OHIO DEPARTMENT OF DEVELOPMENT

Office of Strategic Research

THE OHIO IRON and STEEL INDUSTRY

September, 2005

A State Affiliate of the U.S. Census Bureau

Bob Taft, Governor

Bruce Johnson, Director

THE OHIO IRON AND STEEL INDUSTRY

SEPTEMBER 2005

BA8 Don Larrick, Principal Analyst
Office of Strategic Research, Ohio Department of Development
P.O. Box 1001, Columbus, Oh. 43216-1001
Production Support:
James Kell and Steve Kelley, Editors
Robert Schmidley, GIS Specialist

TABLE OF CONTENTS

EXECUTIVE SUMMARY

- Typically 14 to 17 percent of the raw steel produced each year in America originates in mills in Ohio; the state has ranked second only to Indiana for 1982-2003.

- As judged by the dollar value-added at industry establishments during 2003, factories in Ohio ranked first in the manufacture of steel products made from purchased steel (NAICS 3312) and third in iron, steel and ferroalloys (3311).

- Seventeen companies on Fortune magazine's U.S.-1,000 or Global-500 lists have iron and steel industry operations in Ohio; three of them – AK Steel, Timken, and Worthington Industries – have their world headquarters in Ohio.

- AK Steel is Ohio's largest iron and steel industry employer with 5,875 employees, followed by Wheeling-Pittsburgh Steel, General Motors (GM), Ford, and Republic Engineered Products. GM and Ford are the two largest foundry operators in the state.

- The latest available data show 268 iron and steel industry establishments in Ohio employed over 41,600 people; those figures represent 9.9 percent of the U.S. industries establishment and 15.4 percent of its work force.

- The iron, steel and ferroalloys group (3311) was the largest iron and steel industry group in Ohio, with close to 21,800 workers in 87 establishments – of which over 20,100 work in 80 iron and steel mills (331111).

- The greatest concentrations of industry employment in Ohio were in electrometallurgical ferroalloy production (331112 – nearly 70 percent of the U.S.) and rolled steel shapes (331221 – 32.6 percent of the U.S.).

- Ohioans working in the iron and steel industry averaged almost $47,300 in wages during 2003, higher than the national average of $46,300-plus. This is driven by the high wages paid in iron foundries (331511) and electrometallurgical ferroalloy production.

- About four of every seven industry jobs in 2003 were found in Butler, Cuyahoga, Defiance, Lorain, Stark and Trumbull Counties: adding the jobs in Jefferson and Lorain raises the proportion to almost two-thirds.

- Sixty-one counties had at least one industry establishment, with the majority in 11 counties: Columbiana, Cuyahoga, Franklin, Lake, Lorain, Lucas, Mahoning, Montogmery, Stark, Summit, and Trumbull.

- Sixteen companies from nine foreign nations employed, through their subsidiaries and joint ventures, about 7,060 people manufacturing steel mill products in Ohio during 2004; four of them were on Fortune's Global-500 list. Industrias CH is the largest employer with 2,375 workers.

- Twenty-nine companies announced 36 major industry investments in Ohio from 2002 through 2004; they totaled $695.7 million, as reported by the Office of Strategic Research.

- The proportion of capital expenditures in Ohio for the manufacture of iron and steel mills and ferroalloys (NAICS 3311) averaged 84 percent of the proportion of value-added from the group in Ohio during the 1997-2003 period, but the proportion of capital expenditures in Ohio for making steel products made from purchased steel (3312) averaged 117 percent of the proportion of value-added from the group during the same time.

- The three most significant trends transforming the U.S. iron and steel industry in the last part of the 20th century have been the rise of minimills, the rise of steel imports (i.e., foreign competition), and substitution of alternative materials for iron and steel (most notably by the motor vehicle industry).

- In particular, the rise of imports – both steel mill products as well as other goods incorporating steel – and the substitution of other materials reduced the demand and subsequent production of raw steel in Ohio and the nation beyond the normal variations of the economic cycle.

- Industry employment in Ohio fell from over 52,700 jobs in 1998 to 41,600-plus in 2003, a net loss of 21 percent; this was part of, and proportional with, what happened across the country during the last economic downturn.

- The steel production in 2005 is not expected to increase as much as it did in 2004 due to slower growth expected in key markets for steel mill products; the long-term growth trend for the industry is expected to be slower than average.

- The forecast real growth in output of steel mill products (from 2002 to 2012) is not expected to stem the loss of industry jobs during that time.

DESCRIPTION OF OHIO'S IRON AND STEEL INDUSTRY

Leading and Notable Steel Establishments in Ohio

Key

Steel Establishment Employing:

- 200 - 500
- 501 - 1,500
- 1,501 - 3,800
- Ohio County

Source:
2005 Selectory CD-ROM, Prospecting Business Database, Harris InfoSource, Twinsburg, Ohio

Prepared by:
Ohio Department of Development
Office of Strategic Research
September 2005

R081905A

NOTABLE IRON AND STEEL INDUSTRY MANUFACTURERS

Seventeen companies on Fortune magazine's U.S.-1,000 or Global-500 lists have iron and steel industry establishments in Ohio. Three of them maintain their world headquarters in Ohio: AK Steel, Timken, and Worthington Industries. AK Steel is the largest industry employer in Ohio with 5,875 people, followed by Wheeling-Pittsburgh Steel with almost 2,750. General Motors and Ford are the third and fourth largest industry employers, with 2,500 and 2,400 people, respectively; they also are the two largest ferrous foundry operations in the state.[1] Republic Engineered Products is the only other industry employer with at least 2,000 workers in Ohio.

The map above shows the locations of the 35 establishments with at least 200 employees. The list below includes the Fortune companies with at least 50 people at a site as well as other companies employing 200 or more people in Ohio and having at least 50 people at a site.[2] It is organized by NAICS code and includes the location county of the site. Iron and steel manufacturing is not the principal business of some companies on the list. However, the sites of such companies are included because the primary NAICS codes of the specific establishments define them as part of the industry.

