# Manufacturing Machinery and Multidisciplinary Approach

*or*

*Innovative Production Systems*

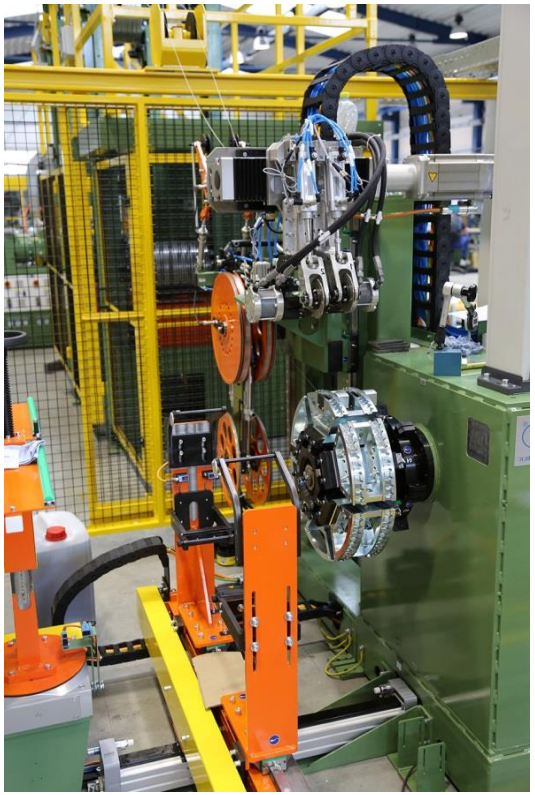
*(not only)*

*for the Tyre Industry*

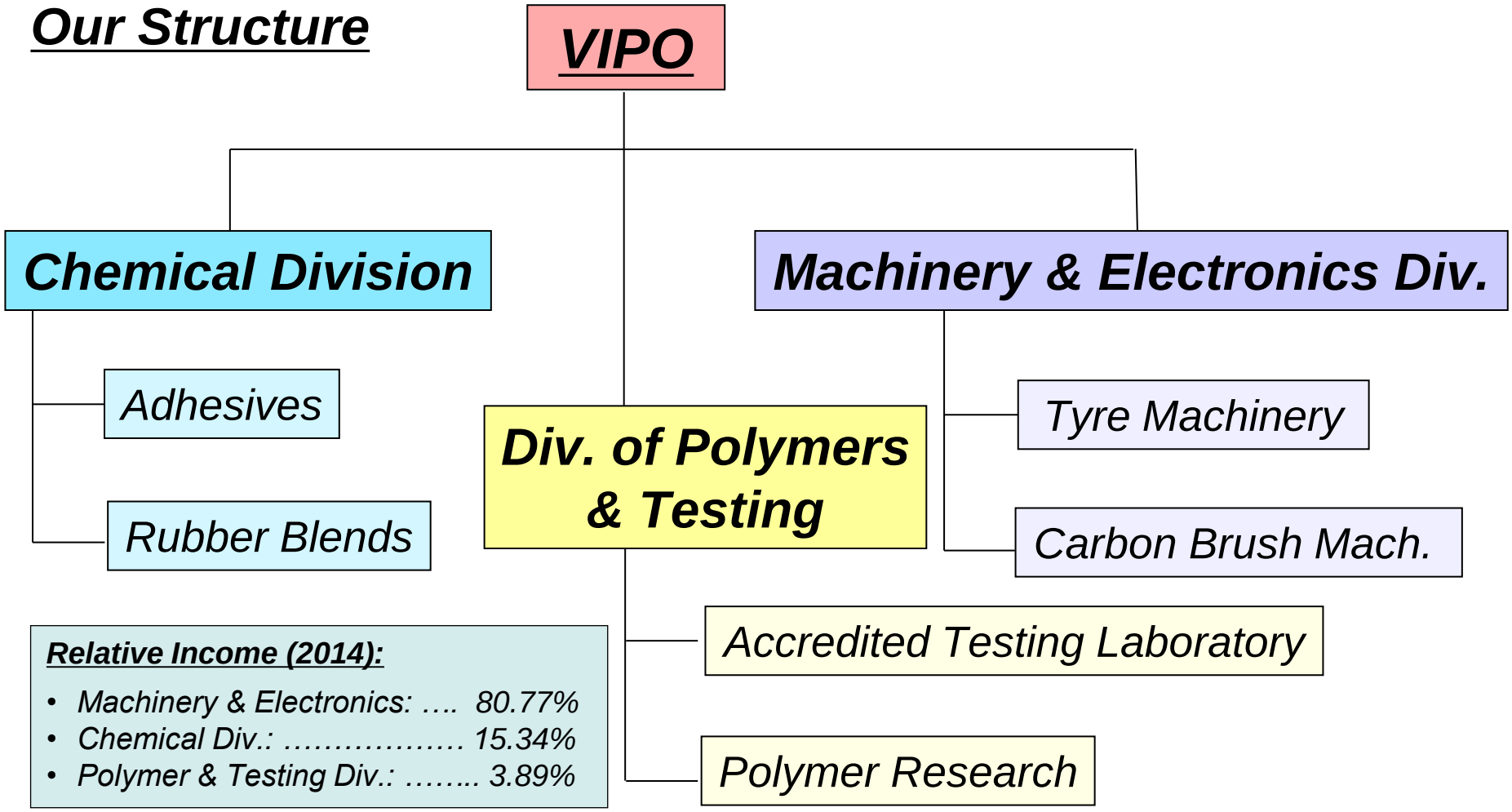
VIPO a.s., Gen. Svobodu 1069/4, 958 01 Partizánske, Slovak Republic

