be realized via conventional plastics. With in-house expertise covering the complete process from product design, testing, tool manufacturing and precision molding up to reliable global supply LS obtained a firm position on the market..

Several of their applications include high-performance seal rings, thrust washers and other friction reducing elements for all transmission types. These components reduce friction, leakage, wear and noise and contribute significantly to more energy efficient designs [Saint-Gobain 2014].

Now LS *co-develops* tailor-made solutions in response to its customers' specific requirements and has expertise in design, tooling, testing and the *processing of high-temperature polymers*. In this regard the synergy effects between Saint-Gobain and LS showed up by the emergence of the Meldin 4000 Series of compounds, based on polyamide-imide (PAI, polyimide), to its product portfolio [Woodward 2014]

According to the company, this product was developed as a result of its collaboration with the recently acquired LS Kunststofftechnologie GmbH and is a perfect fit with the Group's strategy of strengthening its positions in high-performance and co-developed solutions [Woodward 2014].

This new series is part of their Meldin HT product line, which includes the Meldin 1000 and 5000 Series, and complements their other polymer product line, Meldin 7000 thermoset materials.

The Meldin 4000 compounds are stiff, retain high mechanical strength at elevated temperatures, are extremely durable even when used in harsh applications in regards to wear, and are chemically compatible with all common automotive fluids (fuels and oils). Due to the inclusion of these high-performance properties, the Meldin 4000 product became a very suitable *replacement for metal components*, having the advantage of *being much lighter* since the specific gravity is 80 percent less compared to steel [Woodward 2014].

Saint-Gobain Seals' existing Meldin® HT thermoplastic materials product line is available in compression or injection molded, machined components and basic shapes in order to provide the most added value in customization and design flexibility. These materials retain their critical properties over a temperature range from cryogenic through +316 °C for continuous operation and may be used intermittently up to +482 °C [Rowe 2015].

Saint-Gobain Seals is a strategic business unit under Saint-Gobain Performance Plastics' Engineered Components SOA (sector of activity).

Saint-Gobain Performance Plastic L+S GmbH is preparing for future growth with a €3 million investment in a new building at its Wertheim headquarters. Along with building additional *space for the production* portion of their business, the new building will feature *a dedicated global training and technology center,* offering an inventive and constructive environment for their engineers *to develop individual customer solutions* based on growing and future needs [Rowe 2015; Riffenach 2014].

“With this initiative, we will be able to meet our customer’s requirements for innovative solutions,” said the Managing Director of Saint-Gobain Performance Plastic L+S GmbH. And the Global Market Manager – Automotive added “The training and technology center offers a creative environment to work jointly with our customers on new developments which will be a key element for the future.” [Rowe 2015].

Apart from the Meldin® HT (PAI) product line Saint-Gobain Seals also offers fluoro compounds, such as OmniLip™ PTFE Rotary Shaft Seals, Rulon® High-Performance Fluoropolymer Compounds, Meldin® 7000 Thermoset Polyimide Materials [Rowe 2015].

The electrical and electronics (E&E) industry is under unprecedented regulatory pressure to conform to tough health, safety and environmental directives that render many commonly used plastics and elastomers non-compliant. The issue for suppliers is improving performance while reducing the health and environmental impact of the materials used.

Legislation required the plastics and elastomers used by the industry to be halogen-free and flame-retardant, to produce low smoke emissions, be recyclable, and comply with the WEEE and RoHS Directives and the REACH Regulation on managing chemical risks and substitution. Key standards and tests for E&E industry compliance cover IEC 60335 and UL 94 for the safety of electrical appliances and the flammability of plastics used, EN 45545 for the fire testing of materials and components for trains, and UL 746 to evaluate the physical, electrical, flammability and thermal properties of polymers for electrical equipment.

Flame retardant chemicals find its usage in various electricals and electronics, such as

- Consumer electronics: Smartphones, laptops, DVRs, and TV sets
- Communication and technology equipment: Computer servers, modems, microprocessors, radios, fax machines, and printers
- Electrical appliances: Dishwashers, vacuum cleaners, clothes dryers, and refrigerators
- Electrical parts: Connectors, plugs, switches, USB ports, and socket connectors.

Additives used with commodity polymers cannot give the best results with high temperature polymers. This is because of the lack of high temperature stability of these traditional additives. This has led to the development of *specific additives that can be used with high temperature polymers*. The three main high heat additives comprise antioxidants, flame retardants and processing aids used with high heat polymers.

With regard to flame retardency as a competitive field Bada’s recent efforts in non-halogenated flame retardant (NHFR) compounds included the above described PHOENIX project [Bada 2015a] addressing particular electrical and electronic (E&E) applications and Badamid BA 70 FR HF HH, a non-halogen, flame retardant blend made from PA 66 and PA 6 for European rail traffic [Bada 2015g].

