The Economic Benefits of the U.S. Polyurethanes Industry

2015

Economics & Statistics Department
American Chemistry Council

September 2016

Contents

Published September 2016

Executive Summary

- The contributions of the polyurethanes industry to the U.S. economy are numerous.
- The polyurethanes industry generates upstream jobs in direct supplier industries and even more in expenditure-induced employment. Nearly five jobs are created for each job in the U.S. polyurethanes industry. This is known as the *multiplier effect*, where the spending activity generated by an industry is used to support other industries and jobs through purchases of supplies, equipment, services, etc. and wages to employees which are spent on consumer goods and services, housing, etc.
- There are many other downstream industries that depend on polyurethane products, i.e., transportation, building and construction, furniture and bedding, appliances, etc.
- The top end-use markets for polyurethane consumption (in descending order) are building and construction, transportation, and furniture and bedding.
- The polyurethanes industry operates in nearly 1,000 locations in the United States, directly generating $28.6 billion in output and 48,800 jobs in the manufacture of polyurethane raw materials and polyurethane products.
- The polyurethanes industry indirectly supports an additional $45.7 billion in output and supports more than 180,000 additional jobs in other sectors of the economy.
- In total, the polyurethanes industry supports about nearly 230,000 jobs and $74.3 billion in output.
- Further, polyurethane products are used in industries across the economy generating $280.7 billion in output and employing more than 1 million workers.

Introduction

Polyurethane materials were first developed during World War II as an alternative to natural rubber, and today have found their way into thousands of applications found in homes and businesses throughout the world. Polyurethanes describe a class of materials valued by consumers for their high performance and durability. Polyurethane foam used in furniture, insulation, and bedding may be the most easily recognizable product. But polyurethane materials are also found in paints and coatings, adhesives, sealants, elastomer fibers, and rubberized products, such as conveyor belt rollers.

This analysis builds upon the 2014 End-Use Market Survey of the Polyurethanes Industry in the U.S., Canada, and Mexico and summarizes the importance of the polyurethanes industry to the U.S. economy. It presents the economic impact of both the economic value created by its production activities and the value of the industries that use its products in the production of their output. The research was conducted during August 2016 using end-use consumption patterns from 2014, which were the latest available at the time.

Since the last time this analysis was undertaken in 2013, the output of polyurethane products and the industries that consume them was higher in 2015 as many end-use industries continued to accelerate, especially those industries tied to motor vehicles and construction. Several industries, however, have not recovered from the recession, such as paper, apparel, and some textile products. Weaker economic growth abroad coupled with a high value of the dollar have reigned in export growth, creating headwinds for U.S. produced polyurethanes and manufactured goods.

This analysis was commissioned by the Center for the Polyurethanes Industry of the American Chemistry Council so it could identify the economic contributions of the polyurethane industry for a wide range of stakeholders and audiences. The analysis includes review of the industry along the entire value chain – from suppliers of chemical raw materials to their direct customers and then to the final producers of consumer and industrial goods. In addition to the contributions that the polyurethanes industry makes directly, the results of the analysis also highlight the contributions made by the upstream (supply-chain) industries and downstream consuming industries.

