Varroc Lighting Systems

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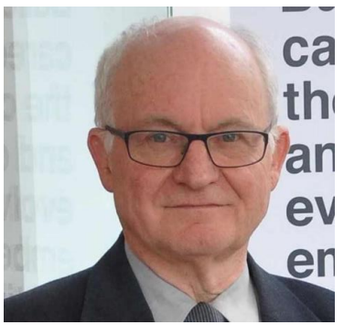
About the author



Jean-Paul Ravier graduated from ISAE SUPAERO (the Institute for Space and Aeronautics Engineering) and IAE Paris (Institute for Administration of Enterprises).

He worked for over 41 years at Valeo, including 29 years at Valeo Lighting where he held a variety of management positions first in IT and finance, and then in R & D, projects, and innovation, including in Japan from 2005 to 2009 at Ichikoh as a board member and managing director. He retired from Valeo in 2013. Shortly thereafter he was appointed chair of the ELS programme (Embedded Lighting Systems) for Advanced Master training and Research in Lighting at the Institut d'Optique Graduate School, ESTACA and Strate School of design. He held that position through the end of 2017 and is now Development Advisor for DVN.

Author's foreword

To build this report, I visited Varroc in Czechia on September 2018. I am deeply thankful to Todd Morgan and Christoph Knour and to their teams who have dedicated time to present in detail Varroc products, innovations, R&D organisation and plants in Czechia in September 2018.
I thank DVN President Hector Fratty for their advice and support, and DVN Chief Editor Daniel Stern for copyediting.

Todd Morgan (left) is Senior Vice President of Global Product Development, leading the company's R&D, new model programs, electronics, and advanced engineering. Todd works in Varroc's Czechia Technology Centre, the largest in the company. He has been in the vehicle lighting field for most of their career, holding various leadership positions at Visteon's global locations. Todd holds a bachelor's of science and manufacturing systems engineering degree from Purdue University in the US state of Indiana.

Christoph Knour (right) is Senior Vice President of Global Sales and is also responsible for the European Customer Business Unit. Christoph leads the business development function on a global basis, while also managing the sales and program management activities for Europe. He has over 27 years' automotive industry experience in various leadership positions at Visteon and Ford. He received a Diplom Ingenieur FH in automotive engineering from FH Köln.

Executive Summary

Varroc are a relatively new company, founded in India in 1990 by the current Managing Director Tarang Jain with their father Naresh Chandra as Chairman and non-executive Director.
The company started activities with plastic parts, then electrical and metallic parts for the Indian transportation industry—particularly for two wheelers. Varroc then extended their activity to lighting in India, still mainly for two- and three-wheelers, this being still today in India their core business for lighting. Varroc are currently the two-wheeler lighting leader in India. Global sales of Varroc group in FY17-18 are at €1.24bn ($1.43bn), supported by 36 plants and 16 R&D Centres round the world.

For the lighting business which is now the main activity of Varroc Group with 61% of sales, the main development occurred in 2012 with the acquisition of the lighting activities of Visteon, boosting at that time the global turnover of Varroc above $1bn and allowing them to become a major participant in the international vehicle lighting industry.

Varroc had strong growth during the last five years at +14% per year, but with an acceleration in the last quarter reported at +28% thanks to internal growth and acquisitions. Varroc's lighting market share is around 4% worldwide, and Varroc say they're currently the 6th lighting set maker worldwide, targeting to rise to third or fourth. Varroc still hold the strong positions with customers held before by Visteon, particularly with Ford and Jaguar Land Rover.

But Varroc have also expanded their activities thanks to a good cost competitiveness mainly due to their locations in low-cost countries naturally in India, as well for global business in Europe in Czechia and Poland, and in North America in Mexico. During the last twelve months, Varroc have accelerated their globalisation with new production plants in Morocco and Brazil, new R&D centres in Czechia and Poland, new activities in small lamps with the acquisition of Sa-ba in Turkey and Bulgaria and new sales centre in Japan.

Varroc are not only supplying low cost products; they also have developed high technology systems for instance LED Matrix ADB for the Jaguar E-Pace, Matrix ADB with laser high beam for the Range Rover Sport or Matrix ADB for the Bentley Continental. These developments were realised in close cooperation with some key suppliers that is a part of the Varroc strategy to accelerate their offer for high-tech products despite a relative lower level of resources compared to their main competitors.

Varroc want to be part of the high technology leaders and for that are increasing R&D resources at a strong rate of 150 new R&D engineers per year. Varroc have for instance announced soon the production of low-cost LED reflectors systems and are developing high definition ADB system with up to 1.3 million pixels.
But the central strategy of Varroc Lighting Systems to develop their business is “to bring leading edge technology to the mainstream markets with high quality, cost competitive solution”.
Varroc are very ambitious for the future, wanting to be one of the three main lighting suppliers in the world. Varroc have some important strengths: a central location in India, likely the "next China" for mass production of cars; a relatively large number of plants and R&D centres in low-cost countries, a global presence, and improvements for developments of high-tech products.
Varroc can also rely now on a new financial support as they have in 2018 introduced the parent company Varroc Engineering in the Indian financial market, so they can continue their quick pace for acquisitions or be part of a future important merger.

Nevertheless, this path to become part of the top three could be relatively long as Varroc are still today relatively small compared to their five main competitors that are currently about three to five times bigger and still growing.

Introduction

Varroc began their activities in 1990 by producing plastic parts for the Indian industry, particularly for two- and three-wheelers. The company was founded by Tarang Jain, great-grandson of Jamnalal Bajaj, a very famous Indian independence fighter, close associate and follower of Mahatma Gandhi. He is also nephew of Rahul Bajaj, Chairman of the Bajaj group with its many industrial activities, being the № 4 Indian maker of two- and three-wheelers. Tarang Jain is owning the majority of Varroc Group, the other part at around 15% being on the stock market since July 2018.

Varroc have been very successful from the start, with continuous progress both by internal growth particularly in India and by external growth particularly with acquisitions notably in the lighting business. In this domain, the most important acquisition was the lighting activities of Visteon in 2012, but Varroc acquired also Tri.O.M in Italy for two-wheeler lighting and Sa-ba in Turkey for small lamps in 2018.

In fact, the lighting activities of Varroc have a much older root, as the current main centre for development and production in Nový Jičín, Czechia, began a lighting activity in 1879 with acetylene lamps, thus being perhaps the oldest lighting centre.

Now the Varroc group have 36 production plants and 16 R&D centres in the world, are № 1 in the two-wheeler market in India, and are the 6th tier-1 automotive exterior lighting supplier with a market share around 4%.

The main short-term target of Varroc Group is to achieve a level of sales of €2.4bn ($2.8bn) by 2020 by being the fastest-growing supplier in their core sectors, and particularly by being among the top 3-4 suppliers in the global lighting business. This might seems ambitious, but Varroc have currently one of the best growth rates in the market and have made very important progress over the last six years.

In the domain of lighting technology, Varroc have now significant resources with more than 1000 persons in R&D, mainly at their R&D centres in Czechia, Poland, India, Mexico, USA and in China through the Varroc-TYC joint venture. In addition, Varroc have significantly extended their production implementation being now really an international supplier

In this matter, Varroc Lighting are remarkably international: an Indian owner, a French CEO based in America, together with American directors for HR, finance, and mergers-acquisitions, an American director for R&D based in Czechia, a French purchasing Director based in France, and a German Sales Director based in Germany. This is unlike their main competitors that have a clear national root even if they are now really international companies, Varroc have roots in America, Europe, and Asia.

In this report, we shall first describe the activities and figures of Varroc Group, then we shall present more in detail the strategy, the customers, the organisation, the products, the innovations and the SWOT analysis of Varroc Lighting Systems.

Varroc Group

Board Composition

Varroc group's board has a majority of Indian members including the family of the owner, but also includes as independent Director Marc Sculewicz, with great experience in the international automotive industry. Stephane Vedie, with his long experience as executive in automotive has recently reinforced Varroc management by being appointed CEO of Varroc Lighting Systems at the beginning 2017.

Naresh Chandra is the Chairman and Non-Executive Director of Varroc group. He holds a bachelor's degree in economics and a master's degree in history from the University of Delhi. He also holds a diploma in business administration from the City of Birmingham College of Commerce, United Kingdom. He has over 50 years' work experience, with over 35 years' experience in the automobile industry and has previously been associated with Kaycee Industries Limited. He has been associated with Varroc since incorporation and became the Chairman in 1997.

Tarang Jain is the Managing Director of Varroc group. He holds a bachelor's degree in commerce from Sydenham College of Commerce and Economics, University of Bombay and a diploma in business administration from University of Lausanne, Switzerland. He has approximately 30 years of experience in the automotive industry. He has been associated with Varroc since incorporation and was appointed as the Managing Director in 2001.

Ashwani Maheshwari is the Whole-time Director and Chief Executive Officer (CEO) of Varroc India Business. He holds a bachelor's degree in Mechanical Engineering from the Indian Institute of Technology, Roorkee and a Master of Science degree in Leadership and Strategy from the London Business School, United Kingdom.

He has also successfully completed Executive Development Programs from the Wharton School, USA and from the Stanford Graduate School of Business, USA.

Prior to joining Varroc, he was the CEO of Century Pulp and Paper Mills, a Birla Group Company and before moving into this role within the Birla Group, he was the President of the Birla Tyres division, part of the Kesoram Industries Limited. He held several leadership roles with Tata Steel and ITC Group, before moving to the Birla Group. He has been on Varroc's Board since March 2016.

Arjun Jain is the Whole-time Director and Business Head – Electrical division of the company. He holds a bachelor's degree in economics and political science from Vassar College, New York. Previously he was associated with Bain & Company. He joined Varroc on 1 October 2013 as the General Manager - Business Excellence Division. He was appointed as the business head of the Electrical Division in May, 2015.

Gautam Khandelwal is an Independent Director of Varroc group. He holds a bachelor's degree in economics from Mumbai University and holds a general certificate of education examination in economics and history from the University of London. He has been associated with Nagpur Power and Industries Limited since 1996. He is currently the executive chairman of Nagpur Power & Industries Limited and the non-executive director of Informed Technologies India Limited. He has been on Varroc Board since 2011.

Vijaya Sampath is an Independent Director of Varroc group. She holds a bachelor's degree in arts from Madras University and a bachelor's degree in law from Mysore University. She is a fellow member of the Institute of Company Secretaries of India. She attended the advanced management program of Harvard Business School, USA and a program on managing strategic alliances conducted by the Wharton School, University of Pennsylvania, USA. Previously, she has been associated with Lakshmikumaran & Sridharan Attorneys as a senior partner and with the Bharti Airtel Limited as group general counsel and company secretary. She has been on Varroc Board since July 2017.

Marc Szulewicz is an Independent Director of Varroc group. He holds an engineering degree from Ecole Nationale Supérieure des Arts et Métiers, Paris. He has previously worked at Valeo as vice president, served as executive vice president in-charge of plastic activities at CarnaudMetalbox, a Crown Cork & Seal Company. Later, he was also CEO of Plastic Omnium Auto Exterior. He has been on Varroc Lighting Systems' board since 2012 and on Varroc Group's board since July 2017.

Vinish Kathuria is an Independent Director of Varroc group. He holds a bachelor's degree in chemical engineering from Indian Institute of Technology, Delhi and a master's degree in science from Case Western Reserve University, in the US state of Ohio. He also holds a master's degree in business administration from Duke University's Faqua School of Business in the US state of North Carolina. He is the cofounder and president of Rank Software, and has previously been associated with Erricson India, HT Mobile Solutions, Indian Angel Network Services, and has served on the boards of Phonon Solutions and Rank Software. He has been on Varroc's board since February 2018.

Varroc Group Executives - Key Management

Stephane Vedie is President and CEO of Varroc Lighting Systems.
He holds a diploma in purchasing management function from the Academy of Grenoble, France and a degree from Amiens Business School, France. He has previously been associated with Magneti Marelli. He has 13 years of experience in vehicle lighting.

T.R. Srinivasan is the Chief Financial Officer. He holds a bachelor's degree in commerce from Bharathidasan University, Tamil Nadu. He has obtained a post graduate diploma in management from IIM, Calcutta. He is a member of the Institute of Cost and Works Accountant of India.He has previously been associated with Hindustan Lever, Philips Electronics India, Reliance Digital Retail, Siro Clinpharm, and ATC Tires.

D S Sethumadavan is Senior Vice President and Head of the Polymer Business. He holds a Master's Degree in Materials Science from Regional Engineering College, Trichy, India. Sethu has 22 years of diversified work experience with a proven track record of business & functional excellence in large multinational conglomerates like Assa Abloy, Stanley Black & Decker, Schneider Electric, General Electric and Lucas TVS. He has strong business and P&L experience in the B2B segment, with hands on understanding of manufacturing operations.

Varroc History

Pre-Varroc period for the lighting activity

- 1879 Establishment of Toro as acetylene lamp manufacturer in Nový Jičín, Czechia
- 1950 The company became Pal (not to be confused with today's Autopal India)
- 1993 Acquisition by Ford
- 2000 Integration in Visteon
- 2012 Integration in Varroc

Varroc history

1998-2000: Inception and development of the company in India, mainly in the two wheelers segment

- Varroc was established by Tarang Jain in 1988 in Aurangabad, India. The company began with the production of plastic parts, called today the polymers division.

- Between 1992 and 1998, the company began product diversification with their electrical division in 1995 and their metallic division in 1997. Varroc also developed their polymer manufacturing facilities particularly in 1997 with two new plants in Pune and Aurangabad.

From 2000 to 2012, Varroc began international development with collaboration and acquisition mainly in other domains than lighting (Polymer, Metallic, Electrical business)

- In 2001, Varroc began a collaboration with Mitsuba Corporation, a Japanese manufacturer of automobile parts.

- In 2005, Varroc collaborated with Umicore, based in Brussels, and started production of automotive catalytic converters.

- Between 2007 and 2010, Varroc acquired IMES in Poland and Italy to strengthen their forging business in European markets. During that period, Varroc also invested in manufacturing capability for polymers in the region of New Delhi to do business with customers in this area of India.