Flame-proof, halogen-free types are possible. In 2011 already Bada introduced a new product range Badamid PPA HT, based on polyphthalamide. In addition to high strength over the entire temperature curve it offers improved processability [Bada 2011f].

In this field also giant firms may be active. For instance, DuPont Performance Materials (DPM) materials offers NHFRs that comply with tough non-halogen, flame retardant (NHFR) requirements and keeps track of key emerging trends of the field. DPM’s NHFR products for electrical components include Crastin® PBT, Hytrel® TPE, Rynite® PET and Zytel® PPA and PA 66 polyamides [SpecialChem 2016],

geba Kunststoffcompounds GmbH

A company and competitor which presents a number of similarities to Bada AG is the German firm geba Kunststoffcompounds GmbH (Ennigerloh, North-Rhine-Westfalia). Its development to the current state proceeded through various phases with different main orientations and

company names, for instance, GEBA Kunststoff-Recycling und Kunststoff-Handels GmbH or EKH Gnegeler Kunststoff-Handelsgesellschaft mbH [Kompany – geba].

geba started as a trading company like the Feddersen Group and its connected firms (like AKRO-PLASTIC GmbH or PolyComp GmbH). It emerged from K.D. Feddersen & Co. which started to trade with plastics, specializing in distributing chemical products. Another example is TechnoCompound GmbH of the German Polymer Group [Runge 2016:81-83].

geba Kunststoffcompounds GmbH sees itself as one of the leading compounders of thermoplastics in Europe.

Apart from the *development and production of plastic compounds and recompounds*, the service spectrum includes product consulting and support for material recycling as well as technical consulting. In addition, geba's main focus is on contract grinding and contract granulation, laboratory testing and analysis, color matching and logistics and storage, including Just-in-time (JIT) delivery. JIT services are offered by geba Polymer Logistik GmbH (transport and inventory services) which was generated as a spin off in 2004 to become operational in 2005.

Generally, recompounds are produced from recycled plastics – with mechanical and/or chemical properties which are very close to the properties of originally new materials. Recompounds are therefore a cost-effective recycling alternative to cost-intensive new products which are specially adapted to customer requirements. The recompounds are basically produced from pure production residues and pure, used plastics.

Concerning JIT services geba stores almost all the plastics granulates of a customer in its warehouse so that the customer's inventory/stock is connected electronically to geba's. The company works under a "just-in-time" formula doing all the customer's shipments on time and in the short term, regardless whether the amount is large or small [Interempresas.net 2011].

For instance, for years, the customer Hella has stored almost all of its need for geba's granules with geba and is calling for the required quantities between a few kilograms and several tons via both the electronically interlinked inventory management systems. Quality-tested compounds are *delivered just-in-time* [Plastiker 2011].

Basicallt geba's service package ranges from application advice and help with component and application-oriented formulation development through customer-specific color design to pre-production development and homogenization of product batches. The service also includes material testing and individual logistics solutions. This was seen to provide geba a special market position [EB geba 2006]. geba's service for injection molding and extrusion ranges to pre-production development [Kunststoff Web – geba].

geba was founded in 1986 in Gütersloh. A year later, it moved to Ennigerloh and built its own production plants in 1990. It is a *family-business* and was founded by **Di**eter and **L**iane Gnegeler. In 1998 their son **S**ven Gnegeler founded the subsidiary Gecomplast SL in Valencia, Spain (Figure 6) [Interempresas.net 2011].

Gecomplast SL has its own development and production of compounds, tailor-made "everything of own production" service and proximity to the customer in terms of production and service. Dieter Gnegeler said that "with its proximity to the customer, we have positioned in a situation of exclusivity, which has opened more doors for us to access international clients in the sector of automotive, household appliances, electrical & electronic and sporting goods." [Interempresas.net 2011]

With the start of a new plant in St. Veit in Carinthia (Kärnten – Austria) in 2006 geba was focusing on the booming plastics processing industry in the south and south-east of Europe. According to a sales and distribution manager of geba Kunststofftechnik GmbH & Co KG "We want to position ourselves as the first address for thermoplastic granulate and powder compounds as well as for colorbatches in Austria, Italy, Hungary, Czechoslovakia and Slovakia as

well as in Slovenia." Doubling sales here until 2011 shall be achieved by "*everything from one hand*" service. Cryogenic fine grinding of thermoplastics plays a central role [Plastiker 2006].

The new plant started operation in 2006. In total, more than six million euros were invested. The number of employees was planned to be increased from 10 in 2006 to mid next year to 23. The technical equipment included, among other things, two extrusion lines and two systems for the cryogenic fine grinding of thermoplastics. Both processes had a yearly capacity of 2,500 tons in the first stage of development [Plastiker 2006].