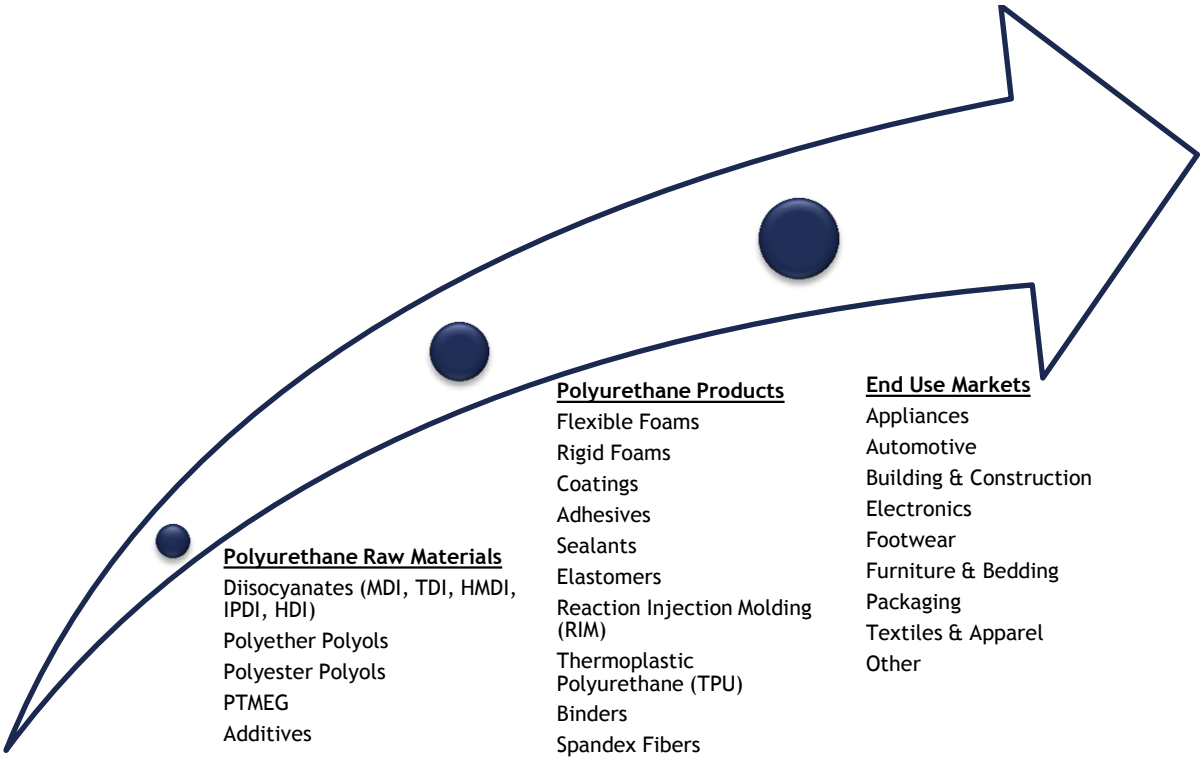
The Economics & Statistics department of the American Chemistry Council conducted the analysis and prepared this report of the findings.

What are Polyurethanes?

Polyurethanes are a class of plastic materials that are made by reacting a polyol (an alcohol with more than two reactive hydroxyl groups per molecule) with a diisocyanate or a polymeric isocyanate in the presence of suitable catalysts and additives. Because a variety of diisocyanates and a wide range of polyols are used to produce polyurethane, a broad spectrum of materials can be produced to meet the needs for specific applications.

Polyurethanes exist in a variety of forms, including flexible foams, rigid foams, chemical-resistant coatings, specialty adhesives and sealants, and elastomers. These polyurethane products are used in numerous ways throughout the economy.

Figure 1 - Polyurethanes Value Chain



The Polyurethanes Industry

The polyurethanes industry includes basic polyurethane materials (polyols, diisocyanates, and additives) and polyurethane products (polyurethane coatings, spandex fibers, basic polyurethane foam products, etc.) (Figure 1). The polyurethanes industry directly generates $28.6 billion in output (or revenues). The $28.6 billion in revenues is used to pay workers, purchase raw materials, energy and supplies, invest in equipment, purchase transportation services, etc. Through these mechanisms,

the economic activity generated by the polyurethanes industry spreads. Households use the wages earned by polyurethane workers to pay for their consumption (housing, groceries, consumer goods, etc.) and upstream industries like suppliers to the polyurethanes industry also pay wages to their employees and these employees make purchases of supplies, as well. These cycles of spending and re-spending are referred to as the *multiplier effect*.

The economic activity generated by the polyurethanes industry is an important contributor to the U.S. economy. In 2015, the polyurethanes industry operated in nearly 1,000 locations throughout the United States. As mentioned, the polyurethanes industry directly created 48,800 jobs paying $2.8 billion in wages to its employees and generating $28.6 billion in output (or revenues). Through supply chain and payroll-induced impacts, the polyurethanes industry supported 229,400 jobs through its purchases of raw materials, equipment, services, etc. Upstream or indirectly, more than four jobs are created for each job in the polyurethanes industry, totaling nearly five jobs in the economy for each job in polyurethanes. In total, the polyurethanes industry supports $12.2 billion in wages paid to employees in the U.S. generating $74.3 billion in output (or revenues). Table 1 details the upstream (or indirect) economic activity generated by the polyurethanes industry.