## About Us

| | |
|---|---|
| *Name:* | *VIPO, joint-stock company* |
| *Established:* | *1974* |
| *Place:* | *Partizánske, Slovak Republic* |
| *Capital:* | *3.4 mil. EUR* |
| *Employees:* | *123 persons* |
| *Turnover:* | *10.0 mil. EUR* |



## Our Structure




**Relative Income (2014):**

- Machinery & Electronics: …. 80.77%
- Chemical Div.: …… 15.34%
- Polymer & Testing Div.: …….. 3.89%

## What We Do

Principal Products

### Tyre Making Machinery

- **bead winding lines**
- **bead apexing lines**
- **integrated bead winding and apexing production units**

### Commutator Carbon Brush Making Machinery

- *single-purpose carbon brush machining devices*
- *automatic carbon brush machining and assembling lines*

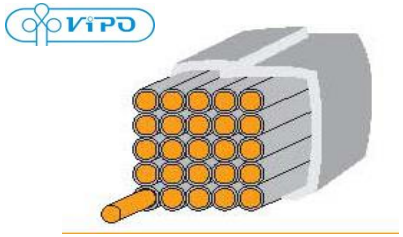
### Hot-melt and dispersion adhesives

- *adhesives for bookbinding*
- *adhesives for furniture making and upholstery*

### Rubber Products

- *solvent-free vulcanising cements*
- *solvent-free marking dies*
- *special rubber blends*

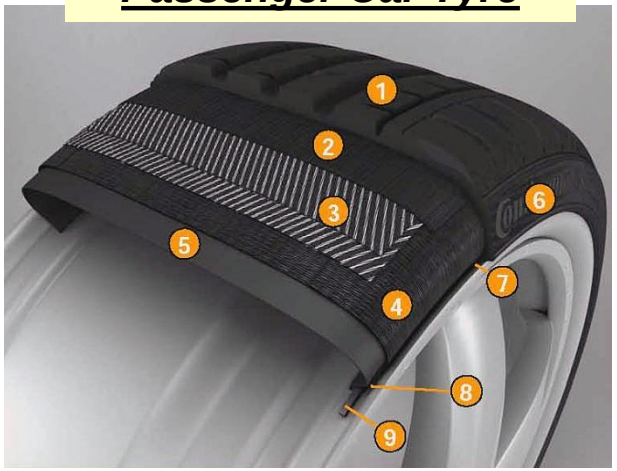
# Tyre Bead & Apex



9 – Bead (Ring)