Thermoplasts, waxes and various rubbers can be ground by them. geba views the *cryogenic fine grinding of thermoplastics* as a unique selling proposition (USP) relative to its competitors. Certain functional plastics are only made possible by small particle sizes of about 100 µm (micrometer) [Zwettler 2006].

Other important fields of application for the finely ground thermoplastics are solvent-free hot-melt adhesives, respiratory-active impregnation of rainwear and sportswear, coating of filter fabrics as well as the lamination of fabric and non-woven inserts during shoe manufacture [Zwettler 2006].

At the plant in St. Veit the technical equipment for the production of *color masterbatches in microform* was also installed. These are currently experiencing strong demand because the dyeing process with them can be more economical and controlled [Zwettler 2006].

geba views *color matching* as a *core competence* and experience, especially for assemblies in the car interior and for domestic appliances, the individual parts of which are composed of different thermoplastics [Zwettler 2006].

The plants in Austria and Spain allow geographic proximity to the customer. geba viewed the plant location of Carinthia with its bordering to many countries as a real location advantage and wanted to benefit from the economic growth of these countries [Zwettler 2006].

A strong Europe-wide distribution network provides a presence all over Europe. Representations are located in Christiansand (NO), Wroclaw (PL), Vienna (AU), Porto (PO), Budapest (HU) [geba –Worldwide].

geba Kunststoffcompounds GmbH is funded mainly via the parent company DLS Beteiligungs GmbH (Figure 6).

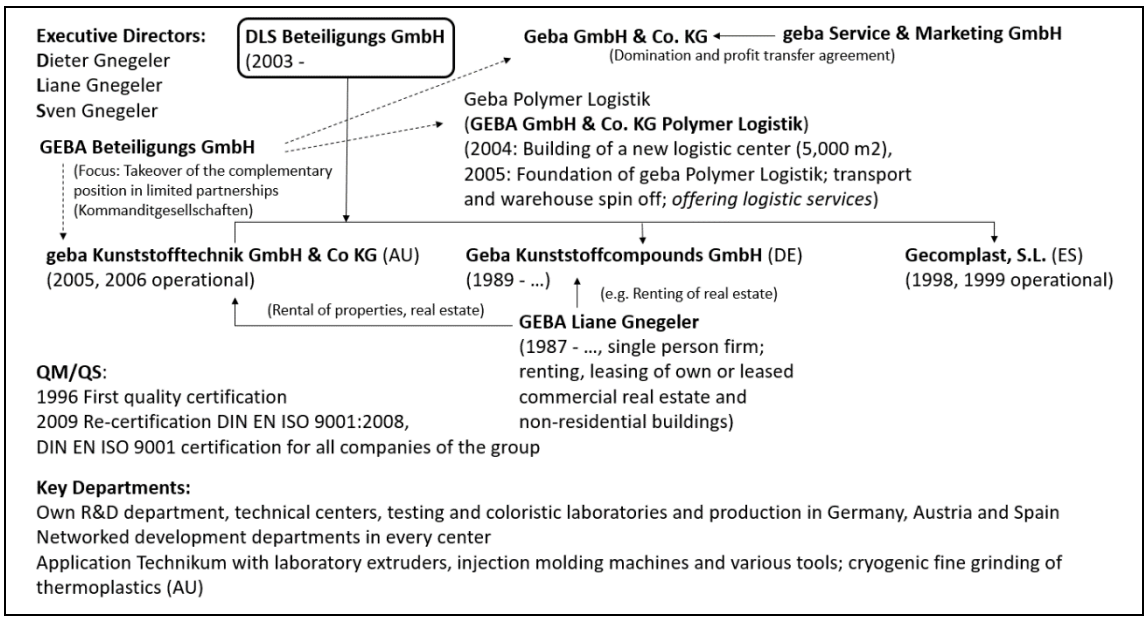

Figure 6: Sketching the geba Group as a network of firms managed by one or two members of the Gnegeler family.

The DLS contruct means that there are no liabilities to credit institutions, so the company is independent from bank loans [EB geba 2009]. However, the geba Group is a rather complex network of firms involved in financing and management or functions of the value chain.

The company's founders see the *success* in the development and production of exclusively proprietary compounds in high quality with service ranging from application advice, customer-specific color design to individual logistics solutions. Development services are provided at all sites [Plasticker 2011].

The first step of individuality of products and/or services is an intensive discussion with the customer of the application required. With a view towards concrete goals a specific requirement profile is developed.

A particular area is the development of compounds with *special colors or with optical effects*. geba has extensive experience in the color matching of assemblies whose components are composed of different materials.

In 2011, the commpany's 25th anniversity, geba was mainly involved in customers of the *automotive, household appliance, electrical/electronic and sporting goods industries*. For example, together with the customer the German firm Hella complex questions, such as color matching, the use of metallic compounds in headlamp components or the application-specific formulation development of compounds for electronic components were performed. [Plasticker 2011].