Table 1 – Output, Employment, and Payroll of the Polyurethanes Industry (2015)
($ millions)

	Output ($ billions)	Employment	Payroll ($ billions)	Average Wages ($)
Polyurethane Raw Materials	**$11.7**	**7,100**	**$0.6**	**$86,200**
Polyurethane Products	**$16.9**	**41,700**	**$2.2**	**$52,000**
Polyurethane foam products*	$10.7	34,600	$1.6	$46,900
Adhesives, sealants, coatings, and fibers	$6.1	7,100	$0.5	$76,700
Total Polyurethane Industry	**$28.6**	**48,800**	**$2.8**	**$57,000**

Upstream Polyurethane Supplier Economic Impact in the United States

The economic contributions of the polyurethane industry are numerous, though often overlooked in traditional analyses that consider only the direct jobs and output of the industry. Not only are jobs created directly by the industry, additional jobs are supported by the polyurethanes industry and by the subsequent expenditure-induced activity. The polyurethanes industry pays its employees' wages and salaries and purchases supplies and services (including transportation, contract workers, warehousing, maintenance, accounting, etc.). These supplier businesses, in turn, make purchases and pay their employees, thus the polyurethanes industry generates several rounds of economic spending and re-spending.

In addition to the direct effects of the polyurethanes industry, the indirect and induced effects on other sectors of the economy can also be quantified. The economic impact of an industry is generally manifested through four channels:

* Appendix Table 1 details state-by-state data on the polyurethane foam product industry.

- Direct impacts - such as the employment, output and fiscal contributions generated by the sector itself
- Indirect impacts - employment and output supported by the sector via purchases from its supply chain
- Induced impacts - employment and output supported by the spending of those employed directly or indirectly by the sector
- Spillover (or catalytic) impacts - the extent to which the activities of the relevant sector contribute to improved productivity and performance in other sectors of the economy

This report presents the economic contributions related to the first three channels. Spillover (or catalytic) effects do occur from polyurethanes, but these positive externalities are difficult to quantify and thus were not examined in the analysis.

Table 2
Economic Impact of the Polyurethanes Industry in the U.S.

Impact Type	Employment	Labor Income ($ billion)	Output ($ billion)
Direct	48,800	$2.8	$28.6
Indirect (Supplier) Effect	89,000	$5.5	$31.4
Payroll-Induced Effect	91,600	$4.0	$14.3
Total Effect	**229,400**	**$12.2**	**$74.3**

The output and employment generated by the polyurethanes industry is significant. As discussed previously, more than 48,800 jobs in the U.S. are in the direct manufacturing of polyurethane materials and products. Those workers were paid $2.8 billion in labor income. In order to produce its output, polyurethanes producers purchased supplies and services from other industries which accounted for another $5.5 billion in indirect economic output and 89,000 jobs. Finally, the payrolls of workers in the direct and indirect segments are spent by households in local communities. In this manner, more than 91,600 payroll-induced jobs are supported by the economic activity of the polyurethanes industry and its suppliers in the U.S. All told, 229,400 jobs are supported by the economic activity (direct, indirect, and payroll-induced) of the polyurethanes industry in the United States.

In addition, the polyurethanes industry generated $1.6 billion in federal tax revenues and $1.2 billion in state and local tax revenues.

The Economic Impact of End-Use Markets for Polyurethanes (Downstream Impact)

The polyurethanes industry also contributes to the U.S. economy through the unique and essential properties of the materials it produces. Polyurethanes are widely used in our homes, offices, cars, and can even be found in the shoes and clothing we wear. One of the most recognized applications is the flexible polyurethane foam that is used in furniture. Another commonly recognized use is in elastic fibers, i.e., spandex used in swimsuits, elastic waistbands and hosiery. They are also made

into rigid foam used to insulate refrigerators and homes. Durable polyurethane coatings are used to protect hardwood floors, wood furniture, and automotive and machinery finishes. High strength polyurethane adhesives are used to join parts in autos, machinery and in homes. Sealants made from polyurethanes are used to seal windows in light vehicles and damp-proof basements. Polyurethane binders are used to make strong oriented strandboard for building and in metal casting. Through a process known as reaction injection molding (RIM), polyurethane materials are made into exterior vehicle and machinery parts, etc. Thermoplastic polyurethanes are used in a myriad of applications from automotive parts to medical device applications to gaskets and seals.

The diverse range of high performance properties (some of which are mentioned above) make polyurethanes essential to a multitude of end-use applications. Table 3 shows the total pounds of polyurethane materials consumed by each major end-use market. The following pages describe how polyurethanes are used in each of these markets and how, in fact, the output of these industries is dependent on the unique properties of polyurethanes. Table 4 summarizes the economic impact of selected end-use markets that are dependent on polyurethane materials.

