

THE PORTER REPORT

2Q 2018 | RICHMOND, VA INDUSTRIAL MARKET REVIEW

MID-YEAR REVIEW: INDUSTRIAL DEVELOPMENT CONTINUES

⇒ At mid-year, the **overall industrial market occupancy** has increased to **94%**, up from 93% at the end of the prior reporting period following another round of strong sales activity. **Class A occupancy** has decreased slightly to **97%** down from 98% at the end of the first quarter, with demand for larger warehouse spaces remaining strong. The **Class B occupancy** rate has increased to **88%**, up from 86% at the end of the first quarter. The quarter closed with a positive net absorption over 350,000 square feet with a notable increase in manufacturing expansions as noted below.

⇒ **Becknell Industrial** has closed on the purchase of a 60-acre parcel off Laburnum Avenue and Seven Hills Boulevard in Henrico County's East End, adding to its holdings near the Richmond International Airport. Becknell plans to construct a four-building high bay industrial complex totaling 805,190 square feet on the site formerly owned by the Ukrop family, and will name the new park the Airport Logistics Center. The first phase of development will include a 246,760-square-foot pre-cast concrete building with 32' ceilings, LED lighting, ESFR sprinklers, multiple dock and drive-in doors as well as trailer parking with 135' truck court depths and a 60' loading bay, scheduled for delivery in spring, 2019.

⇒ Michigan-based vacuum cleaner manufacturer **Bissell Inc.** has acquired 40 acres in the James River Industrial Center in Chesterfield County at a price of \$1.9 million. Previously referred to as Project Goliath, the company has plans to construct a 611,500-square-foot industrial complex in two phases, the first of which will include a 437,000-square-foot building and will add 100 employees. The site will be located next to the future expansion of CSX's rail line, expected to cross Battery Brooke Parkway in the industrial center. The site is also located in one of Chesterfield County's five designated Technology Zones, which encourage manufacturing and distribution operations through incentives and tax abatements. No announcement on the total investment has been made to date.

⇒ Richmond-based **TemperPack** has expanded its local operations and has announced plans to create an additional 141 jobs. The company manufactures sustainable packing technology for perishable goods and has relocated to a 130,000-square-foot plant at 4447 Carolina Avenue in the Richmond Distribution Center in eastern Henrico County. The company currently has 55 full-time employees and approximately 300 hourly personnel, and the new plant has the capacity for 450 to 500 hourly personnel. Products are used for shipping perishable materials like food and pharmaceuticals, and a new proprietary insulation material will also be made at the Henrico County facility.

⇒ **Sabra Dipping Company** has announced plans to construct a third addition to its Chesterfield County facility to expand distribution and manufacturing operations. The hummus maker plans to add 38,000 square feet to its 220,000-square-foot plant located on the 48-acre campus it owns in the Ruffin Mill Industrial Park. The company is jointly owned by PepsiCo and Israel-based Strauss Group and holds 26 percent of the market share for refrigerated flavored dips and spreads. No cost estimate for the expansion has been published.

FEATURED PROPERTY

Airport Logistics Center (Henrico, VA)

Building 1: 246,760 SF (Expandable)

805,190 SF Total • Four Pad-Ready Sites Available

Master-Planned Industrial Park • Laburnum Ave & Seven Hills Blvd

1.5 Miles from Richmond Int'l Airport (RIC)

Immediate I-64, I-95, I-295 & I-895 Access

Less Than 80 Miles from the Port of Virginia

135' Truck Court Depths • 60' Loading Bay • 32' Clear Height

Multiple Docks + Drive-In Doors

ESFR Sprinkler System • LED Lighting • Pre-Cast Concrete

45 mil TPO Roof Membrane System

For Lease: Call for Information

Contact Exclusive Agent: **Clifford B. Porter, CCIM, SIOR**

804.521.1442 | cliff@porterinc.com



SELECTED INDUSTRIAL LEASE TRANSACTIONS.