From 2012-2012, Varroc have pushed their lighting activities by important international acquisitions

- In 2011, Varroc acquired European two-wheeler lighting organisation Tri.O.M. S.p.A., including that outfit's R&D centre. Tri.O.M have plants in Italy, Roumania, and Vietnam.

- In 2012, Varroc acquired the lighting activities of Visteon for $92m, boosting their turnover to more than $1bn. Thanks to the two R&D centres of Visteon and the production sites in Europe and America, Varroc had from that time the possibility to develop products for the main European and American car makers. Varroc installed their lighting systems headquarters, an R&D centre, and a sales centre in Plymouth, Michigan in 2012.

- In 2012, Varroc established their eighth polymer plant in Pithampur, Indore to do business with Volvo, Eicher, and Mahindra Two Wheelers. Another polymer plant was established in Bengaluru for the HMSI and passenger car segments. The company also invested in design and setup of their 10th polymer plant at Chennai to supply the Yamaha Motor Company.

- In 2013, Varroc acquired Visteon's holding in a 50/50 joint venture with Beste Motor Co, Ltd (Taiwan's TYC) to manufacture automotive Lighting in China. The JV is called Varroc TYC.

- From 2013 to 2016, Varroc continued their developments with investments in new technologies areas, state of the art injection and painting shop, and enhanced their global footprint.
  The turnover touched $1.5bn

- In 2015, Varroc established a partnership with UK Based manufacturer and supplier Scorpion Automotive to provide security products for two-wheelers.

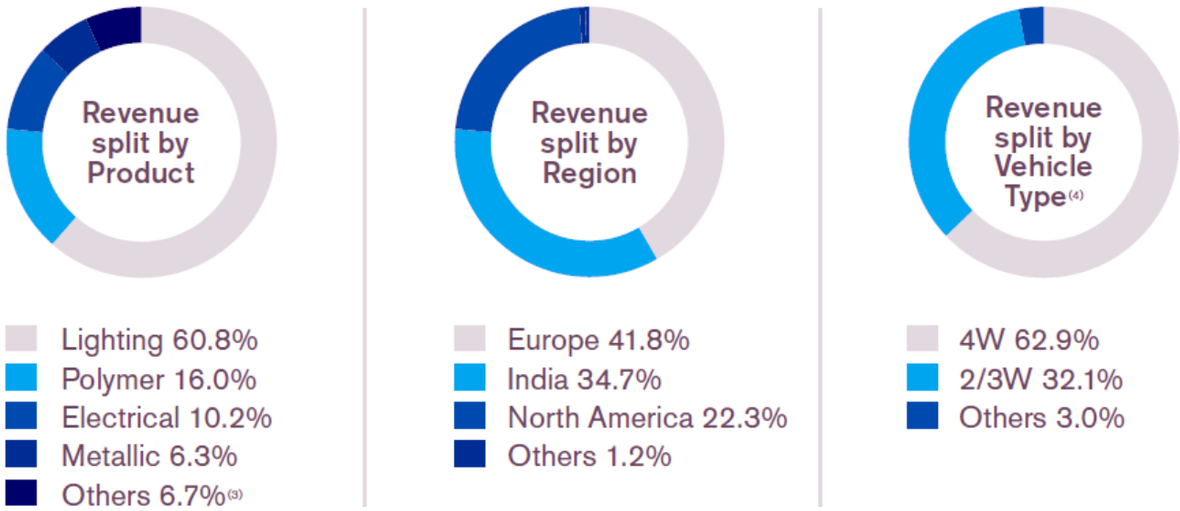
- In 2018, Varroc established new plants for lighting business in Morocco and Brazil, and new R&D facilities in Czechia and Japan for Electronics, and a JV with Elba for Electronics production.

- In July 2018, Varroc acquired Sa-ba in Turkey, a company specialized in small lamps, but that could be a base for deliveries of headlamps and rearlamps in the future from a market of 1.7 million cars produced yearly

- In 2018, Varroc extended their engineering facilities with one complementary site in Czechia in Ostrava and one in Poland in Krakow.

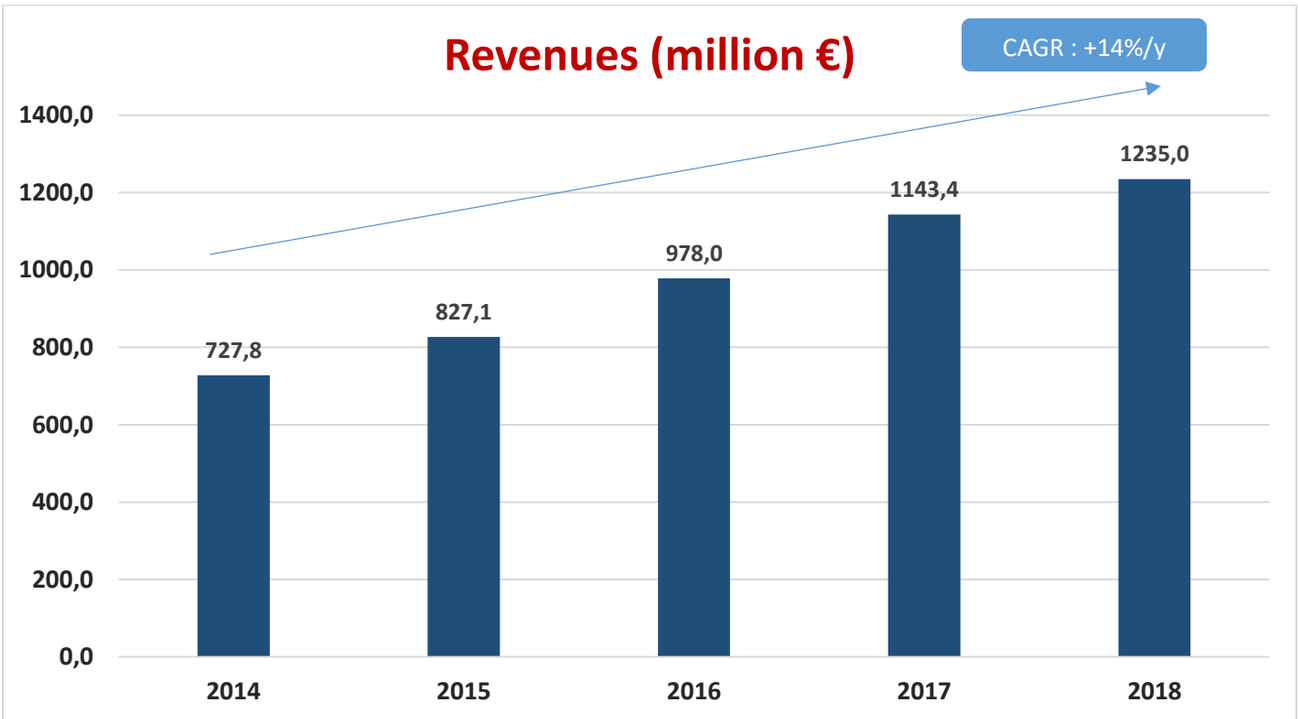
- In June 2018, Varroc Engineering Ltd, the parent company of Varroc Group, were introduced in the market by an IPO in New Delhi, to great success (Subscribed 3.6 times).

Varroc Group Main figures



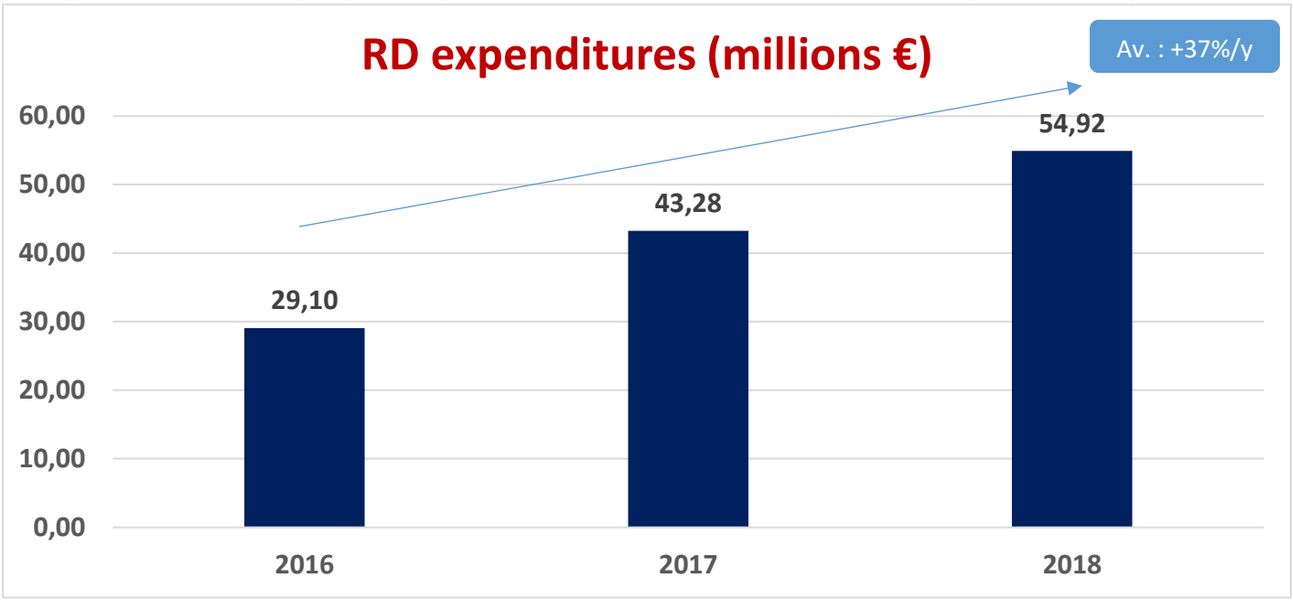
Evolution of revenues of Varroc Group

During the past five years, Varroc have demonstrated a strong increase of their global sales, with an annual growth of +14% reaching in 2018 (year finishing March 31st 2018) a level of sales of €1.235bn ($1.432m).
Lighting, with more than 60% of the total sales, is the clear major activity of Varroc group.



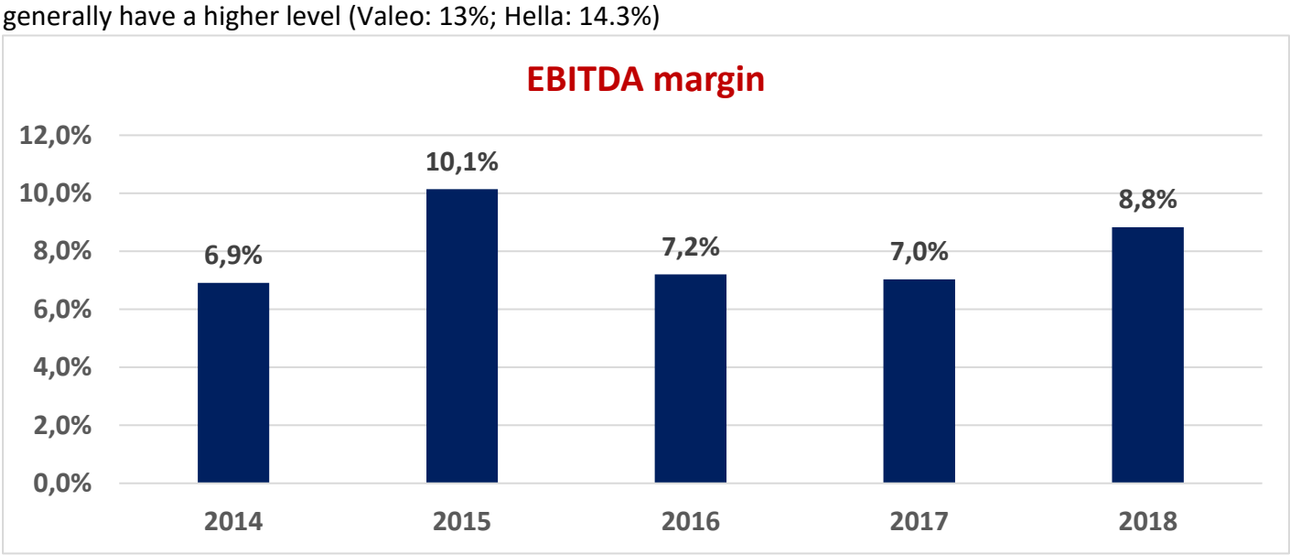
Evolution of R&D expenditures of Varroc Group

Strong increase at +37% per year despite still a relative modest 4.4% of sales compared to competitors



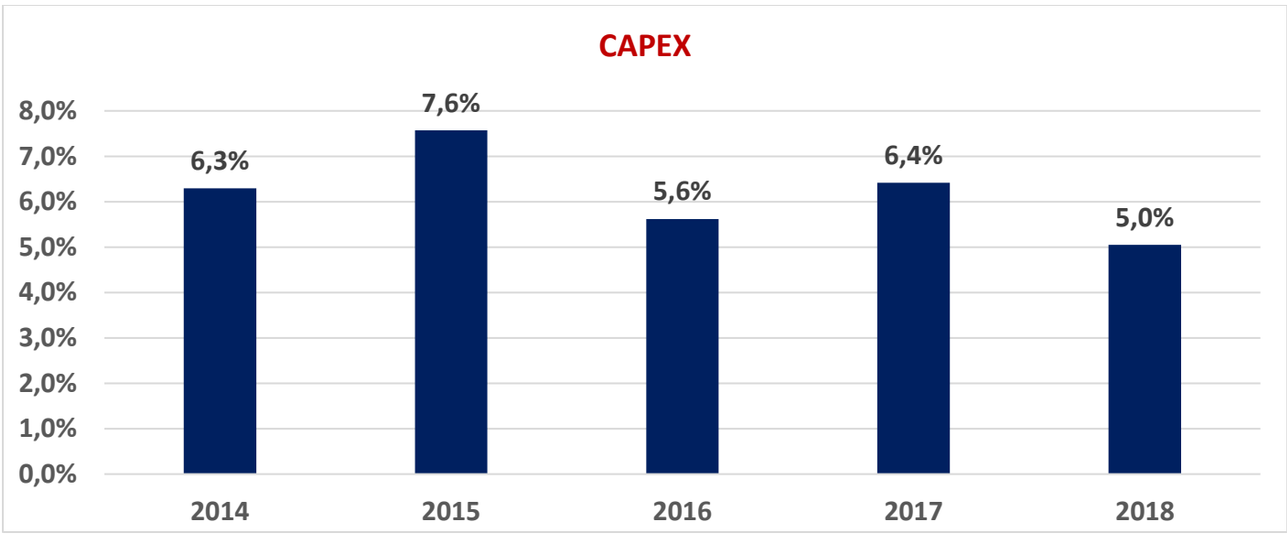
EBITDA Margin:

Positive EBITDA margin during the past years, even though the main big competitors in the lighting business generally have a higher level (Valeo: 13%; Hella: 14.3%)

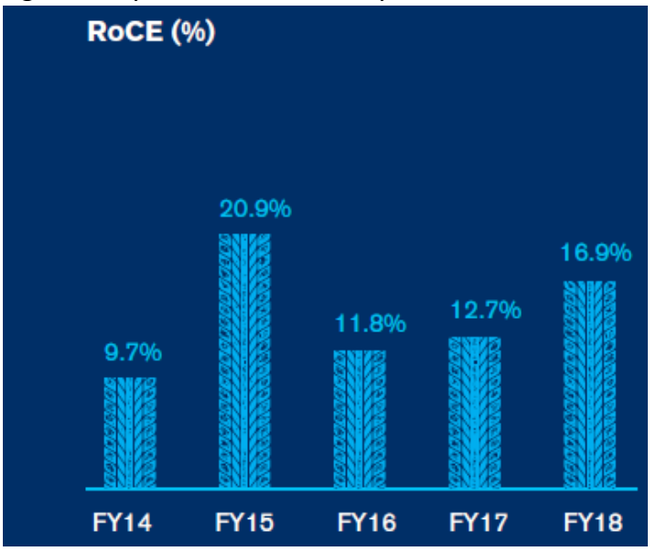


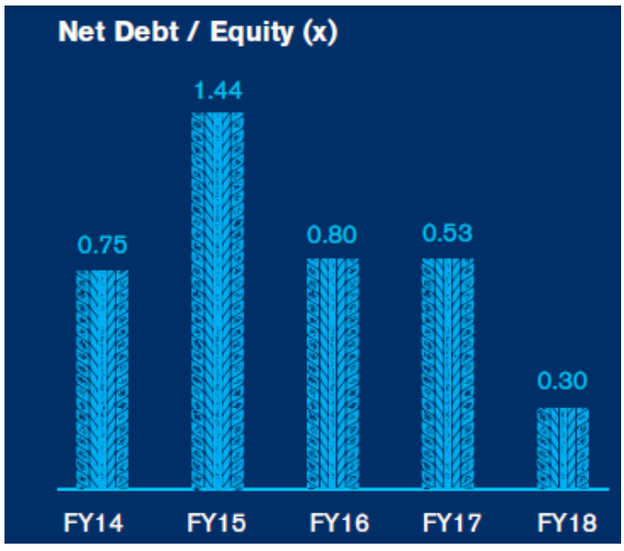
CAPEX:

Varroc are investing significantly in new plants and R&D Centres. Nevertheless, CAPEX is maintained at a normal level, even lower than some competitors (Valeo: 9.7%)



RoCE and Net Debt on Equity are improving significantly over the last three years





Varroc Group main products

Lighting products: €821m ($952m) including JV in China non-consolidated

LED Front Lighting - Range Rover Evoque

Advanced Front Lighting Systems - Bentley

LED Mini-Projectors Low/High Beam Sub-Assembly - Lincoln

LED Signature Rear Lamp - Peugeot

Iconic Signal Lighting - Skoda Superb

Projector Headlamps with LED Signature - Mahindra XUV 500

LED Signal Lamp

Polymer activity products: €198m ($229m)

Instrument Panel

Door Trims

HVAC & Under Hood Parts

Interior Trims

Mirror Assemblies

Air Filter Assemblies

Seat Assemblies

Painted Fairing & Seat Cowl

Rubber & Rubber to Metal Bonded Parts

Electrical activity products: €126m ($146m)

Digital Instrument Cluster

CDI and TCI units

Regulator Rectifier (RR)

Starter Motor

Wiper Motors

Magneto

Catalytic Converter

Handlebar Assembly

Switch

Metallic activity products: €78m ($90m)

Transmission Assembly

Engine Valve

Crankpin

Crankshaft

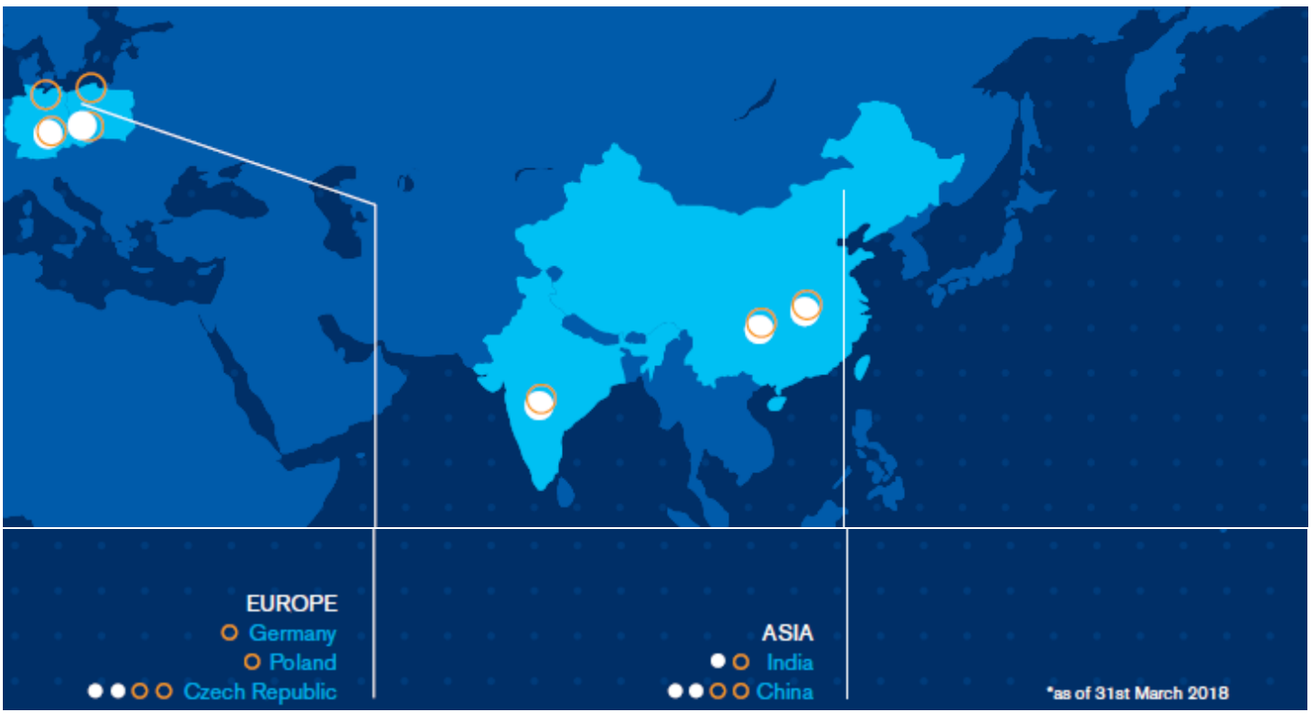
Connecting Rod

Camshaft

Varroc Group geographic coverage: globally 14,000 employees

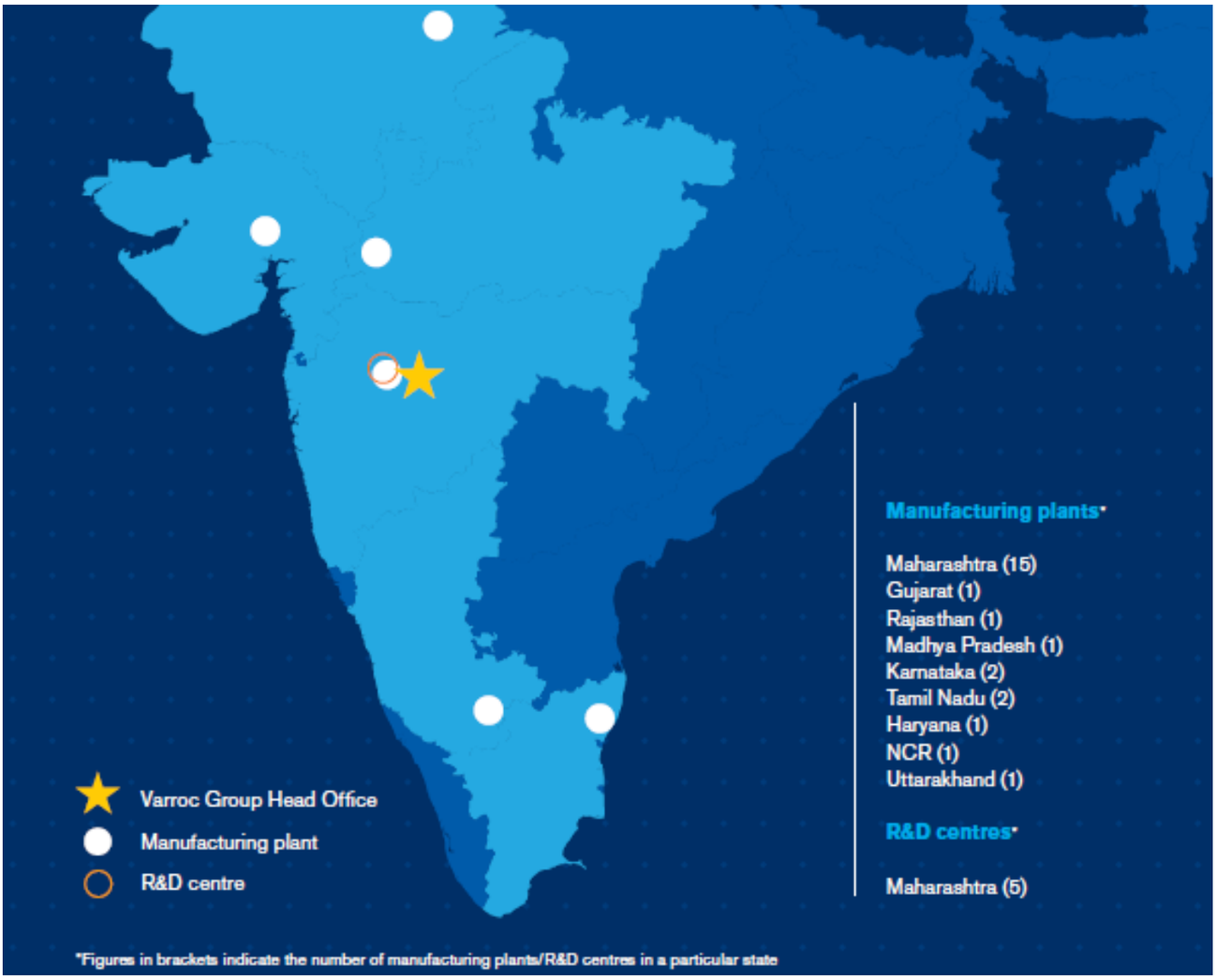
Global presence for Varroc Lighting Systems:
- 9 R&D centres with 1,000 persons
- 9 production plants with 6,000 persons

Europe – Asia:



America:

Varroc plants in India:



Varroc Lighting Systems India PVT Ltd
Pune, Maharashtra

Interview: Tarang Jain,
Varroc Group founder and
Managing Director of
Varroc Lighting Systems,
May 28th 2018 by the Hindu BusinessLine

The Varroc Group have two core businesses: exterior lighting for cars, an operation acquired from Visteon in 2012, and two-wheeler parts in India. Jointly, they account for 95 per cent of revenues. Jain has reasons to be pleased with the car lighting business, which was of a smaller size in terms of sales as well as margins at the time of the buyout six years ago. "Over the years, we have been able to align well with the existing customers in the business such as Ford and Jaguar Land Rover and have also won a lot of new business from our existing customers," he says.
While this has boosted margins, what has been equally significant is the turnaround achieved in the Mexico and India operations. These were the two loss-making units in the lighting business at the time of acquisition. Some of Varroc's plants saw lower utilisation levels in the previous years but 2017–18 saw things improve substantially across their 25 facilities in the country. Varroc foresee their growth revolving around their core businesses of exterior lighting for cars globally, and two-wheeler parts in India. These will be the pivots for future trends, which include electrification, shared mobility, connectivity, and related matters.

In the passenger car lighting business, Jain believes it is important to increase the global footprint because of customer needs for more platforms. When Varroc took over Visteon's lighting business, their presence was confined to Mexico (catering to the North American market), Czechia (which serviced Europe and Russia), China, and India.
They opened their second plant in China a couple of years ago and with Morocco and São Paulo due to join the parade in the coming months, things are quickly falling into place. The missing gaps are Korea and Japan, which are important markets where acquisitions will be considered part of the growth strategy. Beyond these two countries, the ASEAN region is not very big for the car market. It is also very tough especially with Stanley, Koito, and SL all having commanding presence.

Varroc have also started an office in Japan with sales and engineering people to service at close proximity the two and four-wheeler vehicle maker there. "Our overall lighting market share in passenger cars is 4% and we have a vision to be in the top three or at least number four position going forward," says Jain, whose group is now in sixth place."

Varroc Lighting Systems

Varroc Lighting Systems is the main activity of Varroc Group representing around 62% of the global turnover at 821M€- 952M$ with than 7200 employees in Europe, North America, South America, Asia and Africa.