Industry Group/Company/Subsidiary	Primary NAICS	Location County	Jobs at Site
3311: Iron & steel & ferroalloys			
AK Steel Holding Corp.*/AK Steel Corp.	331111	Butler	400
AK Steel Holding Corp.*/AK Steel Corp.	331111	Butler	3,800
AK Steel Holding Corp.*/AK Steel Corp.	331111	Muskingum	350
AK Steel Holding Corp.*/AK Steel Corp./Mansfield Works	331111	Richland	400
AK Steel Holding Corp.*/AK Steel Corp./Wheatland Tube	331111	Trumbull	125
AK Steel Holding Corp.*/AK Tube LLC	331111	Wood	300
Allegheny Ludlum Technologies/J & L Specialty Steel, Inc.	331111	Stark	325
BHP Billiton*/North Star BlueScope Steel LLC	331111	Fulton	240+
Corus/Thomas Steel Strip Corp.	331111	Trumbull	590+
Dofasco Marion Steel Co.	331111	Marion	115+
Engineering Materials, Inc./Canton Drop Forge, Inc.	331111	Stark	300
General Electric Co., Inc.*/Unison Industries/Elano	331111	Greene	500
Industrias CH, S.A. de C.V./Republic Engineered Products/Canton Hot Rolled Plant	331111	Stark	800
ITT Industries, Inc.*	331111	Fulton	250
Maverick Tube Corp.*	331111	Lorain	100

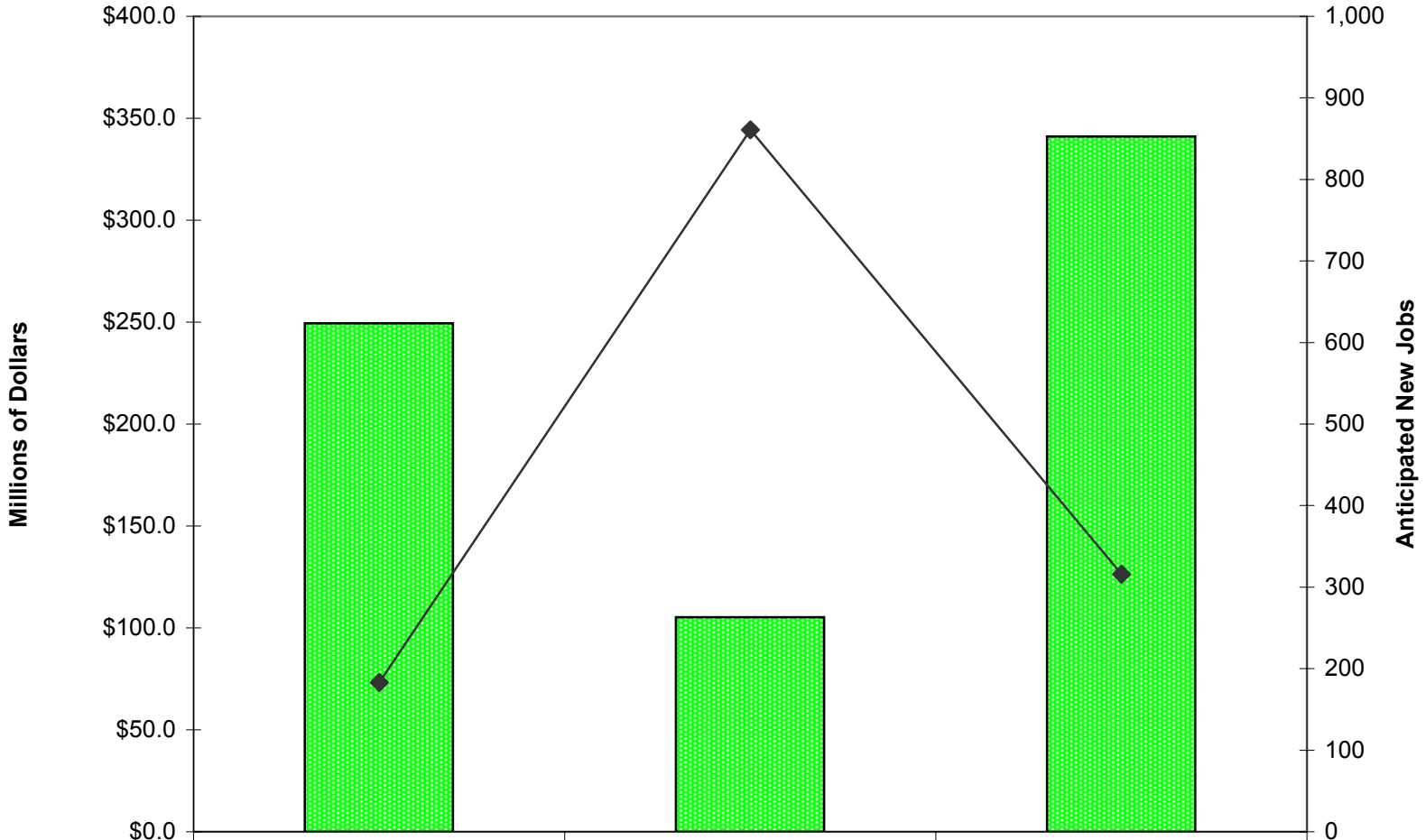
Industry Group/Company/Subsidiary	Primary NAICS	Location County	Jobs at Site
3311: Iron & steel & ferroalloys (continued)			
McWane, Inc./Clow Water Systems Co.	331111	Coshocton	500
Merit Brass Co.	331111	Cuyahoga	225
Mitsubishi Corp.*/Coilplus Holdings, Inc./Coilplus-Ohio, Inc.	331111	Clark	55+
Mittal Steel NV*	331111	Cuyahoga	1,000+
PTC Alliance Corp.	331111	Stark	400
Renco Group, Inc./WCI Steel, Inc.	331111	Trumbull	1,800
TI Group PLC/TI Group Automotive Systems	331111	Fayette	400
United States Steel Corp.*-Kobe Steel/PRO-TEC Coating Co.	331111	Putnam	230+
Wheeling-Pittsburgh Steel Corp.*	331111	Belmont	200
Wheeling-Pittsburgh Steel Corp.*	331111	Jefferson	2,500
Worthington Industries, Inc.*	331111	Franklin	250
Eramet SA/Eramet Marietta, Inc.	331112	Washington	650+
3312: Steel products from purchased steel			
Dofasco/Shelby	33121	Richland	700
Jackson Tube Service, Inc.	33121	Miami	350
((Salzgitter AG/(Vallourec & Mannesman AG)) & Sumitomo*)/V & M Star LP	33121	Mahoning	440+
Timken Co.*	33121	Wayne	150
United States Steel Corp.*/Lorain Pipe Mills	33121	Lorain	550#
AK Steel Holding Corp.*/AK Steel Corp.	331221	Coshocton	500
Greer Limestone/Greer Steel Co.	331221	Tuscarawas	290
Industrias CH, S.A. de C.V./Republic Engineered Products	331221	Lorain	1,400
Industrias CH, S.A. de C.V./Republic Engineered Products	331221	Summit	120
Illinois Tool Works, Inc.*/Hobart Brothers Co.	331222	Miami	400
33151: Ferrous metal foundries			
Ford Motor Co.*/Casting Plant	331511	Cuyahoga	2,400
General Motors Corp.*/Powertrain	331511	Defiance	2,500
Osco Industries, Inc.	331511	Jackson	160
Osco Industries, Inc.	331511	Scioto	74
Osco Industries, Inc.	331511	Scioto	200