- ⇒ 202,560 SF LEASED at Airport Dist Center (Henrico Co)
- ⇒ 116,449 SF LEASED at Enterchange at Walthall (Chesterfield Co)
- ⇒ 81,000 SF LEASED at Richmond Dist Center (Henrico Co)
- ⇒ 80,560 SF LEASED at Enterchange at Walthall (Chesterfield Co)
- ⇒ 40,000 SF LEASED at 2601 Maury Street (Richmond City)

NOTE: Porter Realty Company transactions shown above in RED.

SELECTED INDUSTRIAL SALE TRANSACTIONS.

- ⇒ 135,000 SF SOLD at 5601 Corrugated Road (Henrico Co)
- ⇒ 78,000 SF SOLD at 1306 Jefferson Davis Hwy (Richmond City)
- ⇒ 55,000 SF SOLD at 6380 Beulah Road (Henrico Co)
- ⇒ 50,560 SF SOLD at 4731 Eubank Road (Henrico Co)
- ⇒ 40,242 SF SOLD at 20 Westover Hills Blvd (Richmond City)
- ⇒ 23,400 SF SOLD at 5220 Klockner Drive (Henrico Co)



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FEATURED PROPERTIES 2Q 2018

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Modern High Bay Facility



Airport Logistics Center
Building 1: 246,760 SF
Four Pad-Ready Sites Available
32' Clear, ESFR Sprinkler
LED Lighting, 60' Loading Bay
135' Truck Court Depths
RIC Airport Area Location
For Lease: Available Spring, 2019

RIC Airport Area Location



Airport Distribution Center
Bldg C: 20,240 SF Available
Warehouse/Distribution Zoned
M-1C, 3 Docks & 1 Drive-In
32' Ceilings, Car & Trailer Parking
ESFR Sprinkler, LED Lighting
Direct I-64 & I-95 Access
For Lease: Call for Information

Prime Boulevard Frontage



1101 & 1103 North Boulevard
2-Building Complex on 0.49 Acre
1st Floor Retail: Auto Repair
2nd Floor: 3 Renovated Apts
Fully Leased, TOD-1 District
Across from Scott's Addition
Investment or Redevelopment
For Sale: Call for Information

Investment/Redevelopment



1700 Venable Street
57,360 SF Total Facility
Up to 20,000 SF For Lease
2.06 Acres Zoned M-1
Wet Sprinklers, Freight Elevator
6 Dock Doors, Up to 15'8" Ceilings
For Sale: \$4,000,000
For Lease: Call for Information



Byron Holmes
CCIM, SIOR
804.521.1448
byron@porterinc.com

Midlothian Tnpg Corridor



5611 Pride Road
26,190 SF Industrial Facility
20' Clear Ceilings, 3 Docks
6 Amp 3 Phase Electrical
Fire Sprinkler System, Zoned M-1
Easy Access to Route 60 &
Chippenham Parkway
For Sale: \$975,000

Midlothian Tnpg Corridor



8221 Midlothian Turnpike
6,000 SF Office Building
0.64-Acre Site, Zoned C-5
Pylon Signage on Rt. 60
Built 1982 + Renovated
Owner Relocating
Leasing Opportunities Available
For Sale: \$850,000

Class A Office Park



711 Moorefield Park Drive
Office & Warehouse Available
Suite C: 2,032 SF
Suites E-G: 9,984 SF
Dock Loading, 100% HVAC
Ample Parking, Zoned I-1
For Lease: \$7.50 to \$9.95/SF
Co-Listed with: Cliff Porter

Minutes to Magnolia Green



10051 Old River Road
134,000 SF Facility on 15 Acres
Includes 9,066 SF Office
Zoned M-2, 22' to 30' Ceilings
3000 Amp 277/480 Volt Service
Fully Sprinklered, High Speed Data
For Sale: \$2,300,000
For Lease: \$2.25/SF NNN



Kevin Cox
804.521.1468
kevin@porterinc.com

Retail For Sale/Lease



7401 Taw Street
7,200 SF Free-Standing Retail
4,500 SF Available for Lease
Fully Conditioned, Zoned C-3
36 Parking Spaces, Frontage on
Jefferson Davis Highway
For Sale: \$895,000
For Lease: \$15.00/SF NNN