Hella is a global, more than 100 years old German family-owned company listed on the stock exchange. It develops and manufactures lighting technology and electronic products for the automobile industry and has one of the largest retail organizations for vehicle parts and accessories in Europe. Sales are around €6.4 billion with 34,000 employees.

In the future, as a direct supplier of large OEMs, other industries, such as medical technology, shall also be developed. And the goal is also to benefit from new markets resulting from global megatrends, such as electric mobility or alternative energy generation, by specialty compounds developed for customers or in-house [Plasticker 2011].

Sven Gnegeler, as Manager of Gecomplast in Spain and Board explained that "in the future we want to maintain our position *as an international producer Full-Service-Compoundeur* and grow in other areas such as the *medical industry* as well as direct manufacturer of large OEM." And he pointed out that "in addition we intend that through our compounds we can enter into new niche markets developed through global megatrends such as electric vehicles and/or renewable energies." [Interempresas.net 2011]

The *success formula* of the company is: "Exclusively own development and production of compounds in top quality, an all-in-one service fitted to the customer and proximity to the customer in production." [Die Glocke 2011]

"We focused early on supporting our customers with a broad range of services ranging from application consulting, customer-specific color design to individual logistics solutions. We also sought geographical proximity to our customers and followed them to new regions in Austria and Spain to develop, produce and provide services on site. This has allowed us to quickly develop a unique selling proposition (USP) that has opened the door to many well-known customers in the international automotive, household appliance, electrical / electronic and sporting goods industries." [Die Glocke 2011]

Also capacity expansions were planned. More than 20 extrusion lines with 18,000 tons capacity annually were installed. Still in 2011 the machine parks in Ennigerloh/Germany and Spain were to be expanded by two modern extrusion lines.

Now it operates more than 25 extrusion lines and its own R&D department as well as technical centers, testing and coloristics laboratories in Germany, Austria and Spain [Lüling Marketing 2010].

geba's current mission statement emphasizes the following aspects [geba – Mission]:

"As one of Europe's leading *independent full service compounders* we refine engineering thermoplastics and high performance polymers with about 160 employees at three locations in Germany, Austria and Spain. *Customer orientation* and *quality* are our trademarks. The customer stands always in the focus. Our plastics are tailor-made and developed together with the customer and meet the customer's needs. From development to delivery and reprocessing":

"The constant efforts to reduce energy consumption during the manufacture of our products, the avoidance of waste by means of measures to reduce the scrap material and the reasonable re-use of scrap quantities and the use of basic materials from recycling sources if possible and meaningful."

Concerning *cooperation* agreements, Bayer MaterialScience (now Covestro) was developing TPU compounds, which geba produces and sells for the Leverkusen chemical firm. With Ticona, geba combines a strategic partnership in the compounding of polyoxymethylene and liquid-crystalline polymers (LCPs) [Plasticker 2011].

geba is *particularly interested in* the growth potential of *thermoplastic polyurethanes (TPUs*) for slush skins of car instrument panels. Therefore, it had entered into a *research collaboration in St. Veit with Bayer MaterialScience* to fine-tune special variants of Bayer's Desmopan® products. These products for the car fitting do not use plasticizers and thus, in contrast to the still current PVC, avoid plasticizers which always diffuse to the windshield [Zwettler 2006].

Following Covestro's high quality TPU types of Desmopan® both partners develop also other tailor-made TPU compounds. Current polyurethanes (TPUs) cooperation refers essentially to "Desmovit". Desmovit® covers reinforced, additived thermoplastic polyurethanes of geba-Group and Covestro. Additionally, geba Group offers a separate, comprehensive range of polymer specific color and additive systems. Together with Covestro geba developes reinforced, electrically conductive and colored thermoplastic polyurethanes.

The Desmovit® model series meets a variety of specific customer requirements. It is continuously being customized and refined to adhere to broadly diversified fields of application, in order to complement the classic and well-proven types of Desmopan® and satisfy new customer requests. The newly developed series Desmovit® DP R CF is a range of ester-based, carbon-reinforced TPUs.

As a member of the geba group, geba Kunststoffcompounds GmbH produces and distributes exclusively inked, conductive and glass fiber-reinforced TPU products of the Desmovit® brand [EB geba 2014].

There has been a long lasting contact of geba with Prof. Dr. Georg Samland of the Department of Mechanical Engineering of the University of Applied Sciences (Fachhochschule) Münster. This led to a cooperation in terms of a student's Bachelor/Master work dealing with the issue how to measure and compare the abrasion of plastics. It had turned out that the devices available on the market do not meet the individual requirements of geba. Hence, a dedicated tribometer according to the requirements of geba customers was set up [geba 2016b].