Industry Group/Company/Subsidiary	Primary NAICS	Location County	Jobs at Site
33151: Ferrous metal foundries (continued)			
Quality Castings Co.	331511	Wayne	290
Precision Castparts Corp.*/PCC Airfoils, Inc.	331512	Lake	325
Precision Castparts Corp.*/PCC Airfoils, Inc.	331512	Stark	400
ASF-Keystone, Inc./Alliance Castings	331513	Stark	400
Columbus Steel Castings Co.	331513	Franklin	1,000
Elyria Foundry Co.	331513	Lorain	500
Industrias CH, S.A. de C.V./Republic Engineered Products/Bloom Cast Plant	331513	Stark	55
Xtek, Inc.	331513	Hamilton	220

Notes: * - a Fortune U.S. 1,000 or Global 500 company; + - number is from Office of Strategic Research (OSR) (2005a), # - number from Lexis-Nexis (2005), all others are from Harris (2004).
Sources: Fortune (2005), Harris (2004), Lexis-Nexis (2005), OSR (2005a), various company websites.

Investment Announcements in Ohio's Iron & Steel Industry, 2002-2004

Three-Year Totals: $695.7 Million; 1,360 Jobs



	2002	2003	2004
Amount Invested	$249.4	$105.2	$341.1
Anticipated New Jobs	183	861	316

Source: Office of Strategic Research.

RECENT EXPANSION AND ATTRACTION ANNOUNCEMENTS

From 2002 through 2004 the Office of Strategic Research (OSR) recorded 36 major investments by 29 companies in Ohio's iron and steel industry totaling at least $695.7 million (M). The largest dollar amounts were announced in 2004 – $341M, but the greatest number of anticipated new jobs came in 2003 – 861.

While no one company dominated investment activity, several companies made notably large investments during these years. These include Wheeling-Pittsburgh Steel – $119.0M, Charter Manufacturing – $116.0M, Mittal – $88.2M, General Motors – $80.5M, Republic Engineered Products (soon to be a part of Industrias CH) – $70.5M, and AK Steel – $69.5M. Other companies investing at least $10.0M include Alliance Castings, Columbus Steel Castings, Eramet Marietta, BCS Cuyahoga, Sawmill Tubular, and Sharon Tube. Alliance Castings also anticipates adding 400 new jobs when the project is completed – the largest number by any company.

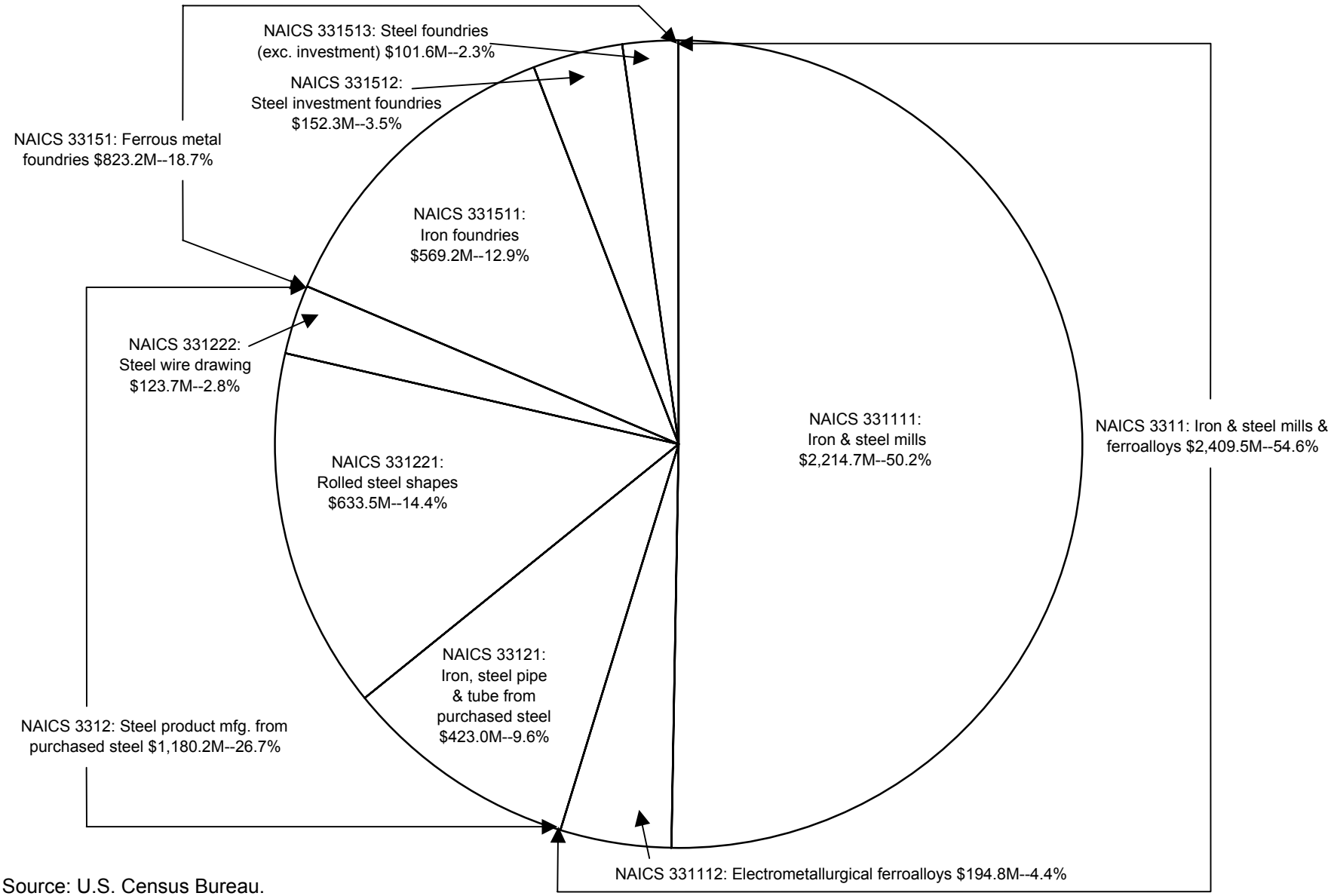
Just over $505M is intended for iron, steel, and ferroalloy products (NAICS 3311), with $485M going for iron and steel mills alone (331111). Over $120M is intended for foundries (33151), with GM's investments in its Defiance plant comprising about two-thirds of that amount. The remaining funds – about $69M – are earmarked for plants making products from purchased steel (3312).