Route 1 Corridor Location



109 S Washington Highway
6,200 SF Retail Building
16' to 18' Ceilings, Zoned B-2
10' Drive-In Door, 3 Phase
Electrical Service
Ashland, VA South of Rt. 54
For Sale: \$620,000
For Lease: \$9.50/SF NNN

I-64, I-295, Rt. 288 Access



2200 Lanier Lane
45,000 SF Office/Warehouse
Includes 2,975 SF Office
Zoned M-2, 6 Docks, 2 Drive-Ins +
1 Oversized Drive-In Door
Fenced, Paved, Lighted Yard
Heavy Sprinkler & Power Systems
For Lease: \$6.50/SF NNN

Sublease Space Available



1708 Belleville Street
6,847 SF Available August, 2018
Includes 1,500 SF Office +
5,347 SF Warehouse/Shop
2 Drive-In Doors (10' x 10')
Scott's Addition Location
Just East of I-195
For Sublease: \$18.00/SF NNN



903 West Grace Street
Retail/Multifamily Investment
4,560 SF Finished + Basement
Four Units, 3-Story Building
Prime VCU Area Location
Off Broad St, West of Belvidere St
For Sale: \$1,375,000
CONTACT: WILSON FLOHR
804.521.1458



Anderson Highway (Powhatan Co)
Join Virginia Physicians Family
Practice! 36.84 Acres Total
Mixed Use Development Potential
Retail Pad Sites from 1.59 Acres
For Sale: ~\$29,900/Ac (Unsubdivided)
Co-Listed with: Byron Holmes
CONTACT: DICK PORTER
804.521.1443



3950 North Bailey Bridge Road
4.16 Acres Zoned C-5
Owner Will Divide, Utilities to Site
Off Route 360/Hull Street Road,
Proximate to Rt. 288 Interchange
For Sale: \$799,000
For Lease: Call for Information
CONTACT: BYRON HOLMES
804.521.1448



7023 Lee Park Road
7,952 SF Office on 1.30 Acres
5,932 SF Available for Lease
38 Parking Spaces, Zoned B-1
~5 Miles to Memorial Regional MC
For Lease: \$12.00/SF NNN
For Sale: \$650,000
CONTACT: KEVIN COX
804.521.1468

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Phone: 804.353.7994 | www.porterinc.com

No warranty or representation is made as to the accuracy of the foregoing information.

FEATURED PROPERTIES 2Q 2018

www.porterinc.com



Intro Rate: \$2.95/SF Base



6062 Quality Way

130,560 SF Modern Facility
Built 2007, 1,300 SF Office
20.2 Acres, Building Expandable
+ Potential Outside Storage
32' Ceilings, New T-5 Lighting
8 Docks + 1 Drive-In Door
For Sale/Lease: Call for Info

Enterprise Zone Location



700 Gordon Avenue

130,000 SF Industrial Facility
Includes 2,700 SF 2-Story Off
5.13 Acres Zoned M-2
Multiple Dock Doors + Ramp
Access to Covered Platform
Wet Sprinkler, 3 Phase Service
For Sale: \$3,250,000

Low Tax Locality



5851 Quality Way

50,880 SF Facility Built 2001
Expandable, Dock & Drive-In
24' to 26' Ceilings, Wet Sprinkler
Foreign Trade Zone, Proximate
to Rolls Royce & Fort Lee
Expandable • Owner Relocating
For Sale: \$3,052,800

Intro Rate Available



2035 Factory Lane

Up to 43,000 SF Warehouse
Includes ~3,000 SF Office
8 Docks, 1 Drive-In, 1 Step-Van Ht,
~20' Ceilings, Dry Pipe Sprinkler
Petersburg Area Location
For Sale: \$1,290,000
Intro Rate: \$2.50/SF Gross



Dick Porter
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Brandermill Retail/Office



13212 Hull Street Road

4,087 SF Available
Join Peds Care, Sherwin-Williams,
& Wells Fargo
Ample Parking, Zoned C-2
High Visibility Location!
71,000 Vehicles Per Day
For Lease: Owner/Agent

Immediate I-95 Access



1801 Willis Road

102,000 SF - Can Subdivide
22' to 24' Ceilings, Zoned I-1
15 Docks + 2 Drive-In Docks
80 Parking Spaces + Container
Storage, ESFR Sprinkler System
Adjacent 13 Acres for Expansion
For Lease: Owner/Agent

