Technical

Opportunities and threats for rubber products

By Irene Yurovska

Rubber technology has played a substantial role in the progressing technical development across industries and continents for over 180 years, and today still has no substitute. Nevertheless, the rubber industry is in the maturity stage of the life cycle characterized by intense competition and low profit margins, and raising questions about the long-term sustainability of rubber industry products and jobs. Significant technical innovations (such as thermoplastic elastomers, injection molding technology, etc.) is improving the value of rubber products and increasing profit margins. However, innovations are not always feasible, so managers must turn to improving cost competitiveness to increase margins. With the continued globalization of the economy, cost pressures, customer quality demands and environmental expenses only will increase. Where innovation is not possible, manufacturers need to find intelligent ways to reduce direct costs of rubber products and processes. We demonstrate that even materials that are termed commodities and are assessed equal in properties can have differences that affect rubber processes as well as final products. Thus, management of change (MOC) rules should be enforced to assure that service life of the final products is not affected.

We argue that quality control and improvement is a hidden powerful tool to help lower costs. However quality work is not recognized as strategic due to a mistaken classification of quality as a pure cost rather than margin enhancement tool and, as a result, frequency is viewed as a “non-value-added activity.”

Intelligent approaches to direct cost reduction contribute not only to higher profit margins, but also extend the life cycle of the rubber products and provide sustainability.

By Irene Yurovska

The author

Irene Yurovska has more than 50 years of experience serving the global rubber, tire and polymer industries. She completed her bachelor’s in chemistry, master’s in chemical engineering (rubber technology) and doctorate in physical chemistry of polymers in the former Soviet Union, and later worked there as a scientist for the tire, rubber and aerospace industries. After the U.S. in 1991, Yurovska was a plant rubber chemist for Textron Apex and a coordinating manager for Precize. She spent 14 years with Cabot Corp., where she was involved with technical service for tire/MRG industries, R&D and application development for the global rubber industry. Her career also led her to become innovation market development manager for Addvantis/SI Group. While working for the U.S. rubber industry, Yurovska completed her MBA in international business and finance. Continuing her commitment to education, she also became a member of the Energy Polymer Group. Yurovska started a consulting business, YIGlobal, and she also serves as vice president of global rubber technical service for Himadri Specialty in India. Yurovska is the author and co-author of more than 50 U.S. and foreign patents and patent applications, and has had numerous articles appear in peer-reviewed and other technical publications. She is an active member of the U.S. rubber industry community and currently serves as the New England Plastics & Rubber Group chapter director. A longstanding member of the ACS Rubber Division, she serves on the Rubber Division Strategic Education Committee and Best Paper Committee, and is a member of the Energy Polymer Group. Yurovska has two children and two grandchildren. She enjoys spending time with her family, world travel, swimming and classic opera.
ists, but not apparent for managers. There is no substitute for rubber—it is impossible to use any other material in many important applications, ergo, rubber products are absolutely sustainable. In technical terms, rubber is a unique state of matter, being viscoelastic, i.e., presenting a combination of properties of solids, liquids and gases (Fig. 3).1,2 Due to its unique state of matter, rubber is a unique material. Materials, such as metals, possess well-defined mechanical characteristics. In contrast, the properties of rubber depend incredibly on many variables that are in the hands of rubber compounders and engineers: polymer type, reinforcing fillers and extenders, oils/plasticizers, crosslinking ingredients, anti-aging ingredients, process aids, rubber mixing equipment and process, relaxation between process stages, curing process, etc.3 Because of this complexity, one can never predict exactly and reliably how raw material substitutions and process changes affect final properties of rubber products.

Furthermore, functional and technical specifications requirements at the stages of design and assembly (such as hardness, sizes, tensile strength, density and color) and manufacturing (such as viscosity, shrinkage and curing characteristics) are different/ incomplete than requirements for service properties (such as extended stress-strain properties, fatigue resistance, compression set, swelling resistance, aging in certain conditions, electrical properties, color stability, etc.). Many of the service properties are not included in the technical specifications, and sometimes not even acknowledged by the end users. The above creates a pyramid of performance demands, some of which are hidden/uncertain (Fig. 4). Due to the unique character of rubber materials, it is impossible to predict the service properties based on the limited manufacturing and design characteristics.

Therefore, quality control and management of change (MOC) are vitally important for the rubber industry and its final products. Numerous trials and tests, costing time and money, are required when any substitutions of raw materials or process changes are made.