8 – (Bead) Apex

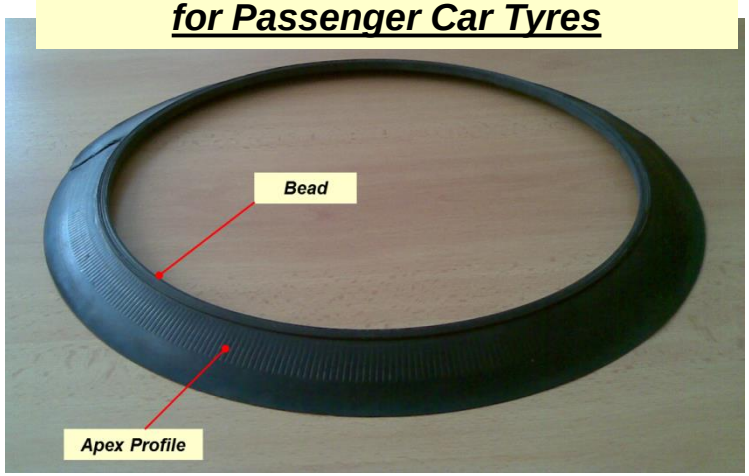
## Passenger Car Tyre




1 – Tread
2 – Cap plies
3 – Steel cord belt plies
4 – Textile cord plies
5 – Inner liner
6 – Side wall
7 – Bead reinforcement

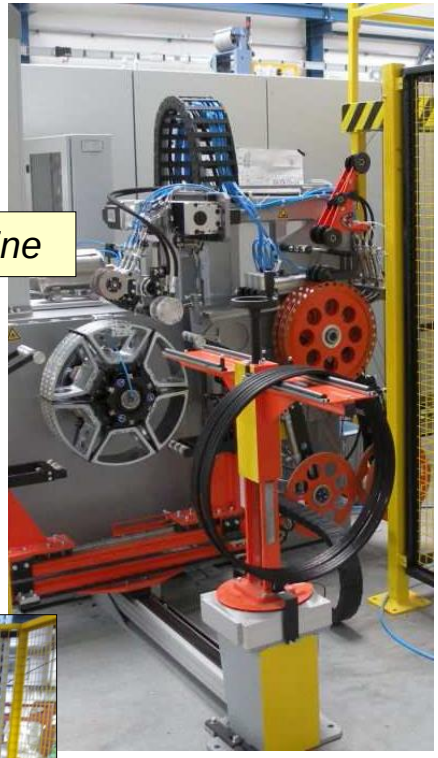
## Apex Profile

## A Multi-wire Bead with Apex Profile for Passenger Car Tyres

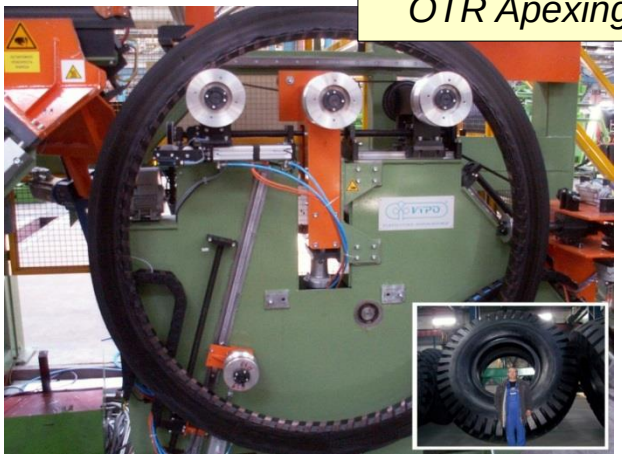


# Tyre Bead Winding & Apexing Machinery

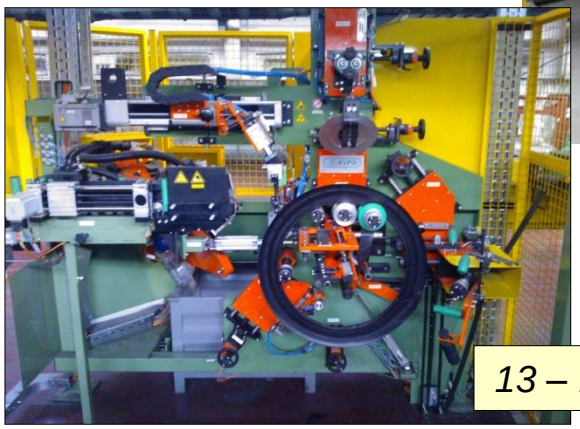
Quintuple (Five-position) Multi-wire Line