Table 3
U. S. Polyurethane Production by End-Use Market (2014)

	Million Pounds	% of Total
Building and Construction	1,901	35.9%
Transportation and Marine	1,069	20.2%
Furniture and Bedding	1,079	20.4%
Machinery and Foundry	326	6.2%
Appliances	273	5.2%
Packaging	198	3.7%
Textiles, Fibers and Apparel	43	0.8%
Electronics	33	0.6%
Footwear	16	0.3%
Other End Use Markets for Polyurethanes	356	6.7%
Total Polyurethanes Production	**5,293**	**100.0%**

Source: CPI 2014 End-Use Market Survey on the Polyurethane Industry

Together, these primary end-use industries represent an additional $280.7 billion in revenues and more than 1 million jobs, nearly 1.0% of total nonfarm employment in the U.S. This section examines the economic impact of the makers of the products and providers of services that rely on the 5.3 billion pounds of polyurethane materials and additives consumed in 2014.

Table 4 – Output, Employment, and Payroll of End Use Markets for Polyurethane Products (2015)

	Output ($ billions)	Employment	Payroll ($ billions)	Average Wages ($)
Building & Construction	$48.0	250,900	$11.9	$47,400
Transportation & Marine	$43.0	155,200	$7.5	$48,400
Furniture and Bedding	$28.2	159,900	$6.1	$38,400
Machinery & Foundry	$88.6	212,400	$13.1	$61,700
Appliances	$25.0	72,300	$4.2	$58,300
Packaging	$3.4	6,800	$0.4	$59,700
Textiles and Apparel	$3.7	26,400	$1.0	$39,400
Electronics and Electrical Equipment	$38.4	129,800	$8.4	$65,000
Footwear	$1.3	10,700	$0.4	$39,100
Other	$1.1	3,700	$0.2	$48,900
End-Use Markets for Polyurethanes	**$280.7**	**1,028,100**	**$53.4**	**$51,900**

Building and Construction

Building and construction accounted for 36% of polyurethanes consumption in the U.S., making it the largest end-use market for polyurethane materials. Like the transportation sector, building and construction represents a market for a diverse portfolio of polyurethane and polyisocyanurate (polyiso) products. One of the largest applications is the use of rigid polyurethane foam as wall and roof insulation, insulated panels, and gap fillers for the space around doors and windows. Rigid foam adhesives are used in some window and door installations and in manufactured housing. There are many benefits to using rigid polyurethane foam insulation, including its energy efficiency, high performance, versatility, thermal/mechanical performance and environmental savings.

Polyurethane and polyiso foams have one of the highest insulating R-values per inch[1] of all commercially available products today. With typical values in the range of approximately R 3.6 to R 7.2 per inch, it is possible to have thinner walls and lower profile roofs while maximizing efficiency, increasing space utilization and reducing operating costs for heating and cooling.

Rigid polyurethane and polyiso foams are made with a remarkably strong, yet lightweight, low-density structure that is both dimensionally stable and moisture-resistant with low vapor transmission. This special combination of properties allows manufacturers to design thermal insulating products that are self-supporting, can be combined with a wide range of substrates while requiring no additional adhesive, and — when combined with the proper materials — perform as external weather and moisture barriers.

[1] The R-value per inch of this insulation varies with thickness. R-value means resistance to heat flow. The higher the R-value, the greater the insulating power.

Polyiso laminate boardstock is one of the most popular insulations used in conventional roofs. In fact, polyiso laminate boardstock, used primarily in roofing and wall insulation, accounts for the majority of total rigid polyurethane foam in construction applications. For special exterior designs, foam core panels offer a wide variety of colors and profiles for walls and roofs, and reduced weight for easier handling and a lighter supporting structure. Some rigid polyurethane foams can be applied on-site to seal gaps and cover irregular shapes. Such foams include spray, pour-in-place, and one-component foams. Spray polyurethane foams form a seamless layer of insulation, fill gaps and seams during application, and cover irregular shapes that are hard to insulate with rigid boards. This reduces drafts considerably while creating quieter buildings. For durability and stability, rigid polyurethane foam-cored entry doors and garage doors are available in various finishes and styles.