Varroc Lighting Systems – Executives - Key Management

Stephane Vedie
President and CEO
Varroc Lighting Systems

Jackie Chizuk
Senior Vice President,
Human Resources and Communications

Phil Cunningham
Senior Vice President,
Strategy, and Mergers & Acquisitions

Maurizio Geli
Senior Vice President,
Global Industrialization

Mandar Joshi
Vice President, India Business Unit

Christoph Knour
Senior Vice President,
Global Sales and European Customer Business Unit

Scott Montesi
Vice President,
Americas Business Unit

Todd Morgan
Senior Vice President,
Global Product Development

William Newman
Deputy General Manager, Varroc TYC

Sylvain Puginier
Senior Vice President,
Global Purchasing, MP&L, and Supplier Performance

Greg Rogers
Senior Vice President,
Corporate Quality

Scott Trujillo
Chief Financial Officer

Varroc Lighting Systems' strategy

Varroc group seek in their core business to reach a level of sales of €2.4bn ($2.8bn) by 2020.
Varroc have defined exterior lighting and two wheelers mobility as their two main markets, representing currently 95% of the sales, and exterior lighting alone more than 60%. In this domain, Varroc are targeting to become among the top 3-4 players in the world. For that, Varroc are relying on a strong internal growth, but also on external growth by pursuing acquisitions.

Varroc are taking into account their size, currently the smallest of the main international suppliers at around 4% of the market, and so don't necessarily want to be the first in the market for innovations, but rather to be a leader for mainstream applications. Nevertheless, for rear lamps, Varroc are estimating to be a technology leader at a similar level to their competitors.
The development of the lighting business is based on competitive cost, thanks to a production base at 100% in low cost countries and a R&D base at 90% in low cost countries.
To enlarge their geographic coverage for a better customer service and to open new doors, Varroc are investing massively in new plants this year in Morocco and Brazil, and next year In Poland. In parallel in 2018, Varroc have acquired Sa-ba in Turkey to extend their portfolio to small lamps, but also to have a production base in an important market for OEMs.

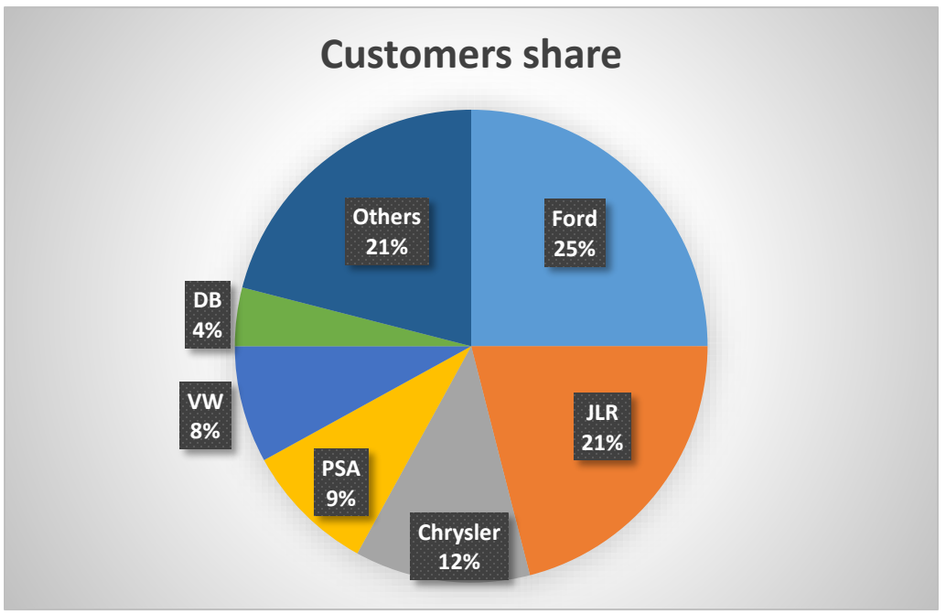
Varroc are sustaining this extension of their activities by a strong increase of their R&D resources, at a rate of roughly +150 persons per year. Mainly based in Eastern Czechia at two sites, important R&D resources are also in India (180 persons) for local service and for a global support particularly for software, but also for optics and mechanics. For American customers, Varroc Lighting have R&D resources in North America in USA and Mexico as well in China through the JV Varroc-TYC for the Chinese market. In 2018, new R&D centres to reinforce this organisation and to attract new talents were established in the centre of Krakow, Poland and in Ostrava, Czechia.

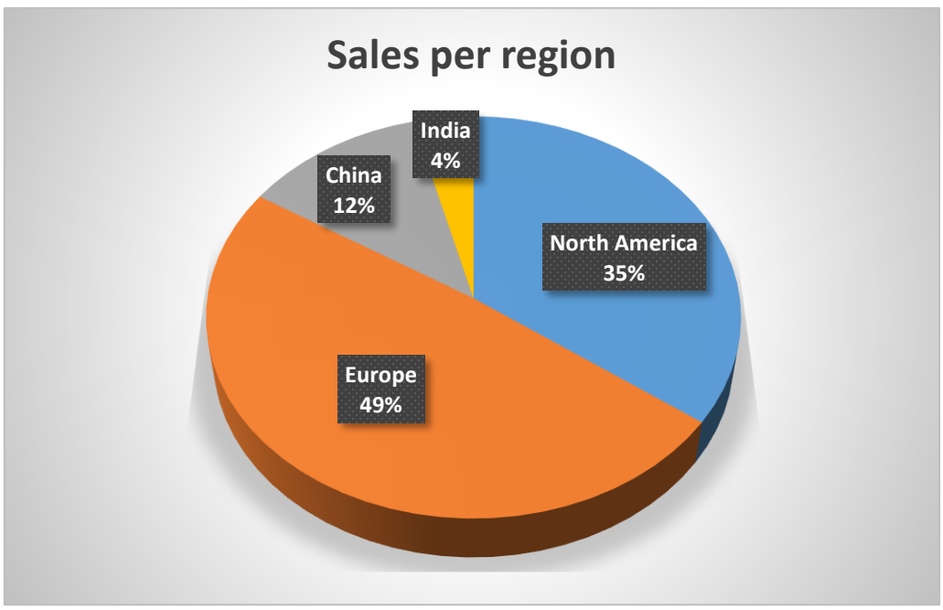
The main mission of Varroc is defined by the slogan:
“Bring leading edge technology to the mainstream markets with high quality, cost competitive solutions.”

Varroc core values:

Varroc Lighting Systems: sales

Main customers of the global Lighting business:



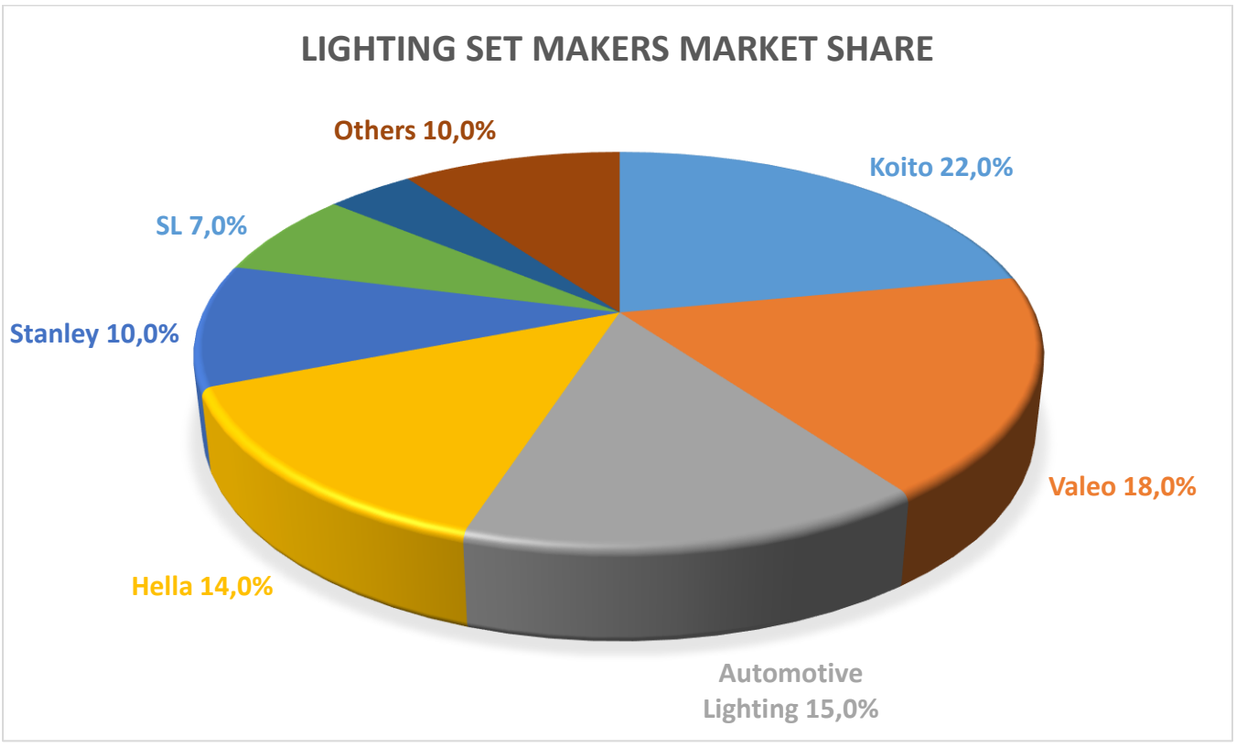


Main customers for India:

- Bajaj
- Royal Enfield
- Yamaha
- Suzuki
- Honda
- Hero
- Piaggio
- Harley Davidson
- Eicher Volvo
- Mahindra & Mahindra
- KTM
- Tata Cummins

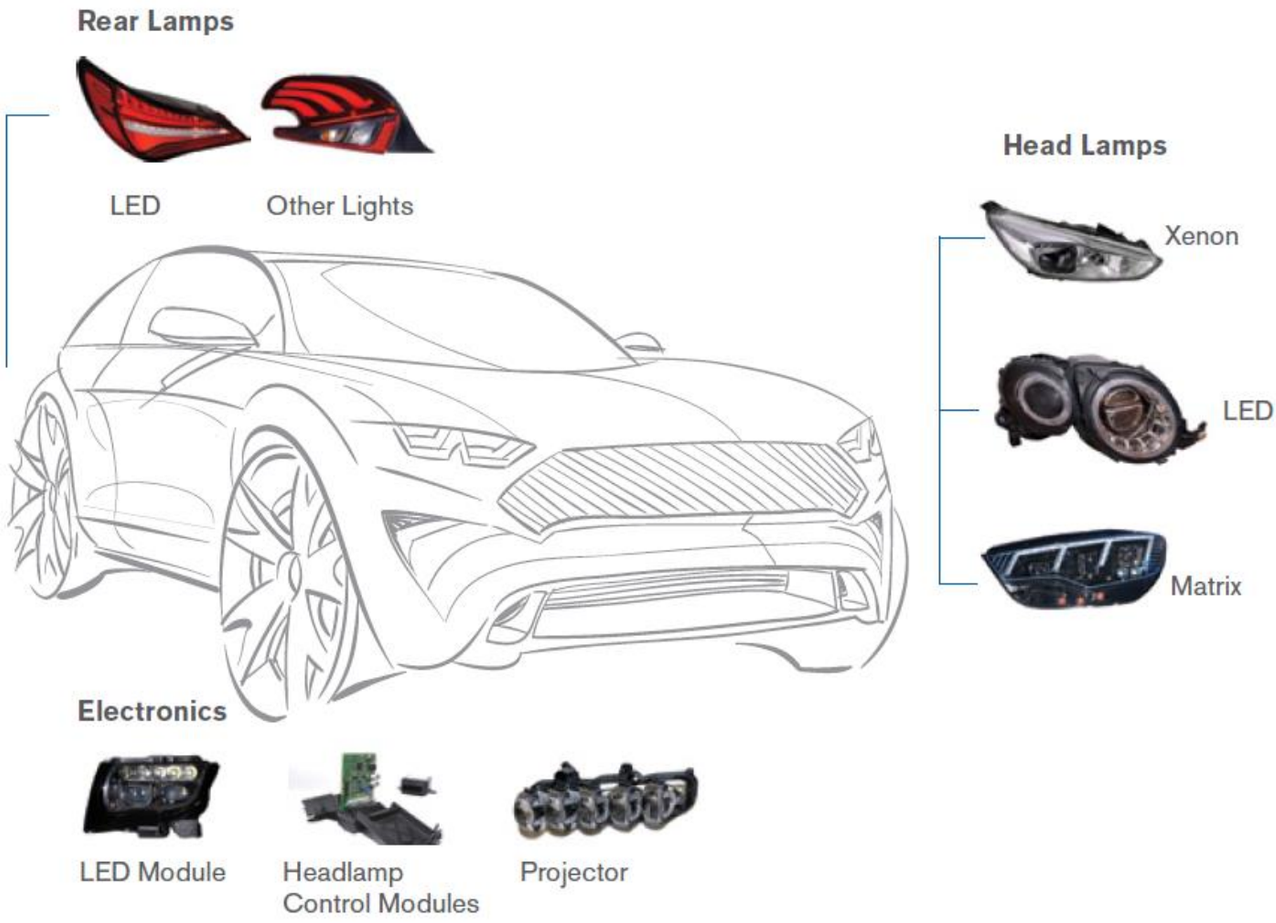
Varroc Lighting Systems: worldwide market share (for automotive):

Despite a strong increase of sales at +14% each year since the acquisition of the activities of Visteon in 2012, Varroc are still occupying a relatively limited position with a market share at around 4% of the global lighting market. This is also due to the parallel progress of their competitors with CAGR sales of roughly +10% during the past five years.



Varroc Lighting Systems: products

Varroc are developing and producing all types of headlamps (Halogen, Xenon, LEDs, ADB) and rear lamps (bulbs, LEDs) with the corresponding electronic control units.