These counts are derived from a list of major investments compiled by OSR (2005b). To be included, a major investment must meet at least one of the following criteria: 20,000 square feet of new space; $1M to be spent for land, building(s), or equipment; or 50 new jobs. Many of the major investments are phased in over a two-to-three year cycle, with production and employee counts phased in after project completion. The data are not comparable with the Census data on capital expenditures.

See Table A1

Value Added in Ohio's Iron & Steel Industry, 2002

Total: $4,412.9 Million--100.0%



Source: U.S. Census Bureau.

THE COMPOSITION OF OHIO'S IRON AND STEEL INDUSTRY: VALUE-ADDED AND VALUE OF SHIPMENTS

Value-added and value of shipment data from the 2002 Census of Manufactures provide both insight into the composition of iron and steel industry in Ohio and a basis for comparisons with other states and the country as a whole.[3]

The chart above illustrates the relative distribution of the output by specific industry. One-half of industry production in the state consists of raw steel production and semi-finished and finished steel mill products made where the raw steel is produced (NAICS 331111). Steel product manufacturing from purchased steel (3312) comprised 26.7 percent of output, the largest part of which was rolled steel shapes (331221 – finished products such as bars, plates, sheets and strips) – 14.4 percent. Foundry operations comprised the remaining 18.7 percent, with iron foundries (331511) the largest part of the subgroup. Of all the remaining industries, only iron and steel pipes and tubes manufactured from purchased steel (33121) exceeded five percent of total industry output in Ohio (U.S. Bureau of the Census, 2005c).

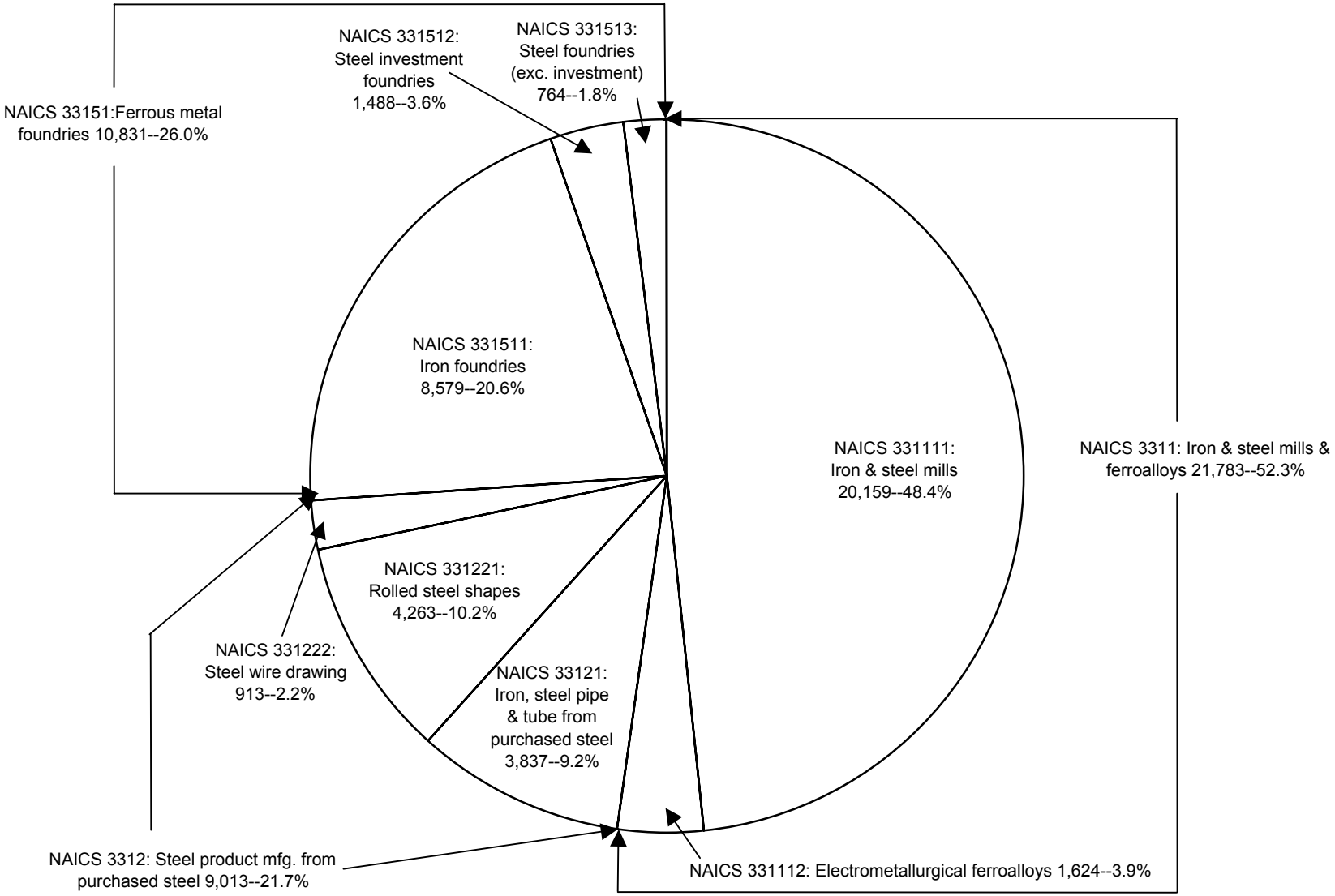
Value-added data from the Industry Series of the 2002 Census of Manufactures permit comparisons of output from Ohio with that of other states, and sometimes the story is dramatically different. For example, the chart above shows that the manufacture of electrometallurgical ferroalloys (331112, other metals that are added to molten steel to give it desired characteristics) comprises 4.4 percent of total industry value added in Ohio. However, of all such alloys produced in the nation in 2002, 67.6 percent came from Ohio! Data from the same series of reports also show that Ohio ranked first in the production of rolled steel shapes and iron foundry output. Ohio ranked second in iron and steel mill, pipe and tube, and steel investment foundry output. Ohio ranked third in steel wire drawing (U.S. Bureau of the Census, 2005d).

Value of shipment data from the Industry Series show that, where information is available, Ohio ranked first in output of eight industry product classes, second in five, third in one and fourth in one. In sum, the reason Ohio is so important as an iron and steel industry state is because it is the source of a wide variety of goods produced in high volumes. Data from the Annual Survey of Manufactures for 2003 show that even in years of relatively low industry output, Ohio still ranked third in iron and steel mill and ferroalloy production and first in steel product manufacturing from purchased steel (U.S. Bureau of the Census, 2005a).