Meadowville Area Location



North Enon Church Road

353.43 Acres Total Site
Zoned I-3 Heavy Industrial
Utilities On Site (Chester, VA)
Immediate I-295 Access
0.5 Mile to Amazon.com
For Sale: Call for Information
Co-Listed with: Kevin Cox

Fredericksburg Complex



46 Commerce Road

20,450 SF Building on 5.7 Acres
12,650 SF Shop + 10 Bay Doors
48 Commerce Road
12,785 SF Building on 2.35 Acres
Includes 6k SF Shop + 4 Bay Doors
For Sublease: Call for Information
Co-Listed with: Kevin Cox



Bob Porter
CCIM, SIOR
804.521.1441

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Downtown RVA Location



424 East Grace Street

7,320 SF 2-Story Office/Retail
Heated Basement (3,660 SF)
Across from Greater Richmond
Convention Center, Hotels,
Restaurants & Office
Sale/Lease: Call for Information
Co-Listed with: Cliff Porter

Hanover Industrial Air Park



11173 Leadbetter Road

1,816 SF Office Available
8,787 SF Total Building
High Exposure Corner Location
Zoned M-3
Recently Renovated
For Lease: \$8.75/SF NNN
Co-Listed with: Cliff Porter

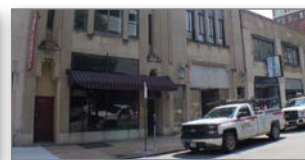
Lakeridge Park Flex Space



10470 Wilden Drive

Up to 8,084 SF Flex Space
3 Docks, 14' Clear Ceilings
Zoned M-2, Ample Parking
Immediate I-95 Access off
Lakeridge Parkway in
Hanover County
For Lease: \$8.00/SF Ind Gross

Historic Downtown RVA



304 East Grace Street

Historic Art Deco Building
2,180 SF Ground Floor
Retail/Creative Office/Restaurant
Opportunity, Zoned B-4
Build-to-Suit Opportunity
For Lease: Call for Information
Co-Listed with: Cliff Porter



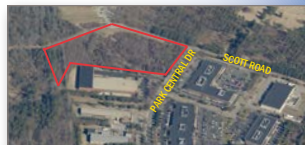
Wilson Flohr
804.521.1458

wilson@porterinc.com



7631 Whitepine Road

5,200 SF Office/Warehouse Available
Includes 1,300 SF Office
Dock Loading, 100% HVAC
230+ 460 Volt 3 Phase Power
Potential Expansion Space Available
For Lease: \$7.25/SF Gross
CONTACT: BYRON HOLMES
804.521.1448



Park Central Drive

8.619 Acres Available
Zoned O-S, Medical, Office &
Warehouse Uses, Immediate I-95
Access @ Parham Road (Exit 83)
Established Upscale Park
For Sale: \$225,000/Acre
CONTACT: KEVIN COX
804.521.1468



5491 International Trade Drive

Parcel A: 9.85 Acres Total
~5 Acres Usable, For Sale: \$450,000
Parcel B: 5.763 Acres Total
Estimated 4 Acres Usable
For Sale: \$450,000
Utilities Prox, Airport Area Location
CONTACT: DICK PORTER
804.521.1443



3017 Vernon Road

34,150 SF Office/Warehouse
Zoned M-1, 14' to 20' Ceilings
4 Docks, 1 Ramp, Sprinklered
1200 Amp 3 Phase Electrical
Near West End Henrico County
Available: Call for Information
CONTACT: CLIFF PORTER
804.521.1442

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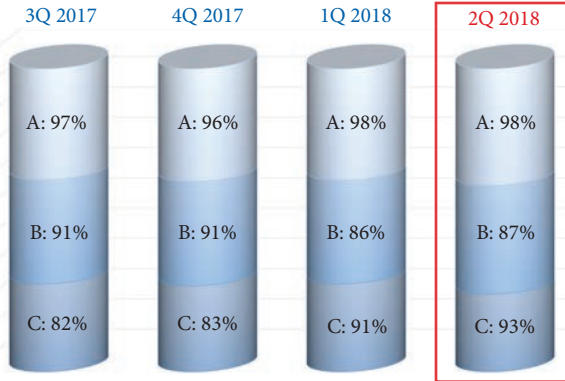
INDUSTRIAL MARKET VACANCY