Varroc Lighting Systems organisation for development and R&D

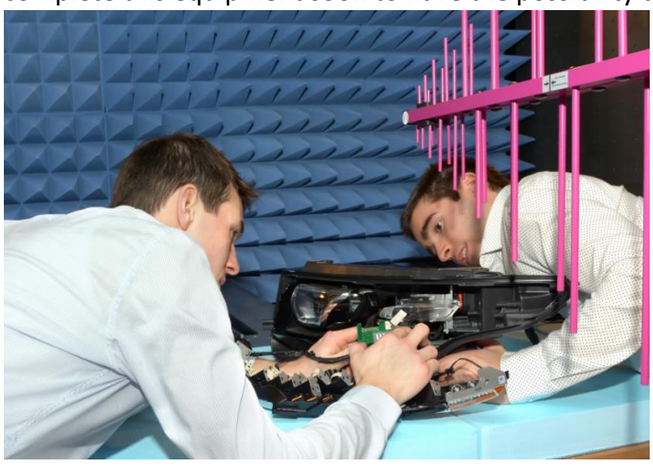
The Nový Jičín technical centre has more than 400 engineers on more than 1000 globally for Varroc Lighting Systems, this number increasing by more than 100 yearly. The Nový Jičín technical centre is the global centre of excellence of Varroc Lighting Systems.

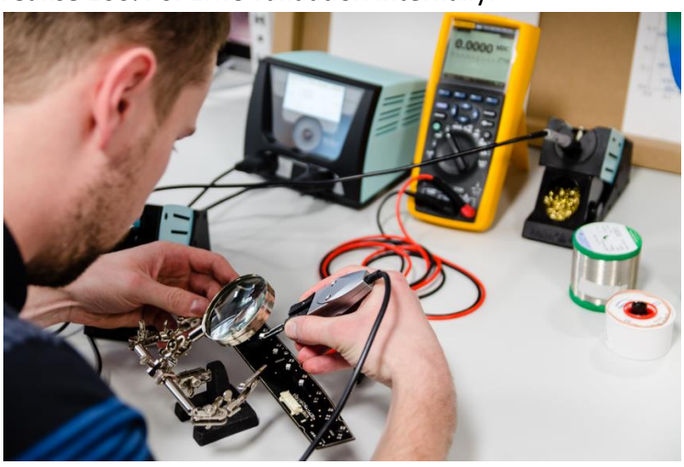
Project teams: The development of products are organised by Project teams, in open space with the different functions on the same project platform. These project teams are mainly in Czechia for European developments, in Monterrey for American developments, in Pune India for local supplies and global support.

Projects and R&D are in a matrix organisation. R&D have so people in the project teams and in teams for support by specialised skills like mechanics, optics, EMC, and so on.

In Optics, Varroc are mainly using the simulation tools Lucid shape and Light tool, but also use internally-designed tools for optical design. They have in optics some support from their Indian R&D base.
Varroc have decided to standardise their goniometers with LMT (Five in Nový Jičín and six in other countries) that are used in 25m darkrooms. Varroc don't use a tunnel of their own to check their optical beams, but rather do that at the Tatra track close to their Czech technical centre.

For Electronics, Varroc are doing all the designs internally. An important team for the development of Electronics is based in Czechia with more than 150 persons and increasing quickly. An important support particularly for software is done by the Indian R&D base. EMC (Electro Magnetic Compatibility) validation is done mainly internally currently with own equipment in large EMC rooms in Nový Jičín. Varroc are targeting to complete this equipment soon to have the possibility to realise 100% of EMC validation internally.





The production of electronics was until now done outside, but Varroc have signed this year a contract with Elba for the establishment of a JV for electronics production in Romania soon, the target being to decrease costs.

Testing: Varroc are using all the traditional equipment necessary for product validation (vibration, vibration with thermal constraints, water tightness, condensation, corrosion, climatic chambers, …). They also use equipment for electronic circuits, such as a climatic enclosure for quick transition between high and low temperature for stress testing. The testing laboratory is used both for the development and for some tests of serial products.

3D reconstruction: Varroc are using a 3D reconstruction system for a quick measurements and analysis of new products.

Moulds workshop: 60 employees are working for the realisation of production moulds. Varroc are mainly doing internally the most complex moulds as for reflectors, bezels and lenses. The other moulds for instance for housings are done externally particularly in China. Traditional machines are used, such as CNC five-axis machines for milling, electro erosion machines,…
Varroc have in addition invested in a very precise (and very expensive) machine for ultraprecision milling, able to deliver directly without polishing every optical part including lenses, light guides, and so on. Modifications and maintenance are representing 25% of the workload.

In Rychvald are installed complementary R&D resources and a demonstration room.

New Technical centre in Krakow

- Opened in 2018
- 60 people at end 2018
- For headlamps & signal lamps development
- Floor space: 1,500 m^2
- Houses cross-functional product development teams, including mechanical, optical and electrical engineers.

Technical Centre in Ostrava

- Opened in 2012
- Mainly engineers for project development
- Very close to Ostrava University; offers trainee programs and internships to students

Plymouth headquarters, Technical Centre and Sales office

- Opened in 2012
- 110 employees
- Close to Ford, GM, and Fiat Chrysler

Varroc Lighting Systems: innovations

Innovations for front lighting

VLS have developed very interesting products for JLR integrating matrix beams and laser technology. The matrix applications are using modules from Osram that were developed in a close cooperation between JLR, Varroc and Osram.

Jaguar's E Pace was launched in July 2017
It was the first application of Varroc matrix headlamp using 20 pixels per headlamp for the ADB function.

Osram Smartrix module integrated in Jaguar E- pace Varroc headlamp.
Each Smartrix module has 10 Oslon Black Flat LEDs.

2018 Range Rover Sport with Varroc headlamp matrix headlamp with 71 pixels with vertical and horizontal strips

Modules integrated in Varroc headlamp for JLR headlamps

There is an option with laser to improve the range to 600 m, with two Osram laser µLARP modules each providing 200 lm and having a high luminance of 450 cd/mm² per headlamp.
For this laser application, Varroc have developed a high safety feature at three levels integrating sensors for the colour, for the beam and a complementary last physical protection.

Bentley Continental with 80 segments LED Matrix headlamps
These headlamps have a nice crystal appearance. The upper module produces the kink and hot spot. The lower module provides a flexible low beam. These modules make low beam, high beam, ADB and dynamic bending light by adapting the intensity in each LED.

Bentley Continental Crystal effect headlamps

High definition ADB – Pixel Lighting

Varroc are preparing high definition systems and have developed several prototypes, including:

- Matrix beams with 10, 19, and 27 segments
- µAFS with 3072 segments using three new µAFS Osram modules
- DMD with 327104 segments
- MEMS and laser with no limit for number of segments

The bench allows to simulate the positions of one or several cars in front. Naturally, with better resolution comes a better perceived result. Nevertheless, even the lower resolutions bring improved safety. The 19- and 27-segment systems were improved compared to current-production parts, with good homogeneity and a clear cutoff. The µAFS system with 3072 segments is under development and still needs improvements to the cutoff, but it is a good base that could be on the market soon. The DMD system gives good homogeneity thanks to its 327,104 segments; Varroc are targeting to launch this kind of systems in two years. However, their current thinking is that in the long run the latest presented solution with MEMS will be the winner in the competition.

Varroc are therefore putting important resources into the development of these high definition ADB in roughly all the main directions except LCD, confirming their strategy to not necessarily be the first to introduce a new technology, but being ready for mainstream applications.

For advanced research, Varroc are collaborating with a variety of companies, such as Brightway Vision to improve the visibility through fog and rain by delivering clear, sharp, highly-detailed, easily-recolourised augmented vision for drivers. A demonstration of this technology was presented during the last CES in Las Vegas this year. During the same event, Varroc presented a prototype integrating their most advanced technologies particularly for communications with other vehicles by dint of lighting devices.

Pixel headlamp

Other significant products in production

Škoda Karoq headlamp

There is an upper part for an AFS low beam-high beam and signaling functions,and a lower part for fog beam. These two parts are in fact only visually separated, being manufactured together.

Citroën C3 Aircross

Other LED Headlamps

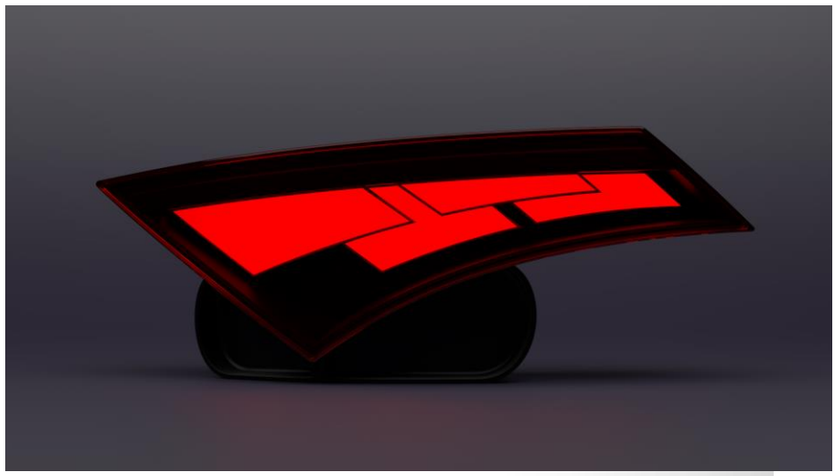
Innovations for signal lamps

Škoda Karoq launched beginning 2017 with volumetric light guides having a very good homogeneous appearance.

Varroc have developed several solutions to improve rearlamp appearance particularly with 2D and 3D.

Varroc prototypes for OLED appearance

giving a similar appearance than OLEDs with LEDs



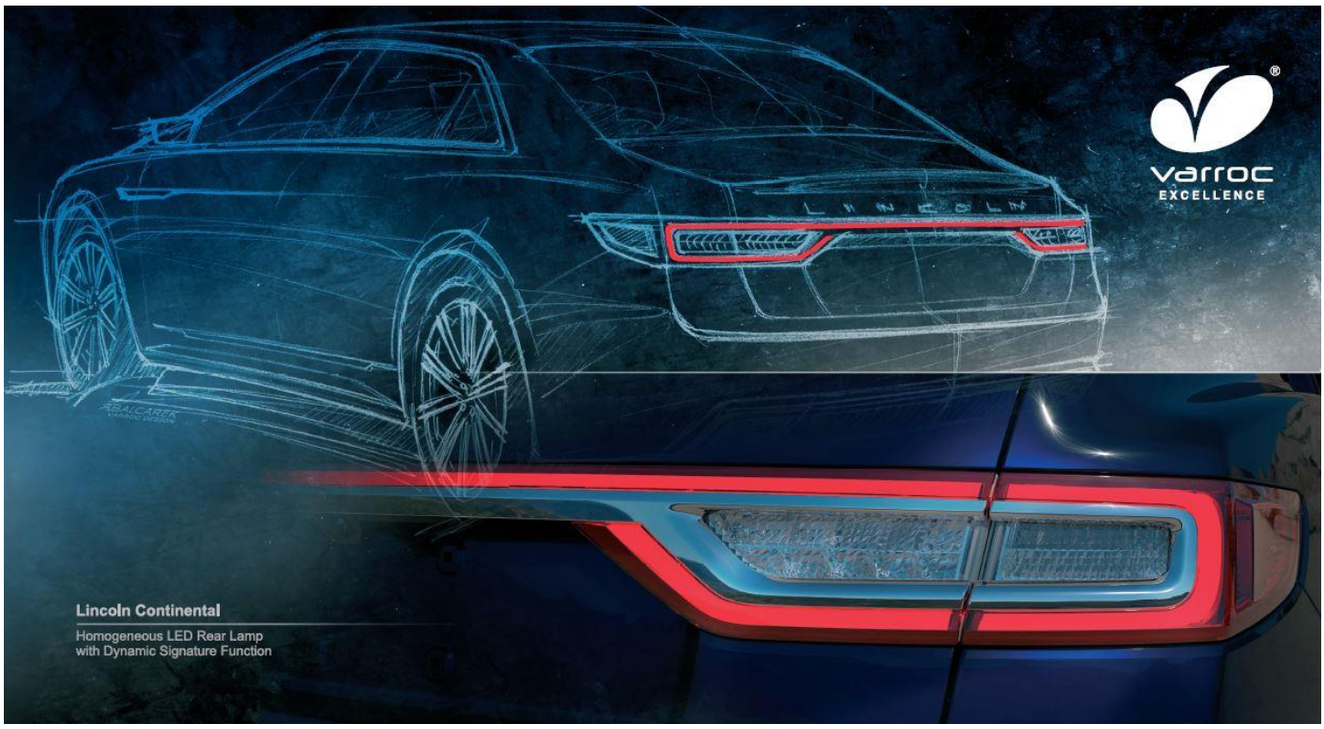
OLED appearance prototype

Varroc have developed a hologram solution giving a 3D perception inside rearlamps, and for safety communications, they're working on a projected signal at the rear of the car that could significantly improve safety when drivers are reversing out of a parking space. The prototype developed by Varroc projects from the car to 10 m several amber arrows dynamically.

Other significant rear lamps in production:

New Ford Fiesta

Lincoln Continental with homogeneous LED rearlamp



Personalization of rearlamp

Two-wheeler products

Headlighting and rear lighting for two-wheelers are now closing the gap for the technology used to automotive applications, LEDs being too more and more often used in this highly cost-sensitive market.

As for automotive applications, the advantages of low power consumption and innovative styling are making this technology very attractive for customers even if halogen is still dominating for two-wheeler headlamps.

For signal lamps, with the cost of low-power LEDs dropping, LED is increasingly becoming the light source of choice for 2-wheeler signal lighting. A low weight with minimal package space makes LED a very interesting technology. Innovative design signatures are key elements to the vehicle for both day and night conditions

Varroc Lighting Plants–Europe:

Czechia Nový Jičín

- Established in 1879
- Employment: 2,077
- largest Varroc plant by production volume
- Products: headlamps, rear lamps, projectors
- More than 90 injection moulding machines

Novy Jicin Plant

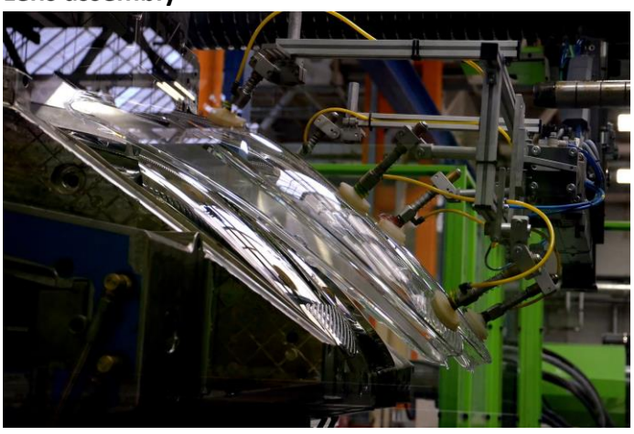
This site is the largest of Varroc Lighting with more than 2000 workers, 600 of them being subcontractors.