Triple-head Single-wire Line



OTR Apexing Line



13 – 25” Apexing Line

# Bead Winding & Apexing Machinery – Why Multidisciplinary?

## Bead Winding Process – Not a Simple Thing

1. ***Wire unwinding*** *– releasing steel wire from up to 24 coils with the mass of 400 – 800 kg each at the speed up to 300 m/min while keeping the constant tension in the wire and ability to stop the process immediately in emergency*
2. ***Wire rubberising*** *– covering up to 24 wires with a thin layer of rubber at the speed up to 300 m/min*
3. ***Wire pulling and accumulation*** *– harmonising the continuous process of wire rubberising with cyclical process of bead winding*
4. ***Bead winding*** *– shaping the wire into beads of exactly specified shape*
5. ***Manipulation and logistic*** *– taking beads out of the former(s) and transferring to further processing at extremely high production capacity*

# Bead Winding & Apexing Machinery – Why Multidisciplinary?

## Bead Apexing Process – Not a Simpler One

1. ***Apex profile extrusion*** *– extrusion of rubber profile of triangular cross-section with precisely defined dimensions. Often assemblies consisting of two rubber profiles of different rubber blends are required.*
2. ***Apex profile pre-treatment*** *– regulation of the apex profile temperature to make it suitable for the application on the tyre bead a cutting the ends in the way allowing smooth connection of the ends after the apex profile is wound on the bead*
3. ***Apex application*** *– automatic attaching the apex profile on the bead*
5. ***Manipulation and logistic*** *– apexed beads may be too heavy for manual manipulation. Incorporation of apexing lines into the customer logistic system is a standard.*

# What Disciplines Are Used in Bead Winding & Apexing?

## Mechatronics:

*Mechatronic principles are used in designing production lines - combination of mechanical engineering systems engineering, electrical engineering, telecommunication engineering, control engineering and computer engineering applied in the creation manufacturing systems meeting the needs of modern industrial production.*

***However, although interdisciplinary enough in itself, mechatronics alone is not sufficient to create a manufacturing system satisfying top-end customers – the machine may run nicely, but the beads are not what they are expected to be!***

## Rubber Chemistry:

*Formulating rubber blends is considered to be an art, and even more so is special-purpose blends are required as it is in bead production. The most advanced analytical instruments and methods are used to optimise the composition as far as its wire-coating ability.*

***However, it happens that even the most carefully optimised rubber blend may not work equally well in two bead winding lines!***

# What Disciplines Are Used in Bead Winding & Apexing?

## Polymer Rheology:

*At specific conditions of extrusion wire rubberising and especially at increasing production capacity and price-optimised rubber blend imperfect rubberising occurs in spite of the fact that the rubber blend shows sufficient adhesion in laboratory tests. It is believed that this phenomenon is caused by rheological and flow properties of elastomeric materials and there is why research in rubber flow in rubberising device ha been launched recently. The rubber rheology and rubber flow at extrusion is also of upmost importance in extrusion of apex profiles.*