See Tables A2a-A2d

Employment in Ohio's Iron and Steel Industry, 2003

Total: 41,627--100.0%



Source: U.S. Census Bureau.

THE COMPOSITION OF OHIO'S IRON AND STEEL INDUSTRY: EMPLOYMENT

Two hundred and sixty-eight establishments employed over 41,600 people in Ohio's iron and steel industry in 2003. The chart above shows that the industry was dominated by the iron and steel mills and ferroalloys group (NAICS 3311), which had 52.3 percent of the industry's employment in the state. The group was, in turn, overwhelmingly comprised of iron and steel workers (331111 – 48.4 percent of industry jobs). The production of metals used in making alloy steel (331112) occupied 1,600-plus people – 3.9 percent of industry employment.

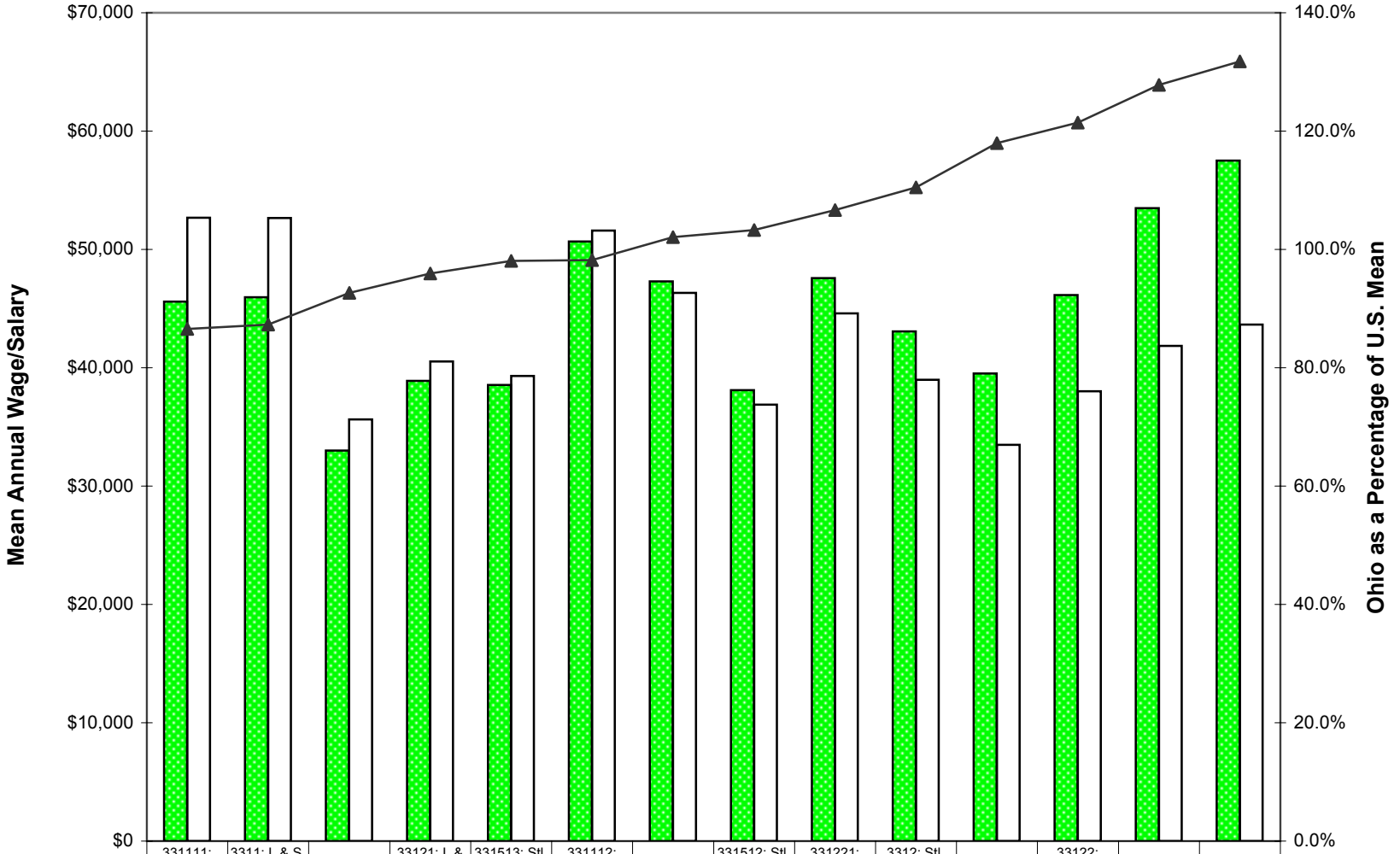
The vast majority of workers in Ohio making steel products from purchased steel (3312) were either making pipes and tubes (33121 – 3,800-plus jobs), or rolling steel shapes (331221 – well over 4,200 jobs). Steel wire drawing (331222) employed just over 900 people.

Almost 10 percent of the industry's establishments and 15 percent of the industry jobs in America are located in Ohio. The overall concentration of industry here is obvious when compared with Ohio's portions of all U.S. private non-farm establishments and employment – 3.7 and 4.2 percent. Some specific industries are particularly concentrated in the state. These include making iron and steel pipes and tubes from purchased steel – 14 and 19 percent of such plants and jobs in the country; rolled steel shapes – 15 and 32.6 percent of corresponding plants and jobs; and electrometallurgical ferroalloy products – an astounding 30 and almost 70 percent of national plants and jobs!

The chart above also shows that more people were employed at more establishments in the ferrous metal foundries sub-group (33151) than in making steel products from purchased steel (10,800-plus vs. 9,000, and 99 vs. 82, respectively). The sub-group was largely comprised of iron foundries (331511) and their workers (well over 8,500). Although there were 69 iron foundries, most of the jobs were probably located at just two: the motor vehicle engine block casting plants of Ford (in Cuyahoga) and General Motors (in Defiance). These two also are likely driving the concentration of foundry employment in the state – 13.8 percent of the national total compared with 9.9 percent of all steel investment foundry (331512) employment and 5.3 percent of non-investment steel foundries (331513).