Plant extension in Novy Jicin

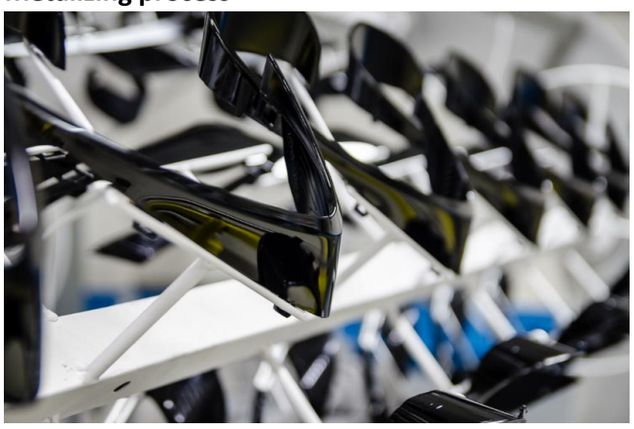
- Very good general cleanliness of the plant and the R&D centre is maintained
- On average, relatively young workers and engineers with good motivation and knowledge
- New machines and new assembly lines for the new high-tech production
- ESD protection strongly implemented (as LEDs and new electronics technology are become the standard)
- Weekly production: 50,000 headlamps; 150,000 rear lamps; and 100,000 projector units.
- The floor space is 33,000 m^2 on a global surface of 1,500,000 m^2 for the complete factory.

Rear lamps are made using traditional processes with injection machines, hotplate welding, vertical vacuum machines for aluminium coating, and assembly lines.
Similarly for headlamps, processes are traditional, with generally new injection machines for new products, external varnish and internal varnish equipment for plastic lenses, large horizontal vacuum machines for aluminium coating, bi component glue for lens and housing assemblies, etc.

Lens assembly



Metalizing process



The assembly lines are not fully automated, only the control processes are fully automated (presence of all components, watertighness, photometry, etc).

Robots for lens assembly

Final assembly

Czechia Rychvald

- Opened in 1969
- 457 employees
- 9,312 m^2

Rychvald Plant

Rychvald plant

Here is where reside the installations for the production of high-tech ADB matrix and laser for JLR applications. Naturally complete new assembly lines, clean and ESD protected, are dedicated to this production. Products are automatically controlled at different stages of assembly, the assembly itself being for a large part manual. For these very accurate modules, the position of the shield is adjusted automatically with the colour checking. Some modules are using laser welding for the assembly of the lens.

At the end of the final headlamp assembly line, Varroc have developed for some limited applications requiring very high accurate geometric assembly an automatic dimensional adjustment for a good fit and finish.

Large horizontal metalizing machines for headlamp in Rychvald

Africa:

Morocco Tangier

- To be completed and open 2018
- Employment: 200 by end 2018
- 16,000 m^2
- Production of headlamps, rear lamps, DRLs

America:

Mexico – Monterrey: Manufacturing, Technical and sales centre

- Opened in 1982
- 2,610 Employees
- 83,640 m^2
- Makes headlamps, rear lamps, fog lamps, CHMSLs and other signal lamps, and retroreflectors

Brazil Sorocaba (State of Sao Paolo)

- Opened in 2017
- 200 Employees
- Production of headlamps and rear lamps

Asia:

China Varroc TYC
Chongking Technical, Manufacturing and Sales Centre
- Opened: 2014
- 660 employees
- 16,200 m^2
- Full exterior lighting products

Chanhzhou Technical, Manufacturing and sales centre
- Opened 1995
- 1,030 employees
- 28,000 m^2
- LED, AFS products

India
Pune Manufacturing, Sales and Technical Centre

- Opened in 2007
- 300 employees

Specific locations for 2-wheeler lighting

Romania Tirgu Mures

- Opened in 1954
- 113 employees
- Floor space: 22,000 m^2
- 2-wheeler rear lamps, fog lamps, CHMSL, flashers and other signal lamps

Italy Cambiano
Manufacturing and Technical Centre

- Opened 1969
- 120 employees
- Products: 2-wheeler head lamps, rear lamps, daytime running lamps, fog lamps, CHMSL and signal lamps

Vietnam Hanoi
Manufacturing and Technical Centre

- Opened 2018
- 90 employees
- Floor space: 8,000 m^2
- Products: 2-wheeler head lamps, rear lamps, fog lamps, CHMSL, flashers and other signal lamps

Awards

- Varroc Lighting have received recognition as a key supplier for Car of the Year in Czechia in 2018. This professional recognition is announced annually by the Automotive Association (AutoSAP) for companies that supply components for the winning car in the Car of the Year survey.
  This year's winner is Škoda's Karoq, which uses headlamps and rear lamps from Varroc.

- Varroc earned the Q1 Ford recognition in China in September 2017 in Varroc TYC autolamps (VTYC).
  Q1 certification is Ford's highest recognition for suppliers, indicating consistent excellence in quality, service and on-time delivery.
  VTYC are one of only two lighting suppliers in China to receive this recognition and also are the first Q1 supplier awarded by JMC.

- Varroc Lighting Systems India received the India Automotive Lighting Technology Innovation Leadership Award at Frost & Sullivan's GIL 2016

SWOT Analysis

Strengths

- Good cost competitiveness with R&D centres and manufacturing plants in low-cost countries
- Implementation mainly in growing markets
- Large product portfolio for cars and 2-wheelers
- Good coverage of customer locations thanks to the new plants in Brazil and Morocco and with JV Varroc TYC in China
- Delivered leading high-tech headlamps to JLR and has good level of innovation for rearlamps
- Stable and ambitious owner; experienced international management team

Weaknesses

- Relatively small size with less than 4% of worldwide market compared to the four main competitors being between 15% and 22%
- Limited presence with Japanese, Korean and German premium brands.
- Image for innovation not as strong as main competitors
- Interior lighting not covered (but this is not really detrimental to exterior lighting activities)

Opportunities

- Customer base not complete, so possibility to have orders from new customers
- The widening markets of LEDs and ADB applications to mainstream cars are requiring low prices where Varroc can put a wedge for market share increase
- Possibility to participate to the reorganisation of the lighting business by acquisitions without big risk of loss of market share after merging

Threats

- Risk to need time for new orders of high-tech products except JLR or niche applications
- Not enough resources to participate to the fight for IA for future systems, particularly for Autonomous cars with as consequences the risk to become a tier 1.5 supplier
- Varroc group are still intimately linked to their main owner with the advantages and risks of family companies. However the recent introduction in the stock exchange for a part of shares helps here.

Interview with Stéphane Védie, President and CEO of Varroc Lighting Systems

Stéphane Védie has a master's degree in purchasing management from Grenoble University in France, a master's degree in management from the Graduate Business School of Amiens in France and a bachelor's degree in corporate finance and strategy from Uppsala University in Sweden.
He has held executive positions at Magneti Marelli, Automotive Lighting, and Valeo in Czechia, France, Germany, and the U.S., and has spent his career in the automotive industry with specific expertise in vehicle lighting.

Since December 2016 he has been CEO of Varroc Lighting Systems, and he kindly granted us this exclusive interview:

DVN: The global sales of Varroc group have strongly increased during the past five years, with an average annual growth of 14%. You have even announced operations at +28% in Q1-FY18 at around €350m. How do you explain this grand increase?

Stéphane Védie: We have a very clear organic growth strategy targeting specific segments and car manufacturers with technology and volumes. Our footprint expansion, particularly in Brazil and Morocco, has enabled us to position ourselves on global platforms where only a few players were present. This strategy has allowed us to win significant incremental business in the last 18 months.

We understand our customers' expectations. We bring technology to the mass market with cost-competitive solutions. A great example is our patented Surface-LED technology, which allows us to reproduce the appearance of OLED with conventional LEDs, providing a more robust quality and durability solution at a significant lower cost.

We offer the right level of technology at the right price and utilise a global footprint to provide superior service to our customers.

DVN: Varroc Group are shooting for €2.4bn in 2020, so roughly twice the level of last year. What is your global strategy to achieve this target?

S.V.: Varroc Group reached a revenue of €1.5bn last year, so our goal is not to double by 2020 but still show important growth. The growth of our India business has been supported by strong volumes in the two- and three-wheeler market plus the introduction of new technologies, mainly driven by regulations and new product lines. In our global lighting business, our organic growth plan is well on track and we are looking at opportunities for inorganic plays.

DVN: In lighting, in your last annual report, you are targeting to be among the top three in the global lighting business. Is there another big acquisition or new JV in the offing, after the JV agreement with Elba?

S.V.: Among the top six global lighting suppliers, three do have an equity connection with a specific OEM. We could therefore say that we are already part of the Top three independent suppliers! Tarang Jain, who is our majority shareholder, is very ambitious about our business. Despite our fast organic growth, we will continue to look for additional acquisition opportunities in order to reach the right scale. Varroc are financially strong; since July of this year we are publicly traded and have easy access to capital. We will continue to be an actor of consolidation in our industry.

DVN: What is the breakdown of your sales among headlamps, rearlamps and other products in lighting activity?

S.V.: Our business is very well balanced between front and rear lighting with each representing approximately 50% in volume.

DVN: Looking at the turnover of Varroc and your competitors, we estimated the Varroc market share at around 3.2%. Do you concur? What can you tell us about your market share?

S.V.: According to a recent third-party market study, we are at 4% market share. We are also very strong in two-wheeler lighting, so if we add Triom (which we now own at 100%) and our India motorcycle lighting business, we should even be above that mark.

DVN: You have a great deal of experience working at lighting set makers—Valeo, then Automotive Lighting, and now Varroc. What are the main differences in the ways these companies work? What do you consider the strengths and points to improve for Varroc compared to your main competitors?

S.V.: Both Valeo and Automotive Lighting are great companies and I did learn a lot during the 20 years I spent with them. At Varroc, we are trying to be different. Our decision process is extremely fast and we are very agile compared to our larger competitors. We put our customers at the centre of everything we do. We have built a very strong leadership team and take only the best people. We have a very strong team spirit—there are no politics and we have fun working together. This creates a strong dynamic that helps us overcome any obstacle.

We might not compete in size but we can compete in speed, agility and creativity!

VN: In a study released last year by DVN, we considered a change of the value chain driven by mega trends in society and industry, by technological developments and by the arrival of super integrators or "Tier 0.5" suppliers. What is the ambition of Varroc on that front?

S.V.: We do not position ourselves as a super integrator and will remain a Tier 1 focused on serving our OEM customers, however we are already inserting ourselves in the new ecosystems built around autonomous driving, connectivity, shared mobility, and electrification. We have defined our value

proposition and can show you some interesting technologies and innovations during the next Consumer Electronic Show in Las Vegas in January.

Interview: Todd Morgan, Senior VP Global Product Development…

DVN: What are the main lines of your history, sales and number of employees?

Varroc: Headquartered in Plymouth, Michigan, Varroc Lighting is a wholly-owned entity of Varroc Group, the second largest automotive component supplier in India. We have more than a century of exterior lighting expertise, dating back to the production of coach lamps in Europe in 1879. We are a global company, with 20 locations in 17 countries on five continents, offering capabilities on every continent where vehicles are produced. Our manufacturing network includes cost-competitive countries such as China, Czech Republic, India, Mexico, Morocco, Turkey, and Vietnam. We currently Varroc Lighting employ more than 7,200 people around the world. The revenue for Varroc Group for FY18 was ₹110 billion.

Varroc Lighting contributed ₹69 billion.

DVN: How many R&D centres and production sites have you specifically for Lighting? During the last six months, you opened an R&D centre in Japan, developed production facility in Vietnam, acquired Sa-ba in Turkey, do you intend to continue this rush for new R&D centres and new production sites to develop

your lighting activity?

Varroc: We remain focused on providing cutting-edge lighting products that are customized to meet customer needs. To do so, we must continue to innovate. This requires a global network of engineering and technical centers. We currently have more than 950 engineers working in our nine Varroc Lighting R&D centres. We will continue to expand as customer and technology growth requires.

DVN: You had a strong increase in your lighting business in the past years, and new technologies such as LEDs and ADB too were expanding. What were the consequences for your R&D organisation?

Varroc: We continue to aggressively expand our engineering capacity and capability worldwide. Our recent expansion in Ostrava [Czechia] and new development centre in Krakow, Poland are good examples of this. It is our strategy to also have engineering capability in each of our new manufacturing facilities as well, so we are actively growing our development capacity in Morocco, Brazil and Turkey as well. Unsurprisingly, the biggest change in our engineering organization is the accelerated growth in electronics and software. We don't see this slowing down, and in fact with the increased requirements for functional safety, ASPICE compliance, and integration of ADAS components, we can expect the demand to continue to expand.

DVN: Have you any difficulty for recruitment of your needed resources in the countries you are installed?

Varroc: OEMs and suppliers around the world have been affected by a shortage of engineers. As a growing company, we are actively searching for candidates to join our robust and growing network of technical experts. We work cooperatively with many universities around the world, and this has also yielded positive results with many young energetic people joining our team. As you know, there has never been a more exciting time to be in the lighting industry, so our turnover is relatively low as well.

DVN: Compared to other lighting set makers, it seems that you are more relying on strategic partners for modules, for instance Laster for some LEDs modules in China, or Osram for Smartrix modules of the Jaguar F pace. Is it a clear strategy in Varroc to compensate the relative more limited resources than bigger competitors by a closer partnership with suppliers?