The qualities of rigid polyurethane and polyiso foam reduce energy transfer, resist moisture, maintain dimensional stability, remain airtight and often play a structural role. Polyurethane and polyiso foams also function well in temperature extremes and resist damage from moisture that may result from condensation.

The environmental benefits of rigid polyurethane foam are significant, and include increased energy efficiency and reduced project weight. Given the widespread use of rigid polyurethane foam in today's construction, these savings are multiplying at an increasing rate around the world.

Another commonly recognized application of polyurethanes in building and construction is clear protective coatings. Polyurethane coatings can provide an attractive covering that enhances the durability of the finished product. They are used in the production for wood floors, basements, buildings and bridges and many other commercial and consumer products. Polyurethane adhesives represent another large market for polyurethane materials. Because of their fast cure time, bond strength, and weather resistance, polyurethane adhesives are used in roofing, flooring, wallboard, and window/door installations. Also essential to building and construction are polyurethane sealants, including sealants for expansion joints, basement and driveway sealants, and energy efficient windows. Construction of running tracks and thermal breaks in metal frame windows use polyurethane elastomers. Polyurethane binders are used to bind reconstituted wood products into oriented strandboard products used as structural panels for construction and in the manufacture of mobile homes.

The building and construction segment dependent on the unique properties of polyurethane materials represented $48.0 billion in shipments and receipts and employed 250,900 people in 2015.

Transportation and Marine

Transportation equipment (i.e., light vehicles, trucks, aircraft, trains, boats, etc.) manufacturing accounted for 20% of total polyurethane consumption. Automobiles provide one of the best examples of the diverse applications of polyurethane materials. Nearly every type of polyurethane product is in an automobile. Some 60 pounds of polyurethane materials end up in each light vehicle, representing 18.0% of all plastics/composites in light vehicles, an increasing share in recent years. Because of the lighter weight of polyurethane materials compared to the materials that they have replaced, polyurethanes have played an important role in the move towards greater fuel efficiency.

Flexible polyurethane foams are used in seating, headrests, arm rests, HVAC and other interior systems for automobiles, airliners, trains, and buses. In these applications, their light weight, resiliency and energy/sound absorption properties make flexible polyurethane foams a key material in automobile and other transportation equipment manufacture. While used primarily as an insulator for refrigerated trucks, rigid polyurethane foam is a material also used in some automotive panels for energy efficiency and sound absorption.

Polyurethane coatings provide a vehicle's exterior with the high gloss, durability, scratch resistance and corrosion resistance. Polyurethane coatings are also used to glaze windshields and windows, increasing strength and providing fog resistance.

Polyurethane adhesives, with excellent bonding and vibration resistance, are used as a bonding agent for both exterior (i.e., bumpers) and interior (i.e., carpet, trim) components. Because of their bond strength and ease of application, polyurethanes are a sealant material for automobile window installation. The unique properties of polyurethane elastomers make them sought-after for use in gaskets, o-rings and other seals.

Polyurethane elastomers protect against tire punctures and are used in other molded components, such as shock absorbers. Thermoplastic polyurethane materials are used in the manufacture of many automobile parts including exterior body parts, trunk liners, anti-lock brake systems, timing belts, and fuel lines.

Another important source of automobile parts is reaction injection molding (RIM). The automotive industry is the largest user of RIM polyurethane parts. RIM is used to maximize the shock absorption of vehicle fenders, bumpers and spoilers, without adding weight or bulk. Lightweight RIM polyurethanes enable better gas mileage and allow engineers the freedom to create innovative designs. Until recently, metal alloys were used for automobile exterior parts. Metal alloys were generally more susceptible to dents, dings, stone chips, and corrosion than polyurethane versions. Many interior components are made with RIM, such as steering wheels, air ducts, floor mats and seat bottoms.

The transportation equipment industry uses and depends on polyurethane materials. Nearly $43.0 billion of shipments from polyurethane-consuming industries in this critical segment were made in 2015. This segment employed 155,200 people in the U.S.

Furniture and Bedding

Furniture and bedding, including carpet underlay accounted for 20% of total U.S. polyurethanes consumption. It is the largest end-use market for flexible polyurethane foam (FPF), accounting for 78% of all flexible polyurethane slabstock foam consumption. These foams are used to create the soft cores of sofas and other upholstered household furniture, commercial/institutional furniture such as office chairs and sofas, and seating for theaters, and stadiums. Flexible foams are desired for this purpose because of their resiliency, durability, comfort, support and other favorable properties. Non-allergenic flexible polyurethane foams are also used extensively in bedding as the trend towards thicker, firmer mattresses grows. Another large use for FPF is for carpet underlay that cushions much

of the 11.7 billion square feet of carpet produced in the U.S. Carpet underlay provides an opportunity to recycle scrap FPF.[2] In fact, most foam carpet underlay is made with recycled polyurethane scrap. In addition to flexible foam, polyurethane coatings are essential to the furniture sector for sealing and protecting wood furniture.