See Table A3

Comparing Ohio and U.S. Industry Wages in 2003



	331111: Iron & steel mills	3311: I. & S. mills, F-alloys	Ttl. Cvrd. Emplymnt.	33121: I. & S. pipe & tube	331513: Stl. Fndrs. (Exc. Invstmnt)	331112: Elctrmtllrgcl. F-alloy	Iron & steel industry	331512: Stl. Invstmnt Fndrs.	331221: Rlld. Stl. Shps.	3312: Stl. Prdcts. frm Prchsd. Stl.	331222: Stl. Wr.Drwng.	33122: Rllng. & Drwng.	33151: Frrs. Mtl. Fndrs.	331511: I. Fndrs.
Ohio	$45,583	$45,963	$33,010	$38,894	$38,539	$50,678	$47,295	$38,099	$47,573	$43,062	$39,519	$46,152	$53,497	$57,500
U.S.	$52,673	$52,654	$35,635	$40,533	$39,304	$51,598	$46,329	$36,885	$44,606	$38,978	$33,493	$38,004	$41,854	$43,640
Ohio as Percent of U.S.	86.5%	87.3%	92.6%	96.0%	98.1%	98.2%	102.1%	103.3%	106.7%	110.5%	118.0%	121.4%	127.8%	131.8%

Industry

Source: U.S. Census Bureau.

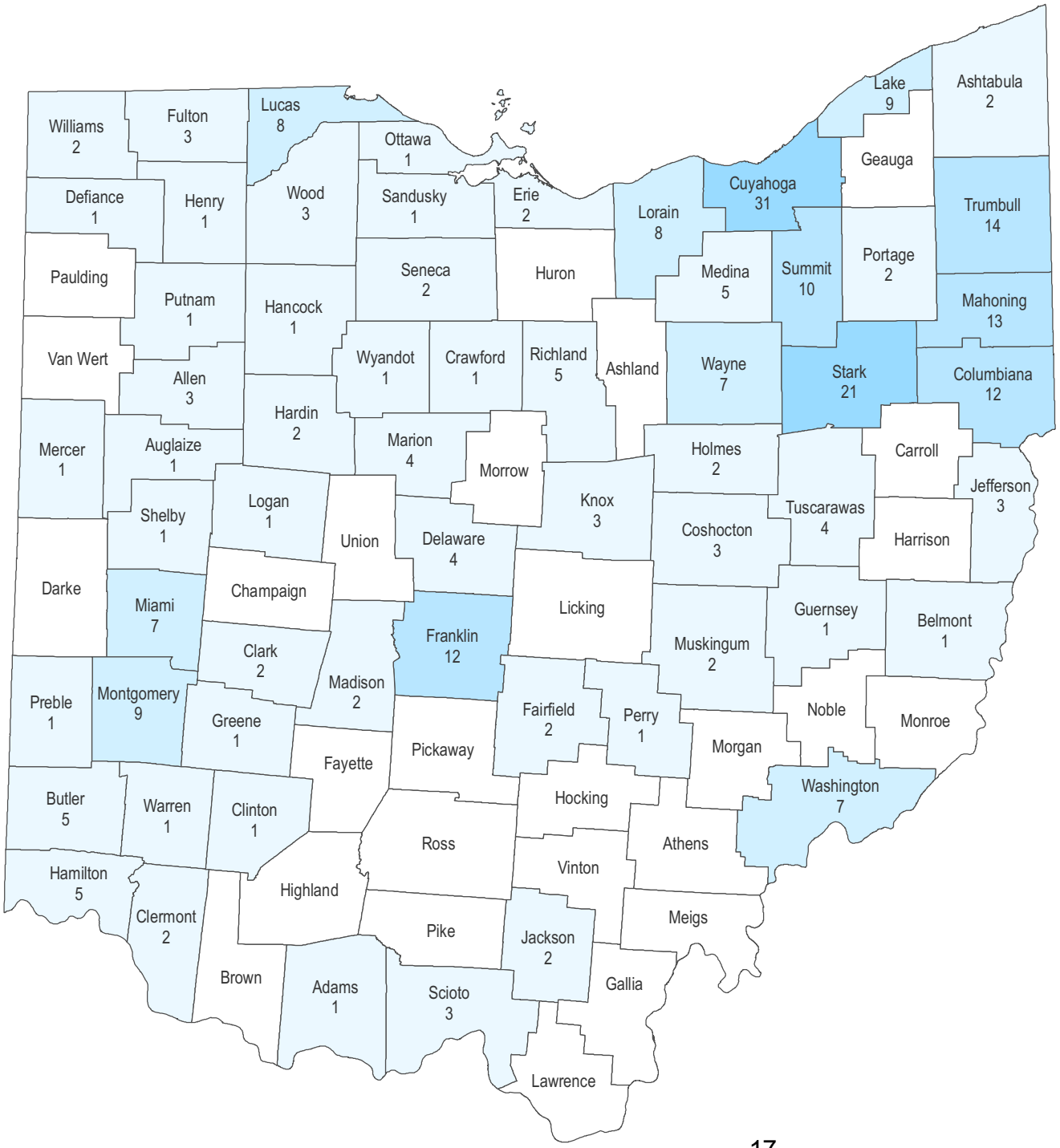
INDUSTRY WAGES

The average annual wage for an Ohio iron and steel industry worker was $47,295 in 2003. This was about 102 percent of the corresponding average for the U.S. - $46,329. Annual averages vary among the specific industries. The highest paying industries were iron foundries (331511 – $57,500) and electrometallurgical ferroalloy production (331112 – $50,678). This contrast with the pay in steel foundries (NAICS 331512-3), steel wire drawing (331222), and the manufacture of pipes and tubes from purchased steel (33121), which averaged between $38,000 and $40,000. Rolling steel shapes (331221) and the production of raw steel (331111) paid between $45,000 and $48,000.

While wages in Ohio's iron and steel industry were slightly greater than the national average, they were not uniformly greater. At one end, the wages and salaries of iron foundry workers in Ohio were almost 132 percent of the national average. (This may reflect the impact of Ford's and General Motors' foundries.) At the other end, those in the production of raw steel were less than 87 percent of the national average. Other industries in Ohio were close to the corresponding national averages: steel foundries, electrometallurgical ferroalloys, and manufacturing pipes and tubes from purchased steel.