Varroc: We regularly work with partners strategically where there is a good business case to do so. The entire industry recognises that it's impossible to be successful without forming good relationships with suppliers, and working collaboratively with them to develop new innovative technologies and products. We will continue to do so in the future. At the same time, we recognize that there are some areas that we want to hold closer, and build that expertise internally. For example, you have seen the recent announcement of our Electronic JV with Elba, so while we will continue to work with partners one some electronic components, there are some cases where we want to produce these ourselves.

DVN: Electronics is becoming very important for lighting systems, and you have just this month September 2018 announced a JV with Elba for electronics production: what is your strategy for electronic development and production?

Varroc: We have always maintained development responsibility for electronics for all of our products, and we will continue to do so. With the establishment of the JV with Elba, we are very happy to add the capability to produce our own electronics as well. Of course, like our competitors, we will continue to work with suppliers and partners in some cases. The trend of growing electronic content in lighting will surely continue, and it's mandatory that we have this capability to maintain our competitiveness, both in terms of technical knowhow and cost.

DVN: Your business in India for lighting is mainly for 2- and 3-wheelers; is there any synergy between this business and your global business for other countries?

Varroc: There are definitely synergies between the two businesses. LED technology is rapidly being adopted in the 2-wheel market, and we are able to share the same engineering tools and best practices, particularly in the fields of optics and thermal management. In the other direction, there are some really interesting cost effective designs that we can adapt from the 2 wheeler market into the automotive space.

DVN: Varroc is developing and producing in low cost countries, and so certainly has good cost competitiveness. What is your ambition about technology leadership?

Varroc: We have a best-in-class footprint in terms of both development as well as production, and our strategy is to maintain that, while continuing to grow our business. Our technology strategy is to bring innovation to the mainstream, and a technology like Surface-LED which give the appearance of OLED but using traditional LED sources is a good example of that. We also concentrate on leading edge technologies like DMD and MEMS based headlamps, but again our focus is on optimising efficiency, performance, and cost to make this technology affordable for a broader customer base.

DVN: What do you consider the best realisations of Varroc Lighting during the last years?

Varroc: I'm really proud of our recent launches of matrix and laser headlamps, and our ability to reuse standard elements of the modules across multiple car lines that significantly reduced the time and cost of development for our customer. Establishment of our new facilities in Morocco and Brazil and our recent acquisition in Turkey are significant steps forward to support our customers, and has opened new opportunities for Varroc Lighting Systems globally. However, the best realisation is our growing and talented team; I'm really proud of the people that I work with every day that make this all possible.

DVN: What is the current level of LEDs in your production? What is your prediction about the evolution for next years?

Varroc: Nearly every program has some level of LED content on it, and this will continue as the cost for LEDs continues to drop and we develop increasingly efficient optical systems. The recent drive to lower CO_2 emissions is definitely driving this trend, as we see an increasing number of OEMs dropping halogen light sources from their portfolio even in the mainstream B/C segments. The desire for personalisation and some form of animation during a welcome/goodbye sequence only makes sense using LED light sources. We will continue to look for ways to reduce the cost of the total system, and to develop new innovative visual effects to ensure that this trend continues.

DVN: Do you think that LEDs could replace halogen even in developing countries as India?

Varroc: The cost of LED headlamps will continue to drop and this is driven by a number of factors starting with the reduced cost of the chips, but more importantly through more efficient thermal management systems and standardisation. While I'm doubtful that we will ever reach the cost of halogen, the developing markets will also want the reliability and styling benefits that LED headlamps offer, and we will get to a price point that is affordable. We will see how quickly electric vehicles evolve, but surely power consumption could become a major factor in speeding up this trend.

DVN: During a demonstration to customers and media this past July in Detroit, you have announced a new generation of low-cost reflector technology with LEDs for mainstream B and C segment cars. Can you describe the corresponding technology?

Varroc: At the recent event in July in Detroit we demonstrated an array of different possible technologies that can be used to deliver ADB. One of the technologies we demonstrated is OPTI-MATRIX which is an indirect reflector solution, it is designed to find a balance between cost and performance. This passive cooled system is now delivering a really homogenous beam pattern, and we have designed it to be scalable so we can tune the number of segments based on the customers need. OPTI-MATRIX is ideal not only for the B/C segment vehicles, but also perhaps for applications on electric vehicles due to its low weight and power consumption.

DVN: Can you describe the ADB systems you have developed? What is your preferred solution?

Varroc: We have a broad range of systems, tuned to our customers price and performance targets. It's important that offer this range to ensure we drive this safety enhancing technology to all segments of vehicles in all markets around the world. We have indirect reflector (OPTI-MATRIX) solution for cost effective applications, or for vehicles where power consumption and weight are a priority. We have recently launched several "classic" projector style designs using primary and secondary optics, and our next generation optical systems are even more efficient and compact. uAFS or EVIOS is a very interesting solution as a first step into a higher resolution system. Finally we have a DMD based module ready for serial production and will soon be introducing our next generation MEMS module to our customers for a full HD beam pattern.

I don't think there is any one preferred solution for Varroc, since we need to match the technology with the customer's needs, but I strongly believe that our focus to bring ADB to all levels of vehicles, and not to focus only on the high-end solutions is the right one. Optimising performance, cost, and efficiency remains the key priority for Varroc.

DVN: You have recently launched ADB systems through a co-development of the modules with Osram for Jaguar Land Rover applications. What were the difficulties? Have you any feedback from the market?

Varroc: We are very pleased with how these modules turned out, particularly in terms of the light output and homogeneity. Our ability to use these modules on multiple vehicles is also a great achievement and the cooperation with the JLR engineering team was very helpful to make that happen. Software was one

of the biggest challenges, and this took many hours of night drives to get the system to work and behave exactly how the customer wanted it to. It's clear that software will play an increasingly important part in the overall performance of any ADB System.

DVN: You have also announced that you will launch in the next two years high-resolution adaptive high-beam systems relying on integrated circuits containing up to 1.3 million pixels to provide illumination: can you give us some more details about that technology?

Varroc: This it really exciting technology, and it's based on the new generation of the Texas Instrument DLP chip. We've really made great progress in reducing the size of the module, while improving the optical and power efficiency. Photometric performance is a given, so our focus is to reduce the cost, weight and power consumption of the module. The ability to not only deliver a best in class ADB System, but also to project images opens up many new possibilities in terms of driver/pedestrian safety and ability to customise some interesting effects that can be performed with light.

DVN: What is your feeling about HD pixel lighting? What will be the future winning technology? What is the strategy of Varroc for HD systems?

Varroc: HD pixel lighting opens up new possibilities that we never had before. There are still some limitations of the total system before we will see the full potential, for example the accuracy of the cameras and other sensors. I think the projection of images, within reason and within the limits of regulations, have some potential, but this needs to be balanced with what can be done with a HUD, and what should be done with the headlamps. The element of personalisation is very intriguing as well, with the possibility of a variety of welcome modes. However, having full control of the beam, the ability to adapt the beam in any way to improve the safety for the driver, and to enhance the effectiveness of ADAS sensors and cameras will undoubtedly require a HD solution in the headlamps.

Our strategy is to bring this innovation to the mainstream, and offer a broad array of options to our customers that fits their performance and price targets. Our goal is to standardise elements are that drive cost, but are less visible (controls, drivers, light sources, etc). Our focus is to drive out cost by improving power and optical efficiency.

In the future, we are very interested in what a MEMS based ADB system could deliver. MEMS is interesting as it has the ability to "redistribute" light where you need it, and reduce it where you don't, as opposed to competing technologies where you are always removing light. There is still some work required on light sources and the MEMS mirror itself, but we are very optimistic that his technology will become more important. In the short term, technologies like DMD or uAFS are very interesting ways to deliver a HD Pixel beam, and we are working very actively on this. Bottom line, we need to understand our customers needs in terms of cost and performance, and apply the technology that has the right fit.

DVN: About new sources for front lighting, you have used Osram laser modules for JLR: can you describe that experience? Are you confident about the future of laser sources?

Varroc: We are happy to be the first to introduce Osram's uLARP Gen1 to the market, and the high beam boost, combined with our matrix modules, deliver superior visibility for the driver. It's really a great system when you drive it. Currently, I think laser is primarily a great marketing tool, since we obviously

can deliver a similar feature in a more cost effective way with an LED light source. However, laser technology played a role in further emphasizing technology and performance in lighting, but given how the many other technologies are developing, I'm a bit skeptical that laser is best used for just a high beam boost. The story of laser light sources is definitely not over, and as our partners continue to improve the lifetime and total flux issues associated with the laser diode, there are definitely future systems that will require a laser light source. We are confident that we will see new laser-based applications in the future.

DVN: Are you too developing signal lamps with OLEDS? What is your feeling about the future of this technology? How do you see the future of signal lamps?

Varroc: OLED offers some technical advantages, and we have some customers that value this technology and what can be accomplished from a styling perspective, so yes, we have development activity dedicated to OLED. However, we are actively looking for alternatives that achieve the appearance of OLED, but using a more cost effective and reliable technology. Varroc's Surface-LED technology has received a lot of attention from our customers and we continue to work to improve the appearance and design flexibility.

We are focused on developing new optical systems as well, such as holograms or other interesting effects. Personalisation is going to continue to become important to our customers, and signal lighting will become an important communication tool on the vehicle. So we are actively developing new innovations to bring to our customers in this field.

DVN: Are you preparing the arrival of autonomous cars? How do you see the consequences on your activity and more generally on lighting business?

Varroc: We are definitely adapting our technology roadmap for autonomous vehicles. Lighting will continue to play an important role on the vehicle. The importance "to be seen" will perhaps outweigh the need "to see" at some point. The integration of ADAS sensors, and how we use lighting to complement these the various vehicle sensors is a very interesting topic that we are actively working on. We may need to adapt our performance criteria to better match the needs of cameras as opposed to only the human eye. We will also likely see new lighting functions appear related to autonomous driving. Software will become increasing important, and we are actively taking steps to expand our capacity and capability in this field.

DVN: Are you too developing communications devices with lighting equipment?

Varroc; Using lighting as a communication tool is definitely something we see becoming more important in the future. There is so much hype about autonomous cars, but we will have many, many years that we will have both autonomous and non-autonomous vehicles on the road at the same time, so lighting can be used to communicate between other drivers and pedestrians. Most likely we will need to re-evaluate the regulations as the technology evolves to reach the full potential. We also look at some opportunities related to car to car communication, and we are exploring a few options to achieve that.

DVN: How do you see Varroc in ten years? With which products?

Varroc: I'm confident that our cost-effective manufacturing and development footprint will continue to

expand, as we adapt to support our customers in areas where they are also growing. Our strategy to bring innovation to the mainstream market will remain a strength for Varroc, as we continue to develop high value technologies for our customers. Obviously, electronics and software will continue to accelerate in its importance in the lighting product line, and we will be much stronger in this field. Autonomous and electric vehicles will also drive new innovation in weight, power and added functionality, including the integration of various sensors. So we will not only be continuing to improve the visibility for the driver, but also allowing the vehicle to see for itself.

Conclusion

Varroc have very old roots, but are nevertheless giving the perception to be a recent company with the new organisation put in place after the acquisition of Visteon lighting in 2012 and with the strong evolution seen from that time.
A lot of work has been done to improve the efficiency of manufacturing, some of the plants for instance Mexico that were in huge difficulties are now recovered. More recently and particularly during the last twelve months from end 2017, a lot of investments were done with two new plants for new markets in Brazil and Morocco, with two new R&D centres in Ostrava, Czechia and in Krakow, Poland, with the acquisition in Turkey of Sa-ba allowing to enter both a new small lamps business and in a new market of 1.7 million cars produced yearly. This acquisition enlarged Varroc's production capacity with a large new plant in Bulgaria, and finally with a new sales office in Japan.
Varroc lighting systems are not forgetting their strong 2-wheeler business, and continue to invest this year with a new factory in Vietnam.
In parallel, Varroc have launched in close cooperation with JLR and some key suppliers high-tech products with matrix beam and laser technology. They succeeded as well to enter the high-range segment of VW group with the development of the Bentley Continental with an improved Matrix beam technology.
Thanks to this base and to their R&D workforce of more than 1,000 engineers, Varroc have the possibility to develop by themselves new high-end technology for instance in the domain of high-resolution ADB where they've demonstrated interesting prototypes. Varroc can also rely on good technologies for signal lamps to continue successfully in this business.
So Varroc, who seemed weak in 2012 with the dubitable heritage of Visteon's limited number of customers and conventional technologies, are now becoming a more global player between the major set makers for lighting despite their still relatively small market share of around 4%. They are certainly one of the fast running competitors thanks to their R&D and production locations in low cost countries offering at least for now a cost-competitive advantage. Varroc are ambitious with the target to roughly double their revenues in two years and to be among the first 3-4 main suppliers soon.
This seems a tall challenge, but could be realised if Varroc are continuing their pace both with a strong internal growth and new important acquisitions.

Appendix: latest news from Varroc

- **Demonstration in Detroit, 22 July 2018**

Varroc Lighting took over the Royal Oak Farmers' Market north of Detroit to demonstrate for customers and media their latest developments in adaptive lighting, including LED-based systems in certain luxury vehicles already on the market.

They are preparing to launch low-cost reflector-based LED systems for mainstream B- and C-segment cars. Within two years, Varroc also will launch high-definition adaptive high-beam systems relying on integrated circuits containing up to 1.3 million pixels to provide illumination. One of those upcoming vehicle contracts will project a welcome greeting on the ground ahead at startup. Adaptive high beams are not yet legal in the U.S., but they are in Canada and Europe.

- **Introduction on the Indian Stock Exchange, 16 July 2018**

Shares of Varroc Engineering Limited (VEL), the parent company of the Varroc Group, were first listed on the National Stock Exchange and Bombay Stock Exchange in India.

- **Acquisition of Sa-Ba in Turkey, 2 July 2018**

Varroc Lighting Systems increased global presence with acquisition of Istanbul-based SA-BA Automotive. With that, Varroc entered a new market of 1.7 million vehicles.