The furniture and bedding segment that uses polyurethane materials generated $28.2 billion in shipments in 2015 and provided employment for 155,900 people.

Machinery and Foundry

Machinery and foundry applications account for 6% of total U.S. polyurethanes consumption. Durable polyurethane coatings are used to coat machinery exteriors to protect them against moisture, heat, and abrasion. High-strength adhesives made from polyurethanes are used to attach electronics and exterior panels to farm and industrial equipment. Polyurethane elastomers are used to make high-performance parts for industrial machinery used in mining and oil and gas drilling, such as rollers, belts, pulleys and gaskets. Thermoplastic polyurethanes (TPU) are used to fabricate belting rollers, tubes, bearings and other machinery components. Metal casters use polyurethane binders in molds and cores. RIM polyurethane materials are used to fabricate strong, light-weight exterior panels for machinery. In addition to high strength and low weight, polyurethane RIM parts can exhibit heat resistance, thermal insulation, dimensional stability and a high level of dynamic properties.

Supported by the high performance properties of polyurethane materials, the machinery and foundry industry generated $88.6 billion in shipments and employed nearly 212,400 people in 2015.

Appliances

Appliances account for about 5% of total U.S. polyurethane consumption. Rigid polyurethane foam is the leading material used to insulate refrigerators, freezers, hot water heaters, and vending machines. Rigid polyurethane foams are well suited to insulate appliances because of their low volatile organic compound (VOC) emissions, dimensional stability and ease of application.

Today's refrigerators and freezers generally consist of a sheet metal outer casing and an inner liner made of polystyrene. In between these is a layer of rigid polyurethane foam that acts as both a structural and an insulating material that is applied and cured in the appliance manufacturer's assembly line. The adhesive properties of polyurethanes ensure a firm bond between the inner and outer walls, while at the same time helping to prevent heat exchange between the inner and outer walls. This type of insulation is used in the majority of refrigerators and freezers. In addition to rigid polyurethane foams, durable polyurethane coatings are used to protect appliances against rust and heat. Polyurethane coatings are also used to protect wires and other electronics in appliances. This application is discussed in the Electronics section.

[2] Recycling may not be available in all areas. A Recycled Plastics Market Database of buyers and sellers of recycled polyurethane and polyurethane raw materials in the United States and Canada is available at www.polyurethane.org.

Polyurethane-based coatings are used to paint appliances to achieve the aesthetic appeal that consumers desire, and to protect them from rust and heat. Polyurethanes also play a major role in tubing and wiring used to run major appliances. Thermoplastic polyurethanes (TPU) is valued as a cable sheathing material on account of its high flexibility even at sub-zero temperatures, its high abrasion and wear resistance, and its ability to protect wiring from undesirable materials and other environmental influences.

The appliance industry as supported by polyurethane products is significant. With $25.0 billion in shipments, this industry employed 72,300 people in 2015.

Electronics and Electrical Equipment

In volume terms, consumption of polyurethane materials in the electronics sector accounted for less than 1% of total U.S. consumption. Polyurethane coatings are used in electronic component manufacturing to protect wires and coils in electronic equipment. These coatings are heat and corrosion resistant and do not interfere with delicate circuitry. Durable, high-strength polyurethane adhesives are also used in electronics to join wires and circuit boards. Strong, flexible polyurethane elastomers are also used to encapsulate and protect electronics and telecommunications equipment.

Often referred to as “potting compounds,” non-foam polyurethanes are frequently used in the electrical and electronics industries to encapsulate, seal, and insulate fragile, pressure sensitive microelectronic components, underwater cables and printed circuit boards. Polyurethane potting compounds are specially formulated by developers to offer a diverse range of physical, thermal and electrical properties. They protect electronics by providing excellent dielectric and adhesive properties, as well as exceptional solvent, water and extreme temperature resistance. Typically, potting compounds are one or two component mixtures, solvent-free, 100% solids and are processed with simple dispensing equipment.