Unfortunately, the issues of technical uniqueness of rubber materials and sustainability of rubber products are not widely taught in schools, and many rubber industry managers live with the assumption that, because the industry is mature, the products will become obsolete soon. Therefore, per their opinions, to increase profit margins, the costs have to be reduced by all means, similarly as it is being done for other materials and high-tech products.

With the modern rubber industry almost 200 years old, it is clearly a mature industry. In the life cycle of industries and products (Fig. 5), mature industries are characterized by maximum sales, lower profit margins and intense competition. This is what is it called 

The author is a longstanding member of AIP and member of the ACS Energy

Substitute your Herzlich Award

Nominations by May 27!

The Harold Herzlich Distinguished Technology Achievement Medal celebrates innovators, who through persistence and dedication have advanced a paradigm shift in tire manufacturing, tire reliability or performance.

Do you know an innovator who should be recognized for their contributions to the tire industry? Nominate them today for the 2022 Harold Herzlich Award!

The winner will be announced at ITEC this September.

To find out more and submit a nomination, scan the QR code or visit itec-tireshow.com/awards
Rubber

Cost structure is presented in Fig. 6.26 Leaving aside the indirect costs, which include overhead, management and R&D costs, let’s consider direct costs. Traditionally, factory costs are considered proprietary information, and they are not easy to find. After an extensive search, we were able to find limited information on typical direct cost structures of tires and rubber goods27 and to compare the direct cost structure for a high-tech product, i.e., LCD TVs.28

As expected, the labor share for the rubber product is much higher than for the high-tech product. While the share of raw materials in the tire direct cost is about 50 percent, the raw materials share in the high-tech product is 85 percent. Due to the higher labor costs in industrial rubber products (compared to tires), it can be expected that the share of raw materials in the industrial product costs is below 50 percent. In fact, per our experience, it is below 35 percent. It is assumed direct cost structure for a rubber product is outlined in Table 1.

For products with high property tolerances for direct cost reduction include reduction of labor, raw materials, process cost and setup cost. Several examples of production steps and cycles, setup and tooling.

While reducing labor costs is tempting, we must admit that for the rubber technology labor intensive processes, and considering the recent wave of M&A/restructuring, as well as regulations, the opportunities for labor reduction are practically exhausted. Reducing raw material costs (such as acquiring raw materials from lower cost suppliers or finding less expensive alternatives) is a valid option. However, it must be considered that substitution of one raw material for another raw material presents unexpected challenges, even when the technical specifications of the two raw materials and certificates of analysis are close.

One example is presented in Fig. 8, where four carbon blacks (CB) with similar morphological characteristics demonstrate different dispersive characteristics (as measured per the extruded tape defect size and number of defects in the same EPDM formulation, while other rubber properties remain unaffected.29

Another example is a widely used advanced antioxidant with the empirical formula—C₆H₅N. Characteristics of this ingredient, manufactured with the same CAS number by two respectable suppliers, are compared in Table 3. As can be observed in the respective technical data sheets (TDS), the chemicals with the same CAS number show a different color and melting point, when manufactured by the different businesses. Also, different properties are specified by different suppliers. For example, raw materials only, ash and volatiles by another manufacturer only. The above scenario is quite typical and can be observed for many rubber ingredients, sourced from different suppliers. Typically, similar properties are tested differently, i.e., per different proprietary SOP. Therefore, even chemicals with the same CAS numbers can be different, and the effects of raw material substitutions on final service properties of rubber products are impossible to predict theoretically based on limited testing, especially when considering the unique character of rubber materials.

Frequently, minor variations of rubber properties that do not affect stage design and manufacturing manifest during the rubber products service. Thus, any changes of raw materials should be followed by a strict MCC, which should include extensive testing of products performance during service.

Another option to reduce direct cost is by lowering process costs, including production cycles, set-up and tooling. These are good, feasible and appropriate options, if followed by MCC, based on the unique character of rubber materials, as was discussed above. Importantly, rubber properties are affected by the curing stage/curing time differently.30 Considering this, for example, an attempt to reduce the curing cycle, while reaching the maximum specified tear strength, can negatively affect extension set or hysteresis (compared to optimum cycle), which are not included in the specification, but are important for the product service performance—see Fig. 9.

Similarly, choosing mixing processes may not be obvious when limited testing is conducted, but becomes critical for final product performance. Furthermore, tooling and setup costs are directly related to the consistency of rubber processes and must be considered when processes are changed to reduce the cycle time. Successful MCC must follow any process changes, with the realization that improvement of the process and a desired property can hurt other properties, especially when these properties are hidden and/or not specified.