According to Sven Gnegeler: "With the help of the tribometer, we are able to precisely determine the friction and wear as well as the scratch resistance of plastics and to create binding measurement series with comparative data. Some customers want modified surface properties. We can already supply them today, but in the future they will underpin verified test results." [geba 2016b]

Currently geba Kunststofftechnik GmbH & Co. KG is taking part in the FFG-sponsored "StoreITup-IF" project for the research and development of thermal storage systems (FFG: Die Österreichische Forschungsförderungsgesellschaft).

The project aims to develop an economic latent heat storage unit with polymer phase change materials (PCMs) in a temperature range of 80 °C to 400 °C [Industrie Magazin 2015].

Aspects, such as increasing the thermal conductivity, increasing the storage density, minimizing the volume change during the phase transition, as well as long-term stability and reproducibility are the focus. In the project, geba takes over the industrial production of polymers developed for the PCM storage in cooperation with the Leoben Montan University of Technology and the Austrian Institute of Technology (AIT) [Königsreuther 2015].

geba was test winner for the thermally conductive polymers with its heat-conducting polymers in the preliminary project StoreITup! against fourteen well-known European plastics manufacturers. Thermally conductive plastics have advantages in free formability, in price, in weight and are thus optimally suited as PCMs [Industrie Magazin 2015].

These heat storage systems have the advantage over conventional systems that they can also store latent energy in addition to the sensitive energy and thus have a higher energy density. The latent energy (hidden energy) stores the enthalpy in the material during the physical phase transformation process, without the temperature of the transformed substance changing drastically. Salts or paraffin oils are currently used as phase change materials.

As a summary, geba strives for an *"All from one" approach*. geba is working on the market with a very broad range in the field of thermoplastics [Zwettler 2006].

geba's service package ranges from application advice, help with component and application-oriented formulation development through customer-specific color design to pre-production development and homogenization of product batches. The service also includes material testing and individual logistics solutions. As a result, geba offers a customer-oriented package solution [EB geba 2007].

geba's product range covers the production and development of plastic compounds in the form of recompounds as well as genuine product compounds. The offer is complemented by masterbatches in the form of color, function and combination masterbatches (Table 11). Sales are made directly (business-to-business) and purely order-related [EB geba 2009].

It offers also producing pure recycled material from the customer's production waste, saving the customer money and resources while providing him with a tested, defined material.

In the past years, it has invested substantially in the expansion of its laboratory and in state-of-the-art production and logistics technology. A strong Europe-wide distribution network provides a presence all over Europe [geba – Company].

geba shows an extremely diversified offering of raw materials and auxiliaries, particularly basic polymers and blends thereof (Table 10) and other offerings and services (Table 11).

Table 10: geba product categories – raw materials and auxiliaries [Kunststoff Web – geba]

Polyamides: Polyamide-blends, PA 11, PA 12, PA 6, PA 46, PA 66 **Polybutylene terephthalate (PBT):** Polybutylene terephthalat blends	**Polycarbonate (PC):** Polycarbonate-blends **Styrene-acrylonitrile-copolymers (SAN)** **Acrylonitrile styrene acrylate polymer blends (ASA)**	**Polyetheretherketone (PEEK)** **Polyetherimid (PEI); Polyethersulfon (PES, PESU);** **Ethylene Vinylacetate copolymers (EVA)**	**Thermoplastic polyurethane (PUR); Thermoplastic urethane (TPE-U/TPU)** **Polymethylmethacrylate (PMMA) and copolymers**	**Polyoxymethylene (POM)** **Polyphenylenesulfide (PPS)** **Liquid crystal polymers (LCPs)**	**Polyvinylidenefluoride (PVDF)** **Tetrafluorethylene/ Perfluoroalkylvinylether-copolymers (PFA)** **Polytetrafluoroethylene (PTFE)**

According to geba's current Web emphasis is on: PC/ABS, polyamides, polycarbonates (pure blends, glass-fiber reinforced and flame retardant); PC Gebalon Ultimate GF plastic granules

are recognized under the Component Recognition Program of UL and have been evaluated V-0 to UL94 requirements. The material meets all applicable requirements for a V-0 rating and has passed the UL tests).

Table 11: geba's range of offerings and services.

Masterbatches; color batches, color matching	Thermoplastic granulates- and powder-compounds	Laboratory testing
Micro-pellets *) for masterbatches, as plastic powder alternative, for micro injection molding	Electrically conductive plastics	Development, manufacturing and selling original plastic; Compounds, recompounding
Metallic compounds	Bioplastics, based in lignin, Bioplastics, biodegradable	Contract development, manufacturing and selling; Logistic services

*) Includes cryogenic fine grinding of thermoplastics.

More information, particularly concerning metrics (number of employees, profit, etc. are given in the Appendix (Table 13).