See Table A4

Steel Industry Establishments in Ohio by County 2003



Number of Establishments in County

- 15 - 31
- 10 - 14
- 6 - 9
- 1 - 5
- None

Source:
2003 County Business Patterns
U.S. Census Bureau

Prepared by:
Ohio Department of Development
Office of Strategic Research
September 2005

R081905A

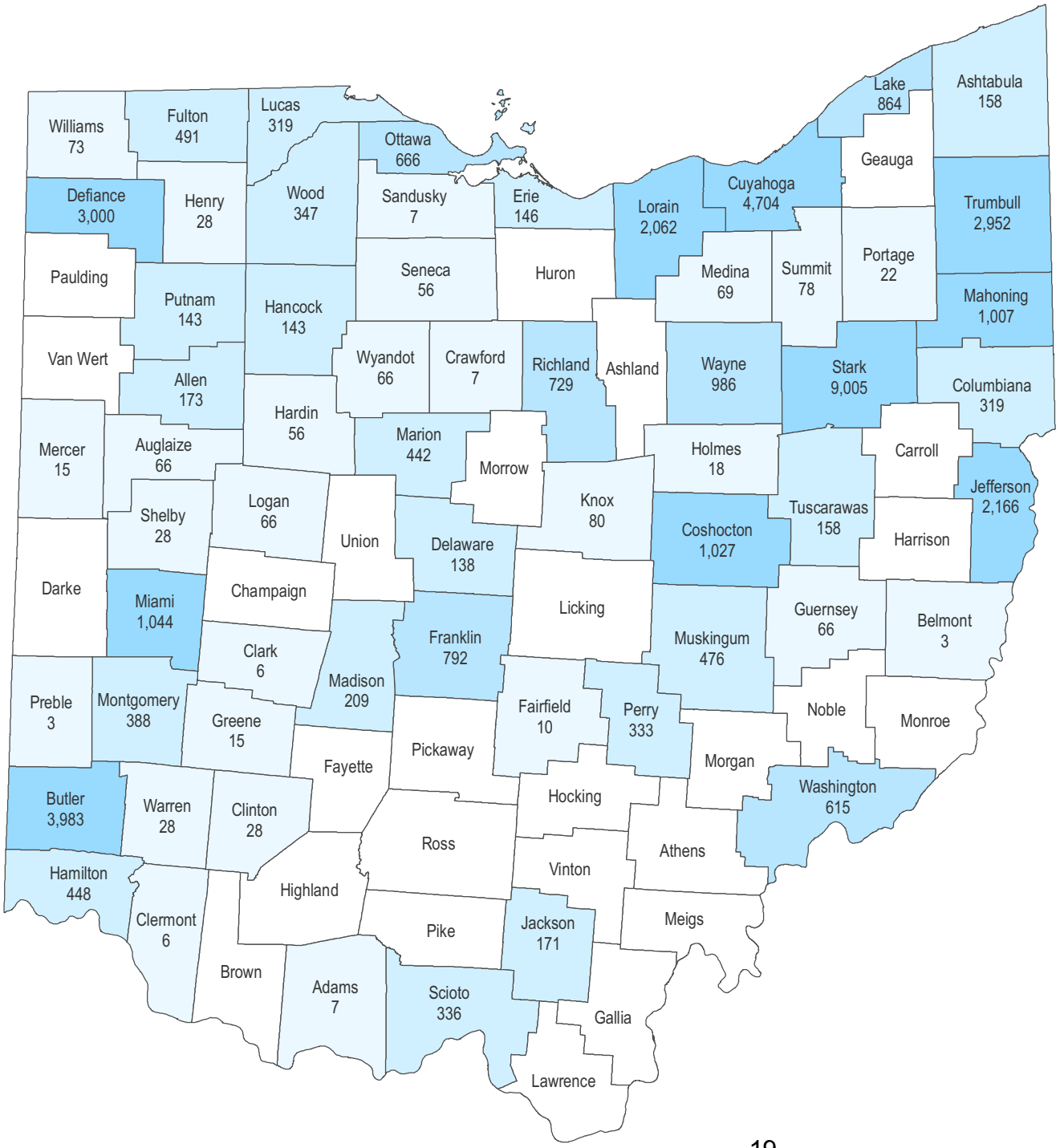
THE DISTRIBUTION OF INDUSTRY ESTABLISHMENTS IN OHIO

The map above illustrates the distribution of 267 iron and steel industry establishments across Ohio in 2003. (County information was missing for one establishment.) Sixty-one counties have at least one industry establishment. However, the majority were located in 11 counties: Cuyahoga – 31, Stark – 21, Trumbull –14, Mahoning – 13, Columbiana and Franklin – 12 each, Summit – 10, Lake and Montgomery – nine each, and Lorain and Lucas – eight each. Miami, Washington, and Wayne Counties each have seven establishments. Forty-seven counties have from one to five establishments.

The map above also illustrates the concentration of industry establishments in Northeastern Ohio. In particular, nine counties – Columbiana, Cuyahoga, Lake, Lorain, Mahoning, Stark, Summit, Trumbull, and Wayne – form a contiguous area with 125 establishments, or almost 47 percent of the industry in Ohio. The other counties with relatively large numbers of establishments – Franklin, Lucas, Miami, Montgomery, and Washington – are scattered across the state.

See Table A5

Steel Industry Employment in Ohio by County 2003



Employment in County

- 1,000 - 9,005
- 500 - 999
- 100 - 499
- 1 - 99
- None

Source:
2003 County Business Patterns
U.S. Census Bureau

Prepared by:
Ohio Department of Development
Office of Strategic Research
September 2005

R081905A

THE DISTRIBUTION OF INDUSTRY EMPLOYMENT IN OHIO

The map above illustrates the distribution of well over 41,000 iron and steel industry jobs across Ohio in 2003. Industry employment is more concentrated than the distribution of establishments. Just five counties can account for almost 57 percent of the industry jobs: Stark – about 9,000, Cuyahoga – about 4,700, Butler – a little less than 4,000, Defiance – 3,000, and Trumbull – about 2,950.[4] Two more counties appear to have at least 2,000 jobs each – Jefferson and Lorain, while three counties are thought to have between 1,000 and 1,100 jobs apiece: Coshocton, Mahoning, and Miami. Six counties have between 500 and 999 jobs, 19 have at least 100 but less than 500, and 26 have from one to 99.

The nearly 22,000 industry jobs in the same nine contiguous Northeastern Ohio counties – Columbiana, Cuyahoga, Lake, Lorain, Mahoning, Stark, Summit, Trumbull, and Wayne – also comprise about 52 percent of the state total, but there are notable exceptions to the generalization that the concentration of jobs follows the concentration of establishments. Counties with smaller numbers of establishments but larger numbers of jobs include Butler, Coshocton, Defiance, and Jefferson. These counties have large steel making and/or foundry operations. Butler is home to AK Steel. AK and McWane have steel making operations in Coshocton. General Motors has an engine block foundry in Defiance, and Wheeling-Pittsburgh Steel has a primary production facility in Jefferson.