## Surface Science:

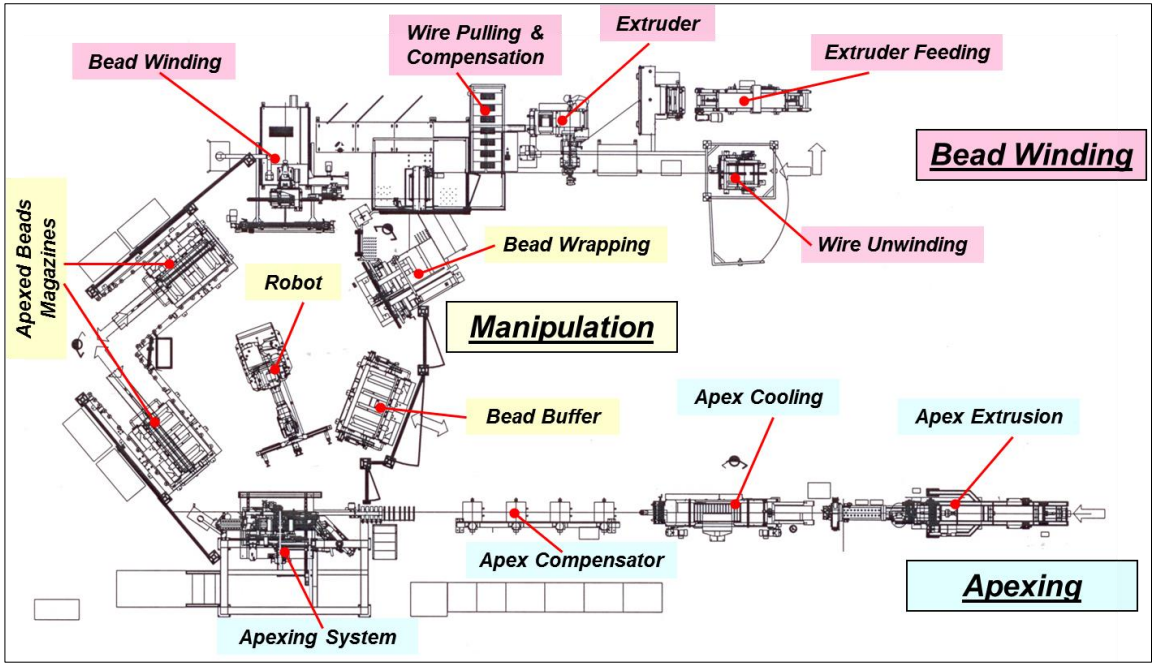
*Adhesion of rubber blends to wire is a complex phenomenon of significant technological importance. That is why studies of different wire surface treatment are carried out to improve the rubber blend adhesion including plasma treatment, application of coupling agents and tackifying adhesion promotors are carried out.*

# What Disciplines Are Used in Bead Winding & Apexing?

## Automation, Robotics & Logistics:

*Bead winging and apexing lines are designed as automatic and autonomous units where just wire coils and rubber come at one end and apexed beads ready for tyre building go out at the other end. It is desirable to interconnects individual technological operations with manipulators or robots to eliminate the manual interventions of operators into the process. The bead winging and apexing production units must allow for the incorporation into the logistic system of the whole plant.*

*An Integrated Automatic Bead Winding & Apexing Centre*



# What Disciplines Are Used in Bead Winding & Apexing?

## Total Quality Control:

*Increasing requirements concerning the tyre performance and exploitation safety must be reflected by improved level of quality control. The goal in this area is to control each technological step in bead winding and apexing – mass, shape, dimensions, tolerances and etc.*

## Ergonomy:

*Although highly automatic, the design and operation of bead winding and apexing lines must respect ergonomic principles to eliminate idle times of the device due to adaptations needed for the change of production assortment and replenishment of materials. Ergonomically optimised design of adjustable parts of production devices helped in significant simplifying the line operation. Ergonomic studies also identified potentially dangerous operations where injuries or job-related illnesses may occur, e.g. in manipulation with heavy wire coils, in guiding wire through individual parts of bead winding device, in manual joining of apex ends and in manipulation with heavy objects in general. Ergonomic aspects are also implemented in the visualisation of the line operation and control as well as in creating instruction manuals which shortens the time needed for training line operators.*

# What We Hope to Achieve by Multidisciplinary Approach?

## Flexibility

*We are open to develop technical solutions for customer's specifications – no two identical machines, no limiting by standardised catalogues*

## Innovations

*Our products are being constantly modernised by research projects and cooperation with leading research centres and contacts with industry leaders*

## Competence

*All machinery and electronics systems are of our own approved designs*

## Competitiveness

*High performance at reasonable prices with higher-than-standard customer care*

# Thank you for your attention

**VIPO – Partner for Innovative Solutions**