2Q 2018

VACANT & INVESTOR-OWNED INDUSTRIAL PRODUCT

40K SF MIN RBA* EXCLUDING FLEX & OWNER-OCCUPIED PROPERTIES | *RBA Total: 25.98MM SF in 166 Existing Buildings

2Q 2018: COMBINED OCCUPANCY RATES & NET ABSORPTION (CLASS A & B PRODUCT)



The combined industrial occupancy rate of Class A & B product has remained unchanged from 1Q 2018 at 94%.

Net Absorption from 1Q 2018: +110,684 SF (Class A/B)

Net Absorption from 1Q 2018: +91,090 SF (Class C)

NOTE: CoStar reports an industrial occupancy rate of 96.4%, unchanged from the 1st quarter of 2018, based on a total 115 million square feet RBA in 2,777 existing warehouse properties, and a positive net absorption of 2.5 million square feet for the quarter, the result of reclassification of the former Alleghany complex, planned for demolition/redevelopment. CoStar's industrial RBA includes both owner-occupied and investor-owned properties, but excludes flex space, defined as 50% minimum office.

Vacancy Rate & Trends

40k < 75k SF RBA

RBA: 2.36MM SF (44 Buildings)

	Class A	Class B	Class C
Total Bldgs	3	25	16
Total RBA	186,000	1,340,250	835,943
Vacant SF	0	112,491	143,525
Vacancy Rate	0%	8%	17%

CLASS A	NWQ	NEQ	SWQ	SEQ
Total Bldgs	0	2	1	0
Total RBA	0	132,000	54,000	0
Vacant SF	0	0	0	0
Vacancy Rate	0%	0%	0%	0%

CLASS B	NWQ	NEQ	SWQ	SEQ
Total Bldgs	9	8	6	2
Total RBA	459,518	422,757	357,595	100,380
Vacant SF	45,416	0	67,075	0
Vacancy Rate	10%	0%	19%	0%

CLASS C	NWQ	NEQ	SWQ	SEQ
Total Bldgs	8	3	4	1
Total RBA	450,882	142,170	175,891	67,000
Vacant SF	64,500	12,025	0	67,000
Vacancy Rate	14%	8%	0%	100%

Vacancy Rate & Trends

75k < 150k SF RBA

RBA: 7.19MM SF (67 Bldgs)

	Class A	Class B	Class C
Total Bldgs	22	30	15
Total RBA	2,601,465	3,200,629	1,386,903
Vacant SF	299,698	242,000	104,000
Vacancy Rate	12%	8%	7%

CLASS A	NWQ	NEQ	SWQ	SEQ
Total Bldgs	4	11	3	4
Total RBA	431,144	1.31MM	342,936	520,198
Vacant SF	0	25,500	0	274,198
Vacancy Rate	0%	2%	0%	53%

CLASS B	NWQ	NEQ	SWQ	SEQ
Total Bldgs	2	11	10	7
Total RBA	209,546	1.15MM	1.15MM	691,777
Vacant SF	0	100,000	40,000	102,000
Vacancy Rate	0%	9%	3%	15%

CLASS C	NWQ	NEQ	SWQ	SEQ
Total Bldgs	3	2	8	2
Total RBA	280,408	147,405	746,090	213,000
Vacant SF	0	0	64,000	40,000
Vacancy Rate	0%	0%	9%	19%

Vacancy Rate & Trends

150k SF Min RBA

RBA: 16.43MM SF (55 Bldgs)

	Class A	Class B	Class C
Total Bldgs	31	17	7
Total RBA	10,954,757	3,814,070	1,460,028
Vacant SF	58,048	617,433	2,500
Vacancy Rate	0.01%	16%	0%

CLASS A	NWQ	NEQ	SWQ	SEQ
Total Bldgs	4	13	1	13
Total RBA	1.15MM	3.80MM	1.10MM	5.11MM
Vacant SF	0	0	0	58,048
Vacancy Rate	0%	0%	0%	1%