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Notes

1. *Plastics Acronyms/Abbreviations*:
http://www.professionalplastics.com/de/ACRONYMS.html (last access 3/23/2016).
… and *Differentiating Polymers*: Thermal data as important differentiators of polymers: *Amorphous polymers*, such as acrylic and polycarbonate, have a glass-transition temperature, Tg, but do not have a specific melting point, Tm. *Partly crystalline polymers*, such as polyethylene and nylons, contract sharply at their melting points during cooling.
https://www3.nd.edu/~manufact/MPEM_pdf_files/Ch10.pdf (last access 3/23/2016).

2. *Kommanditgesellschaft GmbH & Co. KG (*in Germany and Austria*)*:
https://en.wikipedia.org/wiki/Kommanditgesellschaft;
The GmbH & Co. KG is a limited partnership with, typically, the sole general partner being a limited liability company (GmbH). It can thus combine the advantages of a partnership with those of the limited liability of a corporation.
Partnerships may be formed in the legal forms of General Partnership (Gesellschaft bürgerlichen Rechts, GbR or specialized in trading Offene Handelsgesellschaft, OHG) or Limited Partnership (Kommanditgesellschaft, KG).

GERMAN LIMITED PARTNERSHIP (GmbH & Co. KG): http://wwkn.de/en/about-german-legal-forms/german-limited-partnership-gmbh-co-kg/;
https://de.wikipedia.org/wiki/GmbH_%26_Co._KG.
GENERAL
This form of company unites the tax advantages and company law advantages of a corporation and a personal company.
Precisely speaking, it is in fact two companies: a GmbH as a limited liability corporation (LLC), and a limited partnership (Kommanditgesellschaft – KG) which unlike an OHG has only one fully liable person (the general partner) while the other shareholders (limited partners) have only partial share, with their capital investment, in outside obligations of the KG.
The GmbH functions as the general partner of the KG, which leads to a factually limited outside liability of the entire company unit.
The partners represent the company. General Partnership is no corporate entity.
FOUNDING A GMBH & CO. KG
Since this is a case of two companies, as already mentioned, you must first found a GmbH and then in a second step, found a KG in which the GmbH is a participating shareholder. However, both foundings can be carried out in a joint notary consultation to save costs.
MANAGEMENT
Management is regularly taken over by the GmbH as the general partner of the KG, which for its part is represented by its own manager. The natural person appointed as the GmbH manager generally also manages the business of the KG.

LIABILITY
Here it must be differentiated between the two types of shareholder in the KG: the general partner and the limited partner.
The limited partner participates in the KG but is only partially liable. This means that the level of his liability is limited to his share investment.
The general partner functions as a fully liable participant and therefore is liable for outside obligations of the KG, in an unlimited manner with his entire assets. As a GmbH & Co. KG fills this position with a GmbH, its liability is however limited to its own business assets, and the whole GmbH & Co. KG is finally only liable for the amount of the GmbH's nominal capital plus the share investments of the limited partners.
What is a "Komplementär "?
A Komplementär is the general partner of a limited partnership (KG). In order to establish a Kommanditgesellschaft at least one Komplementär and one "Kommanditist" are required. Natural persons as well as legal persons may appear as Komplementär. Compared to the Komplementären, the Kommanditisten were only liable to the creditors up to a certain amount of capital. These capital contributions increase the shareholders' equity of the KG and are registered in the commercial register (Handelsregister). Due to the incomplete liability, the limited partners are legally also automatically excluded from the management.

Rechtsform Kommanditgesellschaft (KG): Rechtliche Hinweise zur KG von Zweck und Gründung bis Nachfolge: https://www.lhp-rechtsanwaelte.de/themen/gesellschaftsrecht/rechtsform-kommanditgesellschaft-kg/

3. Wiltrud Walter-Strobel: Company Bada Holding GmbH. German Enterprise Register, Jan. 1, 2010. ..."Frau Wiltrud Walter-Strobel (Kauffrau)"... . http://www.deutsche-unternehmen-register.com/pub?id=354474, http://www.deutsche-unternehmen-register.com/pub?id=354476 (last access 7/29/2016).

4. *Prokura – Prokurist* (noted: ppa, Name), *Authorized Officer, Officer with Procurement*: https://www.hk24.de/produktmarken/beratung-service/recht_und_steuern/wirtschaftsrecht/gesellschaftsrecht/uebersetzung-gesellschaftsrechtliche-bezeichnungen/1156900;
German job titles: Prokurist http://capitallanguagesolutions.com/en/prokurist/;
A couple of thousand years may have passed since the Roman Empire's heyday, but the concept of the procurator is still alive and well, reshaped to meet the requirements of modern business throughout Germany (and Austria). Prokura, the explicit authorization given to selected senior managers or directors within a company, is explicitly regulated in German law and allows a Prokurist to make commitments on behalf of his or her organization, including:

- hiring and dismissing employees,
- opening and managing branch offices,
- expanding the company's operative business sectors,
- taking on loans, and
- generally overseeing the company's entire operations.