- Expansion into the Turkish market allows Varroc Lighting to support existing customers on global platforms and gain new customers
- Acquisition brings new skills and resources dedicated to small lighting with high-quality, low-cost solutions

Through Sa-ba Automotive, Varroc Lighting gain valuable manufacturing and production capacity with a 10,000-m^2 manufacturing and technology centre near Istanbul and a new plant under construction in Dimitrovgrad, Bulgaria. The 20,000-m^2 Bulgaria plant will give Varroc Lighting expanded and scalable production capacity for European customers.

Sa-ba Automotive adds more than 40 years of experience in interior and exterior small lighting products to Varroc Lighting. In addition, Sa-ba Automotive's existing programs and infrastructure provide increased capabilities, as well an opportunity to develop new products for truck, two-wheeler, three-wheeler, and off-highway customers.

- **New facility in Vietnam, 2 July 2018**

Varroc Lighting opened their new, larger facility in Vietnam to support their global expansion and the company's service of customers round the world. The plant is built on the lighting success from Triom, a Varroc majority-owned Italian company. Triom have a global footprint with six locations; Triom Vietnam was established in Hanoi to supply Asian customers with two-wheeled vehicle lighting solutions as well as finishes for limited-edition special vehicles.

Triom CEO Alessio Caputo joined the firm in 2009, and has more than 25 years of business experience. He led the integration of Varroc Lighting's new business in India by offering technical, logistic, and distribution support and was charged with uniting the international growth of the company

The new facility, located about 30 minutes outside of Hanoi, will have about 120 employees building on the two-wheel lighting success of Triom, and better positioning Varroc Lighting to serve the four-wheeler lighting market.

- **New Varroc Tokyo Office to Serve Japanese Makers, 18 June 2018**

Varroc have a new Tokyo customer and business development centre. The new office, announced in conjunction with the DVN Tokyo Workshop, increases Varroc's presence in Japan to strategically synergise

with the growing two- and four-wheeled vehicle market worldwide and strengthens Varroc Lighting's local engineering support of Japanese OEM customers.

The new location has office and meeting space for up to 14 engineers and expands the company's global footprint to 12 countries on five continents. In addition to Japan, Varroc Lighting recently announced plans to open new plants and development centres in other high-potential vehicle growth and manufacturing markets, such as Brazil and Morocco.

- **Varroc LS: Expansion of development Centre in Ostrava, 5 March 2018**

In a ceremony which also featured representatives of regional and city governments, Varroc Lighting Systems celebrated the opening of their expanded Lighting Development Centre in Ostrava, Czechia.

on the left: Todd C. Morgan, Senior VP of Global Product Development at Varroc LS

Designed as a modern and specialised workspace for the creation of advanced electronics and optical systems, the centre includes a significant increase in office space and an electronics laboratory with an antistatic environment (ESD). More than 150 experienced mechanical, electronics and optical engineers will work on the development of the latest state-of-the-art lighting systems at the facility. The expanded development centre will allow Varroc Lighting to attract more specialists to the engineering team at Ostrava.

- **High-tech Varroc Lights at India Auto Expo, 26 February 2018**

The key highlights of this year's Varroc display at the Auto Expo in New Delhi included a concept car boasting advanced exterior lighting including India's first adaptive bending beam and anti-glare adaptive

high beam LED headlamp.

Varroc's Surface-LED technology uses thin layers of micro-optic filters and conventional LED light sources to achieve the homogeneous appearance generally associated with OLEDs at much lower cost.

- **CES Las Vegas 2018**

Varroc showed very fancy taillamps that looked and lit like OLEDs, but based on inexpensive LED technology, and with a few tricks OLEDs can't do (multiple colours from one surface, for example). Demonstration of the fruit borne of Varroc's cooperative work with Bright Way Vision which sees through fog and rain to deliver clear, sharp, highly-detailed, easily-recolourised augmented vision for drivers, and the hardware is readily integrated into compact Varroc lights.

- **Varroc Lighting on Czech Car of the Year**
  5 February 2018

Varroc Lighting Systems received recognition as a key supplier for Car of the Year in Czechia in 2018. This professional recognition is announced annually by the Automotive Association (AutoSAP) for companies that supply components for the winning car in the Car of the Year survey. This year's winner is Škoda's Karoq, which uses headlamps and rear lamps from Varroc.

Both lamps for the Karoq were developed by Varroc right there in Czechia, in Ostrava. The rear lamp is a combination of both classical electric lamps and modern LED technology. The contour function is followed by modern lighting trends. Homogeneous appearance has been achieved by dint of diffusion materials. The headlamps, with inbuilt fog lamps, create a face for the Karoq. In addition to the incandescent lamps, the headlamps also feature LED DRLs. That's basic equipment; the de luxe version gets full LED headlamps with AFS functionality.

The lamps produced by Varroc Lighting Systems are installed not only in the winning car, but also the other two cars which entered the competition. Varroc supply the Ford Fiesta's headlamps and rear lamps, and headlamps and DRLs for the the Citroën C3 Aircross

The aim of the Supplier for Car of the Year in Czechia is to promote the latest car models and, together with them, innovative technical solutions. "This year's nomination has also shown how significant the suppliers and vendors have represented through their production in the world's most prestigious passenger cars," said Zdeněk Petzl, Executive Director of the AutoSAP Association, who organise the poll.

- **New Morocco Factory for Varroc Lighting**
  18 December 2017

Varroc Lighting have a new manufacturing and product development base in Morocco, the latest step in reinforcing the company's global presence.

The new facility is located in Tanger Automotive City, a major industrial centre with key connections to southern Europe through the Tanger-Med Port, one of the biggest ports in Africa. Upon its completion, the plant and development centre will create hundreds of jobs across a variety of functions.

The Morocco expansion comes on the heels of other new plants announced in Poland and Brazil.

New Varroc Lighting R&D Centre in Poland

- **New plant in Poland, 11 December 2017**

Varroc Lighting are expanding their footrprint in Europe with a new development centre in Krakow, Poland.

Todd Morgan, Sr VP Global Product Development

The engineering centre, expected to open next year, will house cross-functional product development teams including mechanical, optical and electrical engineers. It will offer full design capabilities for complex headlamps and signal lamps, with an emphasis on close collaboration with automakers throughout the development process—from initial concept stages through product manufacturing—at Varroc's plants round the world.

This is Varroc's first lighting facility in Poland, and is being established through a collaboration with local partners including CADM Automotive, AGH University of Science and Technology, and Cracow University of Technology. Existing partner CADM Automotive will provide essential insight into the talent pool and

business environment in Poland, while cooperation with local universities will foster knowledge exchange and promote innovation and talent growth.

- **Osram Matrix, Laser in Range Rover, 11 December 2017**

Following on from the premiere of the innovative SMARTRIX modules in the Jaguar E-Pace, Jaguar Land Rover now are launching their next vehicles with smart headlight technology from Osram. Compared with the Jaguar E-Pace, the Range Rover and Range Rover Sport come with additional modules which make the high beam even more defined and the low beam more dynamic. There is a choice of three versions; the top version is the brightest headlight currently available. The pixel laser LED option with 71 pixels and laser high beam booster, with two first-generation Osram µLARP modules, significantly increases the visual range for the driver. The SMARTRIX modules, with their innovative silicone lens system, afforded JLR's designers the flexibility to give the Range Rover and Range Rover Sport a modern look. Osram Specialty Lighting CEO Hans-Joachim Schwabe says the increased matrix count and functionality add up to "a headlight option that right now is unbeatable.

Jaguar Land Rover's first plug-in hybrid vehicle and the luxury SUV are equipped with premium LED headlamps as standard, and buyers can choose the matrix LED package as an optional extra. The lamps use 20 pixels to distribute the beam in vertical strips, each of which can be individually controlled. Together with Varroc, Osram developed various SMARTRIX modules with innovative long-life silicone optics for the new Range Rover and Range Rover Sport headlights.

- **New Tech for more Stylish Efficient Car Lamps, 30 October 2017**

Varroc Lighting have introduced Surface-LED as their latest innovation in exterior vehicle lighting systems, which gives the appearance of OLEDs without the high costs and application difficulties.

Surface-LED technology uses thin layers of microoptic filters and conventional LED light sources to achieve the homogeneous appearance generally associated with OLEDs. Each homogenously-lit element is only 3.5 mm thick, with a luminous intensity that can be scaled from 2,000–13,000 cd/m2. Surface-LED elements can also be designed and produced in curved and 3-D shapes with multiple colours that enable

various lighting functions.

Surface-LED was unveiled by Varroc at the 2017 ISAL (International Symposium on Automotive Lighting). Aside from showcasing their latest technologies, Varroc experts spoke about the future of the industry, the challenges and opportunities with future headlamp performance requirements, and high current LEDs in next-generation LED headlamps.

- **Spotlight on Smartrix, 25 September 2017**

Intelligent matrix modules with innovative silicone lenses are now being installed in the new Jaguar E-Pace.

The new matrix modules developed by Osram and called "Smartrix", provide ADB functionality ensuring optimum nighttime visibility even in extremely poor weather conditions.

Each Smartrix module features ten Oslon Black Flat LEDs, with 20 pixels integrated per headlight. The LEDs offer high light output even at high currents, a uniform light pattern, and thermal stability. The great benefit of the new Smartrix module is the long-life silicone lenses that enable the lighting system to be made particularly compact. This in turn gives automobile and headlight manufacturers enormous freedom to develop optics and opens up new headlight shapes. Designers can therefore implement innovative functions in the smallest of spaces and continue the trend for narrow low-profile headlights.

- **Varroc earns Ford Q1 in China, 25 September 2017**

Varroc Lighting Systems' joint venture, Varroc TYC Auto Lamps (VTYC), have earned Q1 certification from Ford commercial vehicle investment Jiangling Motors Corporation (JMC).

Q1 certification is Ford's highest recognition for suppliers, indicating consistent excellence in quality, service and on-time delivery. VTYC are one of only two lighting suppliers in China to receive this recognition and also are the first Q1 supplier awarded by JMC.

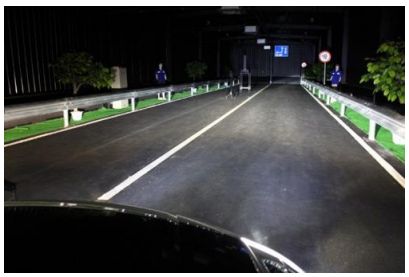
VTYC, an automotive lighting joint venture between India's Varroc Group and Taiwan's TYC Group, has worked closely with JMC since 2000, developing and supplying exterior lighting for the Ford Transit and

several other vehicles. The Varroc Lighting Systems team across Europe and North America also works closely with Ford to design and build automotive lighting solutions.

The team celebrated its achievement at a ceremony at its headquarters in Changzhou. Present were representatives from Ford Asia Pacific region, JMC, Varroc Lighting Systems and TYC, including Varroc Lighting Systems president and CEO Stephane Vedie, and TYC group chairman CC Wu.

To achieve Q1 certification, Ford suppliers must meet stringent criteria, attaining excellence in capable systems, ongoing performance, manufacturing site assessments, customer endorsements and continuous improvement, among others.

- **New China Lighting Test Lab, 28 August 2017**



Varroc have unveiled a state-of-the-art photometric laboratory at their manufacturing and technical facility in Changzhou, China. The facility, home to the joint venture between Varroc Lighting Systems and the TYC Group, enhances Varroc's capabilities to develop and test advanced vehicle lighting.

The 580-m^2 laboratory provides a controlled, repeatable environment for simulating low light and night driving conditions for light beams of up to 50 metres in length. The unique lab is capable of validating beam patterns using a full vehicle, and to simulate real road conditions. It is also equipped with a new goniometer, allowing Varroc TYC engineers and technicians to accurately measure light intensities of headlamps and rear lamps. The facility will also allow for research and development of emerging vehicle lighting technology, including ADB which is expected to be worth USD $1.49bn by 2023 according to a recent report by Business Intelligence and Strategy Research.

- **New Electronic R&D centre in Czechia, 5 March 2017**

Varroc Lighting opened a new electronics development centre in Nový Jičín, Czechia. It's got capacity for up to 100 electrical engineers, and will serve as the company's global research and development hub. The centre represents an investment of nearly €1m in boosting the supplier's pace of innovation and developments in electronics for major automakers.

The 1,000-m^2 facility includes an EMC laboratory with anechoic chamber. Varroc obtained funding from the 2016 Support for Science and Research in the Moravian-Silesian Region subsidy program.

- **Varroc Lighting R&D Expertise Expands to India, 16 January 2017**

At the end of last year Varroc Lighting Systems held a ribbon cutting ceremony to officially announce the opening of its newest R&D Technical Centre

in Pune, India. The Varroc Lighting Systems team began the transition into the facility on 6 September. The Pune Tech Centre will house about 230 engineers working across the Varroc four- and two-wheeler lighting systems and VEPL electrical groups. The new development centre will include expertise in all fields including mechanical design, optics, and electronic hardware and software and allow Varroc to offer additional engineering capacity for new developments worldwide. Pune is the sixth research and development centre location for Varroc; others are in Czechia, Germany, Mexico, the United States, and China.

Engineering resources in Pune will support global lighting programs for Varroc. India was chosen for Varroc's latest tech centre due to the strong engineering capacity found there with technical talent to support the company's growth plan. As products become more complex and varied, engineering capacity must increase.

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Harley-Davidson, USA
Honda, Japan, USA
Hyundai, Korea, Europe
Jaguar-Land Rover, UK
Mahindra Mahindra, India
Nio, China
Nissan, Japan, Europe, USA
Opel, Germany
Porsche, Germany
PSA, France
Renault, France
SAIC TC UK
Shanghai-Volkswagen, China
Seat, Spain
Skoda, Czech Republic
Toyota, Japan, Europe, USA
Volkswagen, Germany
Volvo Cars, Sweden

19 Univ., labs, Consultants
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DEKRA laboratory, Nederland
FEP, Franhaufer, Germany
Fudan university, China
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Nuremberg university, Germany
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38 Set Makers and Tier 1s
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Denso, Japan
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