CLASS B	NWQ	NEQ	SWQ	SEQ
Total Bldgs	2	9	5	1
Total RBA	601,695	1.78MM	982,002	450,000
Vacant SF	142,800	27,000	95,683	351,950
Vacancy Rate	24%	2%	10%	78%

CLASS C	NWQ	NEQ	SWQ*	SEQ
Total Bldgs	2	1	4	1
Total RBA	336,138	200,000	548,890	375,000
Vacant SF	0	0	2,500	0
Vacancy Rate	0%	0%	.01%	0%

*Adjustment in Class C vacancy and RBA attributed to planned demolition of former tobacco storage warehouses & redevelopment as Deepwater Industrial Park (SWQ City)



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REPORT: BIG COMPANIES FINE-TUNE THE ROBOT REVOLUTION

Automation is leading to job growth in certain industries where machines take on repetitive tasks, freeing humans for more creative duties.

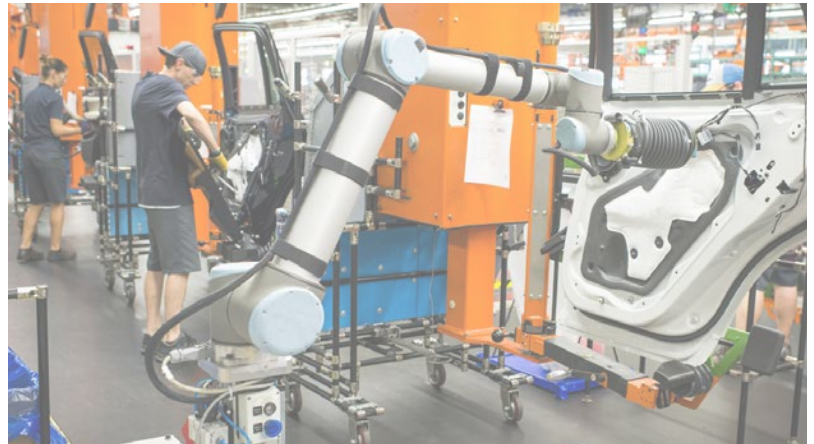
ANSBACH, Germany—A few years ago, Roland Rösch's job involved grabbing scalding-hot auto parts from an oven and inspecting them for signs they had failed a safety test.

These days he still inspects, but the grabbing is being done by Fritz, a robot that auto-parts manufacturer Robert Bosch GmbH installed three years ago at this German factory as part of an automation effort.


Fritz is more efficient at handling the dangerous and repetitive task of lifting the 8-inch metal-and-circuitry pieces out of the furnace. This leaves Mr. Rösch less exposed to potential accidents and gives him time to test 20% more parts than he did before the robots.

The big question surrounding automation has long been whether robots would compete with workers or help them. Initially, workers feared robots would destroy jobs across the economy. Scholarly research and real-life experience have eased that concern, although some types of workers and industries are ending up on the losing side.

Today, the question is more precise: In which industries does automation help both employer... and employee?



The companies that may have cracked the code are those that can assign repetitive, precise tasks to robots, freeing human workers to undertake creative, problem-solving duties that machines aren't very good at. That's particularly relevant for manufacturing, the food sector and service sectors such as billing, where timetable spreadsheets can be automated, freeing up workers to do higher-value tasks.


 **BOSCH** With demand for Bosch-built steering controls high, the company has used automation to increase its output, leading it to hire more people to perform the type of checks Mr. Rösch conducts.

"We looked for 20,000 new hires last year," a mix of new positions and replacement staff, said Stefan Assmann, one of the company's chief engineers, to join Bosch's total 400,000 employees. Bosch factories world-wide now make use of 140 robotic arms, up from zero in 2011. "We can't see robots having a negative impact on our workforce," Mr. Assmann said.

Computers can zoom through activities humans find difficult, such as playing chess, doing calculus or repeating a set of movements precisely over time. Other, seemingly mundane tasks—brushing your teeth or running through the woods—can overwhelm even complex machines.