It is also important to consider that the best levers for cost reduction are around improving yields (or put another way, reducing reject rates). In other words, reducing the cost of raw materials, by 10 percent realizes a total cost saving of about 3.5 percent, considering the roughly 35 percent share of raw materials. Similarly, reduction of the process cost by 10 percent will realize a total cost saving of about 2 percent due to the share of the process cost in total costs.31

Meanwhile, reducing the reject rate by 10 percent, will provide a final cost saving of about 1.5 percent (Note that part that is not rejected realizes a 100 percent savings (Table 3). The table does not even include savings from avoiding the cost of disposing the rejected products and other benefits,32 such as happy customers, improved attributes and productivity of employees, etc. (Fig. 10).

Therefore, quality improvement and reduction in reject rate is the most effective method for total direct costs reduction.26 Meanwhile, those of us with experience in the rubber industry have been observing reductions of quality staff, testing capabilities and resources. Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing tradi-

tional quality positions are being lost. Meanwhile, those of us with experience in the rubber industry have been observing reductions of quality staff, testing capabilities and resources. Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions,30 such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Meanwhile, those of us with experience in the rubber industry have been observing reductions of quality staff, testing capabilities and resources. Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, consolidating and outsourcing traditional quality positions, such as the quality-related activities. This is the most effective method for total direct costs reduction.26

Unfortunately, besides the obvious irrationality, this notion of less testing provides only a temporary escape from the financial difficulties of global companies reducing, abolishing non-value-added activities. The above approach could be quite progressive, useful and reasonable, except that the quality-related work is frequently labeled by the above theories as a non-value-added activity.33 This, together with the managerial theories to recommend to reduce/eliminate quality, testing and inspection projects (Fig. 10).

All of the above theories claim to be based on the outstanding researches of the American scientist, statistician and quality professional William Edwards Deming. Interestingly enough, Deming, who is credited for leading the “Japanese economic miracle” after World War II, never considered quality control and assurance as a non-value activity.34 On the contrary, Deming, in his exami-
ple of a bad practice is "management abandoning their responsibility for quality, occupied with finance ... and short-term plan-
ning." Meanwhile, such wrong classifi-
cation of project quality as non-val-
ue activity is creating the industrial culture of quality neglect. On the contrary, to the assumption made by nearsighted and careless managers, the neglect of quality work will not cause a reduction of direct costs of rubber products, but it will increase the final costs due to re-
jects, expensive failures of associat-
ed equipment and possible devas-
tating catastrophes. The unique nature of rubber is responsible for the difficulty to reliably predict the service properties when relying on limited test data. Attempts of nearsighted man-
ers to lower direct costs by re-
ducing investment in the quality (mistakenly characterized as a non-value-added activity) create the threat to rubber products and technology and business sustain-
ability. In fact, neglecting quality work will increase final product costs due to a higher rejection rate, expensive failures of associ-
ed equipment and possible dev-
astating catastrophes. While lowering direct final cost by reducing costs of raw materials and/or processes is a feasible and valuable approach, it should be conducted intelligently, with the recognition of the unique physical and chemical nature of rubber and with robust management of change (MOC) procedures. Fur-
thermore, the most important way to reduce costs is by reducing the reject rate, as compared with the lower cost share factors, as raw material or process costs.

Investment in quality work, along with a robust MOC process, is an important lever to ensure that, when reducing costs, there are no effects on service life or other properties that may cause premature/catastrophic failures that increase liability or other-
wise affect a customer's trust in products. Education of the global rubber industry staff in the unique nature of rubber and vital importance of quality, as well as the appropriate quality attitudes and policies, will assure sustain-
ability of rubber products, busi-
nesses and rubber jobs.

Conclusion

Status of the mature rubber industry, and sustainability of rubber products, businesses and jobs, are analyzed in this work. Due to their viscoelastic behav-
ior, rubber materials have a unique nature, which makes rub-
ber irreplaceable for many techni-
cally demanding applications. This creates opportunities for rubber products and technology development and for their sus-
nutability. However, the unique nature of rubber also is responsi-
ble for the difficulty to reliably predict the service properties when relying on limited test data. Attempts of nearsighted man-
ers to lower direct costs by re-
ducing investment in the quality (mistakenly characterized as a non-value-added activity) create the threat to rubber products and technology and business sustain-
ability. In fact, neglecting quality work will increase final product costs due to a higher rejection rate, expensive failures of associ-
ed equipment and possible dev-
astating catastrophes. While lowering direct final cost by reducing costs of raw materials and/or processes is a feasible and valuable approach, it should be conducted intelligently, with the recognition of the unique physical and chemical nature of rubber and with robust management of change (MOC) procedures. Fur-
thermore, the most important way to reduce costs is by reducing the reject rate, as compared with the lower cost share factors, as raw material or process costs.