The electronics and electrical equipment industry using polyurethane materials represented shipments of $38.4 billion. This segment employed 129,800 people in 2015.

Packaging

Packaging accounted for nearly 4% of polyurethane consumption. Polyurethane packaging foam provides cost-effective, custom form-fitting cushioning to protect items that need to stay safely in-place during transit. Because of its excellent shock absorbency, water resistance, and resiliency, flexible polyurethane foams are used to protect and cushion especially sensitive products, i.e., computers and other electronics. Rigid polyurethane foams that are poured-in-place to create a tight, impact-resistant cushion are also used to protect sensitive or fragile items. Polyurethane adhesives provide excellent barrier properties and bond strength and are used in packaging for cereals, snack foods and lunch meats.

Polyurethanes used in packaging generated $3.4 billion in shipments in 2015. These products supported 6,800 jobs in the U.S.

Textiles, Fibers and Apparel

As with footwear, the U.S. textiles and apparel industry continues to shrink as more production is moved abroad. This segment accounted for less than 1% of total U.S. polyurethanes consumption. However, the properties delivered by polyurethane materials make them indispensable to the industry that remains in the U.S. Thermoplastic polyurethane elastomers can be molded and shaped into different parts. When these elastomers are spun into fibers they produce a flexible material called spandex. The elastic properties of polyurethane fibers (i.e., spandex) are found in swimwear, undergarments, sheer hosiery, elastic waistbands, and athletic clothing, just to name a few. A small amount of polyurethane foam is used to insulate fabrics including ski gloves and work boots. Polyurethane coated fabrics are durable and abrasion-resistant, while also being soft, light and breathable. As such, they are used in creating more comfortable and sophisticated weatherproof clothing, such as sports anoraks and light rain clothes. Polyurethane coatings are also used for leather-like materials, such as imitation suede and as man-made leather for garments that not only look like leather, but also have similar stretch, stiffness and permeability properties. Moisture-resistant polyurethane adhesives are used to bind fabrics in tents, life rafts and more.

The textiles, fibers and apparel market that uses polyurethane materials in its products accounted for $3.7 billion in shipments and employed about 26,400 people in 2015.

Footwear

Similar to textiles, the footwear segment accounts for an increasingly smaller share of total U.S. polyurethane consumption (less than 1%). Elastomers are the largest use of polyurethanes in footwear. These are used to manufacture shoe soles, including those for athletic shoes and boots. Polyurethanes' inherent properties of good strength and flexibility, along with their resistance to abrasions, wear and tear, and high temperatures, make them often used to produce high-quality, comfortable footwear. Durable polyurethane foams are used to cushion and support many athletic shoe sole designs and have a direct impact on comfort and performance. Polyurethanes are also used to make safety shoe soles because they are resistant to punctures, chemicals and abrasions. Polyurethane adhesives are used to bind soles to shoes where they are the primary adhesive material. A small amount of thermoplastic polyurethanes are used in the production of industrial shoes, ski boots, golf-shoe cleats and in-line skates.

Footwear manufacturing generated $1.3 billion in shipments and provided employment for 10,700.

Other End-Use Markets for Polyurethanes

Other end-use product manufacturing that uses polyurethanes include playgrounds and sport tracks, marine equipment, tanks and pipes, sporting equipment, wheels for industrial equipment, medical supplies and equipment, and decorative applications. These other industries accounted for $1.1 billion in output and employed 3,700 people.

Conclusion

The analysis presented in this study by ACC describes the significant and extensive contributions of polyurethanes to the U.S. economy. The economic impact of the industries that manufacture and use polyurethanes is also significant. More than one million American jobs are in the industries that use polyurethanes materials and products. Beyond the direct economic contributions of the polyurethanes and downstream industries, the use of polyurethanes benefits society in many ways. While polyurethanes materials and products may not always be obvious, their use is essential to many of the end-use products in which they are found. Polyurethanes provide very specific benefits that increase safety, efficiency, and convenience.