Those tasks call on multiple senses, including touch and depth perception, feeding information to a problem-solving brain, which can then finely adjust movements, said Satyandra Gupta, professor of mechanical engineering at the University of Southern California.

For companies, choosing the appropriate tasks to automate is important. Auto maker BMW AG automated some of the physical labor at the Spartanburg plant in South Carolina **while retaining tasks involving judgment and quality control for workers.** Robots fit black, soundproofing rubber tubes to the inner rim of car doors, a task once done entirely by hand, on the more than 5,000 or so car doors that pass through the production line each day. Human workers do final checks on the tube's placement. The division of labor speeds up the process.

 Since BMW introduced this and other automated processes over the past decade, it has more than doubled its annual car production at Spartanburg to more than 400,000. The workforce has risen from 4,200 workers to 10,000, and they handle vastly more complex autos—cars that once had 3,000 parts now have 15,000. Being spared strenuous activities gives workers the time and energy to tackle more demanding and creative tasks, BMW said in a statement.

James Bessen, an economist who teaches at Boston University School of Law, said automation like that at the Spartanburg plant has enabled a huge increase in the quality and variety of products, which help spur consumer demand. BMW's share of luxury-car sales in the U.S. has risen sharply, with over 300,000 cars sold last year compared with just over 120,000 in 1997, company figures show.

RREPORT: BIG COMPANIES FINE-TUNE THE ROBOT REVOLUTION

Tesla Inc., by contrast, has struggled with production of the Model 3 car at its Fremont, Calif., plant after its use of robots got out of balance. Undetected errors in parts built by robots caused bottlenecks in production, meaning it could build only 2,020 cars a week compared with the 5,000 it originally promised, according to the company.



Analysts at investment research firm Bernstein said Tesla automated welding, paint and body work processes, as other manufacturers have done, but also automated final assembly work, in which parts, seats and the engine are installed in the car's painted shell. Errors in this work caused production bottlenecks. "Automation in final assembly doesn't work," said analyst Max Warburton.

"Yes, excessive automation at Tesla was a mistake... Humans are underrated," wrote Tesla CEO Elon Musk in a tweet.

Robots have resulted in pay cuts for low-skilled machine operators, such as those who oversee wood- or leather-cutting machines, who play a diminishing role in production due to automation. And they have eliminated entire occupations, especially in simple manufacturing processes where there aren't value-added jobs for displaced workers to move to.

Mining, for example, hinges on raw high-volume production—dig more rock, make more money—which is better done by machines that won't tire or get injured.

Rio Tinto PLC plans to lay off drivers as it introduces self-driving trucks to move iron ore at its mines in Western Australia. The trucks, which follow sensors and maps of the mining site installed in onboard computers, can operate longer than human drivers and are more reliable. Beneath the ground, robotic drilling rigs have taken over the dangerous work of inserting explosives into holes dug in mining shafts.

The automation would improve safety and unlock significant productivity gains, helping generate annual savings of around \$500 million beginning in 2021, said Chris Salisbury, the Rio Tinto board member in charge of the firm's iron-ore mining operations. The company said it would look to retrain or find new roles for the workers affected by the automation.



Jobs in the garment industry are also disappearing as firms automate repetitive, high-volume tasks such as sewing and knitting, where machines can work faster and more accurately than humans. Technological breakthroughs have enabled robots to take on delicate tasks, such as manipulating pliable fabrics, stitching pockets and attaching belt loops to pants. In the early days of automation, it was thought that humans would be needed for such finishing work.

The International Labor Organization has warned that nearly 90% of garment and footwear workers in Cambodia and Vietnam are at risk from "sew-bots."

At an aggregate level, however, the jobs created by automation outnumber those that are being destroyed, according to analysis by the Massachusetts Institute of Technology's David Autor and Utrecht University's Anna Salomons. People losing jobs, however, may not be the same ones filling newly created ones, since different skills are often required.

The Asian Development Bank said in April that automation had created an extra 34 million jobs in its region after price falls and quality improvements spurred demand for Asian factory-made goods.

More-developed economies have also seen job growth. Automation in the U.K. over the past 15 years has destroyed 800,000 lower-skilled services jobs—such as call centers—but has created 3.5 million higher-skilled ones in their place, according to a 2017 workforce study by consultancy firm Deloitte. The new jobs paid around \$13,500 more than the jobs they replaced, Deloitte said.