These individual rights can be restricted somewhat, for example, by creating a group of Prokuristen so that no single representative has sole authority (Jointly held Prokura – Gesamtprokurist), or by explicitly limiting the Prokura to a single office or branch of a business (individual Prokura – Einzelprokurist).
http://capitallanguagesolutions.com/en/prokurist/;

Authorizations in Germany: https://www.hk24.de/en/produktmarken/fairplay/business-law/authorizations-germany/1159414;
The "Prokura" is a statutory commercial representation under German law. The "Prokurist", the holder of the Prokura, is authorized to execute every kind of judicial or extrajudicial transaction and to perform every legal act associated with the operation of a commercial business.
Prokura holders are not, however, authorized to sell or encumber real property unless they are expressly authorized to do so.

The powers conferred by way of the Prokura cannot be restricted in relation to third parties. Any restriction of the scope of the representational powers of a Prokura holder contrary to the statutory provisions is invalid, and any transactions concluded by the Prokura holder are binding on the company.

5. UL: *What is UL certification*? http://blog.all-spec.com/what-is-ul-certification/; *UL (safety organization).* https://en.wikipedia.org/wiki/UL_(safety_organization) (last access 8/30/2016).

6. *VDE*. Verband der Elektrotechnik Elektronik Informationstechnik e.V. (the (German) Association for Electrical, Electronic & Information Technologies) is the not-for-profit VDE testing and certification institute, headquartered in Offenbach. The independent test engineers of the VDE Institute test more than 100,000 devices per year. If the product passes the tests, it receives the VDE symbol, a triangle that stands for safety. With VDE Global Services GmbH, the VDE Institute performs tests and certifications worldwide.

Appendix

Appendix – Some Metrics for geba Kunststoffcompounds GmbH

The characteristic for geba Kunststoffcompounds GmbH concerning finances is that the published gross profit data are generally changing by roughly 15 percent around a value of €10 million (Table 12) – except for 2009, the time of the Great Recession. As expected there is a notable dip for 2009. The decrease in gross profit for 2011-2013 is also reflected by the number of employees. The average numbers of full and part-time employees show irregular ups and downs.

Table 12: Average numbers of employees of geba Kunststoffcompounds GmbH as well as its gross profit ("Rohergebnis") and profit [EB geba].

	Average Number of Employees (Taking Part-Timers into Account) 1)	**Gross Profit (€ million)**	**Profit (€ million)**
2005	-	12.502,963	2.672,266
2006	87 – 30 white-collar workers, 57 industrial workers	10.390,200	1.317,732
2007	75 – 26 white-collar workers, 53.25 industrial workers	10.726,255	1.278,040
2008	72.75 – 25.50 white-collar workers, 47.25 industrial workers	9.973,859	1.237,162
2009	79.25 – 26 white-collar workers, 53.25 industrial workers	7.389,559	0.549,458
2010	74 – 24 white-collar workers, 50 industrial workers	9.734,415	1.122,385
2011	86.75 – 22.25 white-collar workers, 64.50 industrial workers	11.070,875	1.387,126
2012	80.25 – 20.75 white-collar workers, 59.50 industrial workers	9.977,321	1.234,130

Table **12**, continued.

2013	77.42 – 19.21 white-collar workers, 58.21 industrial workers	9.807,371	1.284,577
2014	81.50 – 19.75 white-collar workers, 61.75 industrial workers	9.807,123	1.136,889
Additional information concerning headcount, different persons per year			
2007: 80 employees, 9 executive staff by Dec. 31, 2007	**2008:** By Dec. 31 85 employees		
2009: By Dec. 31 81 employees	**2010:** By Dec. 31 94 employees		
2011: Dec. 31 98 employees, including 8 apprentices	**2012:** Dec. 31 86 Mitarbeiter, including 10 apprentices		
2013: On average 58 industrial workers (previous year 59), 19 white-collar workers (previous year 20) and 8 apprentices (previous year 10).	**2014:** No further information, number of employees was increased		

1) White-collar workers: Angestellte.

Revenues are mainly generated through the *domestic market* ("Inland"). *Foreign business* ("Auslandsgeschäft") account for *a good fifth of the total turnover*. A portion of this revenue is generated in non-euro area countries. There are no currency risks [EB geba 2014].

There are few data on revenues or employees for the three producing firms of the geba Group (Figure 6) readily available. For instance, for geba Kunststoffcompounds one one finds published data for 2005 and 2006 (Table 13).

Table 13: Revenues 1) of geba Kunststoffcompounds [EB geba 2006].

Year	Revenue (DE, million)	Revenue (ES, million)	Revenue Total (million)
2005	€11.364	€3.697	€15.061
2006	€11.742	€3.788	€15.530
The Group's turnover has already exceeded €20 million in recent years, declined only briefly during the financial crisis and climbed back to the pre-crisis level in 2010 [Plastiker 2011].			
The total number of employees was 170 (10 apprentices); the goal for revenue in 2012 was €32 million [Helmers 2012]			

Table **13**, continued.