Appendix 1 – Foam Product Manufacturing (2015)

	Shipments	Employment	Payroll
Alabama	$71.3	388	$14.7
Arizona	$72.0	179	$5.8
Arkansas	$110.1	415	$19.9
California	$963.1	3,165	$151.6
Colorado	$106.2	360	$18.2
Connecticut	$188.9	453	$31.5
Delaware	$13.6	42	$2.1
Florida	$269.2	571	$25.7
Georgia	$322.4	662	$33.5
Illinois	$381.4	986	$54.8
Indiana	$760.8	3,084	$139.2
Iowa	$122.7	378	$15.1
Kansas	$39.5	122	$6.2
Kentucky	$242.6	561	$23.7
Louisiana	$14.0	43	$2.6
Maine	$74.4	229	$9.9
Maryland	$97.7	301	$15.6
Massachusetts	$232.2	882	$57.5
Michigan	$774.1	3,057	$139.7
Minnesota	$71.2	299	$13.9
Mississippi	$465.9	1,568	$55.4
Missouri	$241.6	810	$34.7
Nebraska	$14.3	44	$1.9
Nevada	$22.0	68	$3.4
New Hampshire	$78.3	241	$11.5
New Jersey	$181.0	405	$28.1
New Mexico	$48.1	148	$6.2
New York	$212.4	449	$23.6
North Carolina	$1,092.3	3,432	$139.8
Ohio	$438.2	1,479	$68.0
Oklahoma	$72.8	210	$7.5
Oregon	$86.8	262	$11.0
Pennsylvania	$607.8	1,613	$82.5
Rhode Island	$43.8	196	$6.6
South Carolina	$75.3	232	$10.1
South Dakota	$39.5	122	$6.2
Tennessee	$372.1	965	$35.1
Texas	$971.4	4,036	$188.3
Utah	$102.9	191	$9.6
Vermont	$2.1	7	$0.3
Virginia	$99.4	306	$20.8
Washington	$215.9	665	$46.2
West Virginia	$86.4	266	$14.9
Wisconsin	$240.6	706	$30.9
U.S.	**$10,738.2**	**34,596**	**$1,623.9**

Note: No data for Alaska, District of Columbia, Hawaii, Idaho, Montana, North Dakota, or Wyoming.

Appendix 2 –Data and Methodology

Polyurethanes Industry Assessment and Downstream Impacts

Information on the production, consumption, and specific uses of polyurethane raw materials (isocyanates, polyols, additives) and basic polyurethane products (coatings, adhesives, sealants, etc.) was gathered from the IHS Chemical *Chemical Economics Handbook and 2014 End-Use Market Survey on the Polyurethane Industry*. Data on the value of shipments, employment, and payroll were derived from the Annual Survey of Manufacturers, Economic Census, and the Bureau of Labor Statistics Covered Employment and Wages data.

Upstream Impacts

The indirect and payroll-induced impacts of the polyurethanes industry were estimated using the IMPLAN model. An input-output model such as IMPLAN is a quantitative economic technique that quantifies the interdependencies between different industries (or sectors) of a national economy. Although complex, the input-output model is fundamentally linear in nature and as a result, facilitates rapid computation as well as flexibility in computing the effects of changes in demand. In addition to studying the structure of national economies, input-output analysis has been used to study regional economies within a nation, and as a tool for national and regional economic planning. A primary use of input-output analysis is for measuring the economic impacts of events, public investments or programs such as base closures, infrastructure development, or the economic footprint of a university or government program. The IMPLAN model is used by the Army Corp of Engineers, Department of Defense, Environmental Protection Agency, and over 20 other agencies, numerous government agencies in over 40 states, over 250 colleges and universities, local government, non-profits, consulting companies, and other private sector companies.

ACC Economics and Statistics Department

The Economics & Statistics Department provides a full range of statistical and economic advice and services for ACC and its members and other partners. The group works to improve overall ACC advocacy impact by providing statistics on American Chemistry as well as preparing information about the economic value and contributions of American Chemistry to our economy and society. They function as an in-house consultant, providing survey, economic analysis and other statistical expertise, as well as monitoring business conditions and changing industry dynamics. The group also offers extensive industry knowledge, a network of leading academic organizations and think tanks, and a dedication to making analysis relevant and comprehensible to a wide audience. The lead author of this report was Martha Gilchrist Moore.

Dr. Thomas Kevin Swift
Chief Economist and Managing Director
202.249.6180
kevin_swift@americanchemistry.com

Martha Gilchrist Moore
Senior Director – Policy Analysis and Economics
202.249.6182
martha_moore@americanchemistry.com

Emily Sanchez
Director, Surveys & Statistics and Editor
202.249.6183
emily_sanchez@americanchemistry.com

Heather Rose-Glowacki
Director, Chemical & Industry Dynamics
202.249.6184
heather_rose@americanchemistry.com