Industrial employment in Germany is expected to rise 1.8% by 2021 because robots and automation are making the country's factories more competitive, according to the Germany-based Centre for European Economic Research in April.

Automation can help feed demand for a product - because quality improves or it becomes less expensive or more available - which can create jobs as a result.

Finnish firm Fiskars AB, manufacturer of iconic and once pricey orange-handled scissors, used automation to reach more customers. Workers at its Helsinki plant formerly forged steel blades by hand in 2,700-degree furnaces, repetitive and dangerous work that was slow and costly.

When robots took over the tasks in 2011, technicians moved to quality control, testing the scissors to make sure the blades made the right "snip" sound as they sliced together, and if they smoothly cut strips of fabric. If necessary, workers could adjust the blades bit by bit, in a process calling on multiple senses that machines couldn't replicate.

REPORT: BIG COMPANIES FINE-TUNE THE ROBOT REVOLUTION

Once the process was partly automated, the company was able to increase production and lower prices, stimulating new demand without sacrificing quality, according to Chief Supply Chain Officer Risto Gaggl.

Employment at Fiskars has soared along with higher production, with the company now employing 8,560 people in its factories and offices compared with 4,515 in 2007.

In Europe, “we couldn’t find anyone who has been fired because of robots,” said Professor Wolfgang Dauth, leader of a yearslong study into the impact on workers of robotization on the continent by the Bonn-based Institute of Labor Economics. Part of the reason is strong labor unions require retraining for workers when robots take over tasks. Another part is that Europe’s more-complex industries need human thinkers to work in complement with machines.



Electrolux AB, the world’s second-largest appliance maker by units sold after Whirlpool Corp. , has spent millions of euros on automating the production of washing machines and other devices, which are now assembled almost entirely by machine.

The company said robots freed up technicians to spend time on a creative task that is impossible to automate: designing and implementing changes to the factory floor and robot layout to customize procedures and make production more efficient. The constant, incremental improvements make a broader range of production in the same factory space possible, which in turn supports more workers.

The company said it tweaked hiring and training so that its workforce could successfully operate with robots, including a month of robotics training when hired and bimonthly half-day sessions. The company also built robot-testing areas at its factories where technicians can experiment with different robot hardware and software.

Employment at Electrolux has risen to more than 55,000 in 2017 from about 53,000 in 2011, reversing a yearslong trend of shrinking staff numbers after China’s December 2001 entry to the World Trade Organization flooded the market with cheaper washing machines.

“We don’t see automation going over 50%,” said Jan Brockmann, chief operations officer at Electrolux. “There’s not much point.” He said machines would likely take over routine work like assembly, freeing workers to make repairs and improvements to an increasingly efficient production line.

The slow pace of robot rollouts can shield workers, providing time for retraining. Companies rarely automate all of a worker’s tasks in one swoop, and it takes time to work out how best to use robots. The high cost of adding new automation also slows the process.

Bosch developed training courses for workers, teaching once single-skilled welders, joiners and mechanics basic software coding skills to enable them to use robots as tools much like hammers or screwdrivers. “We employ designers, engineers and scientists,” said Mr. Assmann, one of the firm’s chief engineers. “But you still need people who are good with their hands.”

U.K.-based food delivery company Ocado Group has progressively automated work processes and has added workers as demand for its once-exclusive internet-grocery shopping service has surged, in part driven by the efficiency savings that have lowered prices.

The company’s chief innovation is a complex web of grocery-transporting conveyor belts that allow it to process consumers’ online orders. Another set of robots under development will be assistants for its human maintenance staff, allowing them to be more productive in managing the conveyor belts and other machinery. The company shuts down operations for three hours each day for maintenance, and missing that window could mean being unable to process deliveries.

Instead of walking around the factory to collect whatever tools are needed, the robots will anticipate what tools the workers need, and bring them to hand, acting as automated assistants.

“Our business model would just fail if these machines didn’t work,” said Graham Deacon, head of automation at Ocado. “We need humans to make sure they don’t break down.”