The *rate* of *material usage* (relates to Gross Profit Ratio) in 2013 was 43.5% compared to 39.8% in the previous year [EB geba 2013]. Using the data in Table 12 and the formula in Table 5 ones estimates for revenues in Germany for two years: 2012: €25.0 million (deviation of €7 million from above mentioned estimated goal) 2013: €22.5 million.
geba has ca. 160 employees at three locations [geba 2016a].

1) Revenue data are given for the domestic and foreign firms. Data for ES could contain a small contribution by AU.

Recent financial data for the Spanish subsidiary are given in Table 14.

Table 14: Recent financial and employee data for Gecomplast, S.L. [Infocif 2016].

	Revenue (€)	Profit (€)	Equity (€)	Employees
2013	5,023,745	499,974		
2014	5,034,428	550,526		
2015	4,556,608	327,334	3,401,972	22

For GEBA Kunststofftechnik GmbH & Co KG in Austria there are also only few data (easily) available:

- For the situation of the firm when becoming operational in 2006 the number of employees was to be increased from currently 10 to mid next year to 23 [Plastiker 2006].
- There were 18 employees; revenue was estimated to be €2.89 million [FirmenABC]. This may refer to 2007 (estimated referring to number of employees).
- Revenue is €3.80 million (no year given) [Unternehmen24].

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Table 15: Business Model Canvas of Bada AG, containing implicitly its Spanish subsidiary (Template by Alexander Osterwalder).

<table>
<tr>
<td rowspan="2">Key Partners
Customers in their role to initiate innovations (“the customer as the innovator”)

Contract work for firms to further develop and produce products for which Bada has a license agreement (BASF)

Partners in publicly financed projects containing other firms, but also universities or public research institutes

Collaborative research and development projects with partners</td>
<td>Key Activities
Developing and producing essentially compounds and blends

Development of customer- or application-oriented product solutions, particularly application-focused on special compounds

According to customer specifications corresponding “fine-tuned” compounds meeting modified performance characteristics

Developing a rather broad spectrum of “basic” polymers and blends with given performance profiles and application options</td>
<td rowspan="2">Value Proposition(s)
Products: Customized engineering plastics compounds optimized to suit a variety of applications, e.g. lightweight, metal replacement. Bada also offers individually customized materials solutions.

Addresses niches of polyamide (Badamid®), PBT (Badadur®) and styrene-based thermoplastic elastomers (Badaflex® TPE-S); a range of Badamid®L specialties (BASF technology/license agreement)

Also ABS-specialties (Badalac®) and a product family of thermoplastic elastomers: Partially cross-linked EPDM/PP (Badaprene®)

Offers high performance plastics like PPS (Badatron®), PA6/6T (Badamid T®), PPA (Badamid PPA®), Badamid PA12®, Badamid 610® and Badamid®612

Nanocomposites:adding nanoscale additives or fillers;

Ultimately Bada follows a "one-stop-shop" approach – for the customer everything from a single source: products, services, or coloration, individual color matching and releases for the markets, offers listings like UL services</td>
<td>Customer Relationship
Fundamental operational principle is customer-orientation

Keeping existing customers and simultaneously catching new ones (Find/Attract them) and convert them into permanent customers (Bind them)

For tailor-made solutions and individual modifications it advises and supports mainly end customers in the implementation of challenging new projects and in development projects to the point of release for series production.

Bada offers offers service which often starts right at the point of product development.

A Technical Marketing department will assist and advise customers from the idea to the start of production</td>
<td rowspan="2">Customer Segments
Much diversified application areas and end customer markets

Industries served:
Electrical & electronics (E&E), automotive, building and construction, furniture, household, medical technology, leisure and sports.

For different countries and industries usually different kinds of regulations and/or standards; enters different specifications by customers

Almost all markets can be served with first approaches towards sustainability via biobased chemicals or fibers</td>
</tr>
<tr>
<td>Key Resources
Comcerning finances the primary resource is generating income (profit) through business – also to feed innovation (“investment and innovation persistence”)

Sometimes also loans or silent participations are used

State-of-the art technology for development, manufacturing and analytics

Intangible resources: corporate culture and Bada’s employees</td>
<td>Channels
Distributors for direct sales of Bada products in numerous countries (70 countries served in 2015)</td>
</tr>
<tr>
<td colspan="3">Cost Structure
Expenses for raw materials, auxiliaries, operational materials etc.(a main factor), personnel, maintenance of building, plants, production/development equipment, investments in innovation</td>
<td colspan="3">Revenue Streams
Own business (develop, produce and sell compounds and blends) and license-based contract work for BASF, funds for publicly subsidized R&D projects (very small contribution)</td>
</tr>
</table>