In fact, neglecting quality work will increase final product costs due to a higher rejection rate, expensive failures of associ-
ed equipment and possible dev-
astating catastrophes. While lowering direct final cost by reducing costs of raw materials and/or processes is a feasible and valuable approach, it should be conducted intelligently, with the recognition of the unique physical and chemical nature of rubber and with robust management of change (MOC) procedures. Fur-
thermore, the most important way to reduce costs is by reducing the reject rate, as compared with the lower cost share factors, as raw material or process costs.

References

rubber-chemical-compound/Development-
of-the-natural-rubber-industry, reviewed
August 6, 2021.
3. https://www.toyota.co.jp/en/kaku/ faq/1/0/0/9/act/6%20x%20total/6 correction%20percent20of%20rubber%20raw%20materi-
als%20percent20of%20rubber%20raw%20materials%20percent20of%20rubber%20raw%20material%20co-
struction%20processes, reviewed August 6, 2021.
6. F.F. Khosravi et al., General Rubber Tech-
7. I. Yurkovna, YGlobal, Rubber Manufac-
turning Economics, Online Class, ACS Rubber Division, 2021, p.15.
8. https://www.statista.com/statis-
tics/275399/world-consumption-of-natu-
rnal-and-synthetic-caoutchouc/, reviewed
September 9, 2021.
9. https://www.freedomgroup.com/indus-
try-study/world-rubber-2843.htm, reviewed
August 26, 2021.
10. https://www.shell.com/resource-
s/2020/my-shefaris-forecasts-the-glob-
motormarket.com/press-release/rubber-
market-2021-growth-analysis-and-value-
industry-update-developments-trend-to-2026-
with-top-country-data-2021-07-13; https://
global-industrial-rubber-products-market-es-
timated-to-reach-us-315-billions-by-2025-trans-
parency-market-research-6759758181, reviewed
September 9, 2021.
11. P.J. Walker, An Industrial Comparative:
Custom Molded Rubber Products, Keysive Ad-
dress for ACS Rubber Division Meeting, 2013.
12. J. Alkemade, W. Macktow, Introduction to
Polymer Viscoelasticity, p. 109, Wiley-Inter-
science publication, 1985.
13. M. Ashby, Materials Selection in Mechani-
14. C. Robertson, K.S. Bounds, ACS, Rubber
15. Financial & Managerial Accounting, 19th
blog/14091/marginal-cost-life-cycle,
reviewed August 26, 2021.
18. I. Yurovska, YIGlobal, Rubber Manufac-
turing Economics, Online Class, ASC Rubber Division, 2021, p.15.
19. What is cost of quality defects? https://knowl-
covertimereport.com/110104/COOPER-
TREEK-AND-RUBBER-CO.-AKC-2011, reviewed
21. Structure of production costs in footwear
manufacturer, United, 2009.
cost-analysis-and-price-trend/, reviewed
September 9, 2021.
23. Himadri Speciality Chemical, KLAXX
24. A.Y. Corn, Volatility, p. 250 in Science and Technology of Rubber, Edited by F.R. Ei-
25. What is cost of quality defects? https://knowl-
.html, reviewed May 26, 2023.
27. J. Barfield et al., Cost Accounting, Tradi-
tions and Innovations, 4th Edition, South West-
.html, reviewed May 26, 2023.
30. T. Kakish, et al., The Certificated Six Sigma
31. 2000: NON-VALUE ADDED ACTIVI-
of Production and Management. Management
Springer, Boston, MA, https://doi.org/10.1007/
452-0-012-0-8, 432.
32. Handbook of Cost and Management Ac-
counting, 2nd ed., edited by R. Horng, Pot-
net/nordinbill/120584852, reviewed
September 9, 2021.
33. J. Orsini, The Essential Deming, 386 p., Mc-
34. D. Kano, Reengineering the Japanese
Economic Miracle. Harvard Business Review,
1998.
35. W.E. Deming. Out of the Crisis, 450 p.,
36. Y.J. Walker. Stopping the Statistical Con-

Troy Nix
Executive Director
Manufacturers Association for Plastics Processors (MAP)