See Table A5

FOREIGN INVESTMENT IN OHIO

Sixteen foreign-based companies have subsidiaries and/or joint ventures in Ohio's iron and steel industry; four are on Fortune's Global 500 list. All of the companies are listed below, along with the countries where the home office is located, their Ohio Subsidiaries, and the total number of employees here. The ownership patterns may be complex. For example, the Franco-German partnership, Vallourec & Mannesman (which is majority-owned by the German Salzgitter), has a joint venture with Sumitomo of Japan in V & M Star LP.

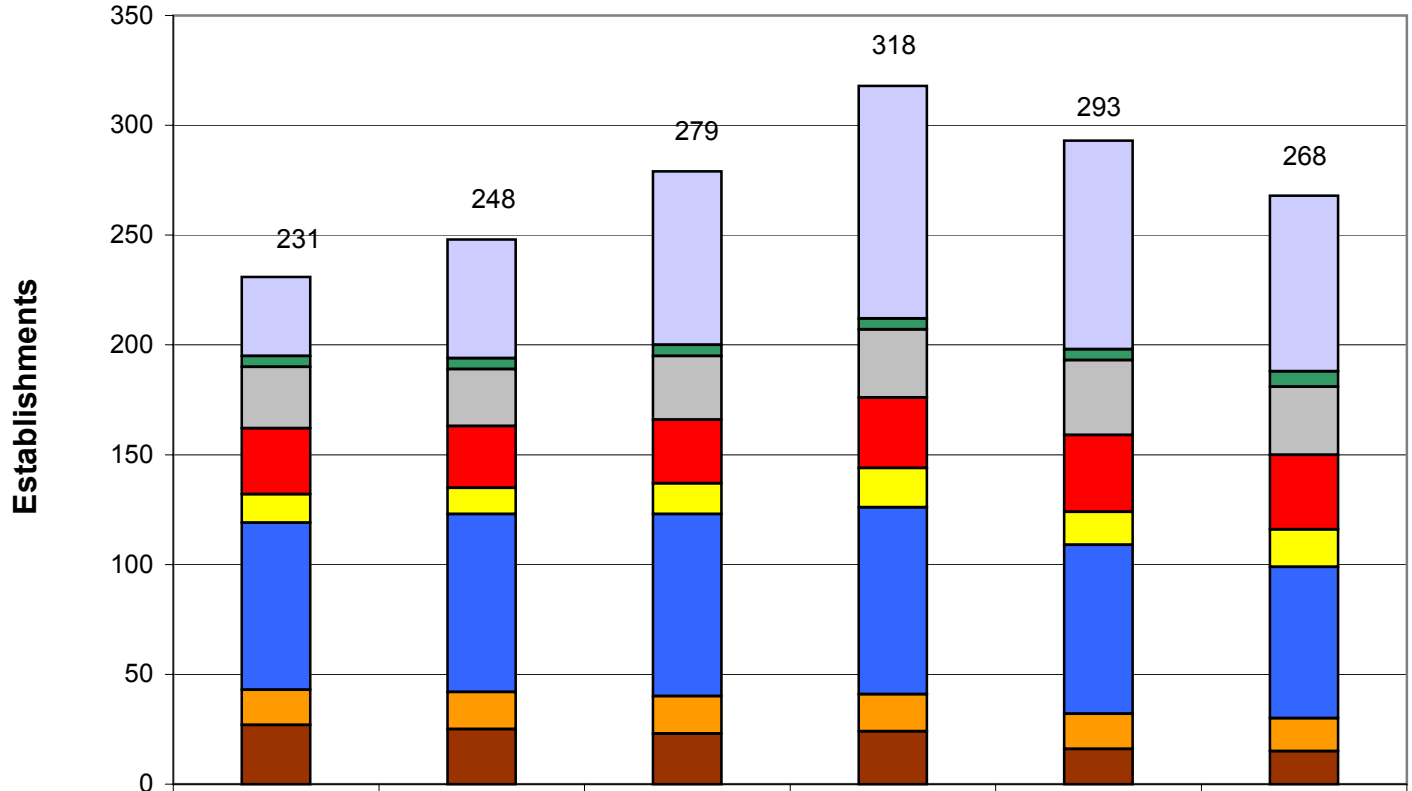
Foreign Parent(s) / Country & Partner(s)	Ohio Subsidiary	Co. Jobs
BHP Billiton* / Australia	North Star BlueScope Steel LLC	240
Corus Group / United Kingdom	Thomas Strip Steel Corp.	590
Dofasco, Inc. / Canada	Dofasco Marion, Inc.	115
	Dofasco Shelby (f.k.a. Copperweld/Shelby)	700
Eramet SA / France	Eramet Marietta, Inc.	650
Fette GmbH / Germany	LMT Fette, Inc.	150
Industrias CH, S.A. de C.V. / Mexico	Republic Engineered Products	2,375
Kobe Steel & United States Steel Corp.* / Japan & U.S.	Pro-Tec Coating Co., Inc.	230
Metalurgica Gerdau SA / Brazil	Ameristeel Bright Bar, Inc.	50
Mitsubishi Corp.* / Japan	Coilplus-Ohio, Inc.	55
Mittal Steel NV* (f.k.a. Ispat International) / Netherlands	Mittal (f.k.a. International Steel Group)	1,000
Nissho Iwai-Nichimen Holdings Corp. / Japan	BCS Cuyahoga LLC	65
(Salzgitter AG/(Vallourec & Mannesman AG)) & Sumitomo* (Germany/(France & Germany)) & Japan	V & M Star LP	440
TI Group PLC / United Kingdom	TI Group Automotive Systems Corp.	400

Notes: * - a Fortune Global 500 company; f.k.a. – formerly known as. Sources: American Business Directories (2003), Fortune (2005), Harris (2004), Larkin (2005), Lexis-Nexis (2005), OSR (2005a), various company websites.

The foreign parent companies or joint venture partners have headquarters in nine nations. Four are located in Japan, three in Germany, two each in France and the United Kingdom. Australia, Brazil, Canada, Mexico, and the Netherlands are home to one each. Altogether, the 16 companies employ about 7,060 people. Industrias CH is the single largest employer with 2,375. None of the subsidiary operations is a foundry.

TRENDS

Establishment Trends in Ohio's Iron & Steel Industry: 1998-2003



	1998	1999	2000	2001	2002	2003
331111: Iron & steel mills	36	54	79	106	95	80
331112: Electrometallurgical ferroalloys	5	5	5	5	5	7
33121: Iron, steel pipe & tubes	28	26	29	31	34	31
331221: Rolled steel shapes	30	28	29	32	35	34
331222: Steel wire drawing	13	12	14	18	15	17
331511: Iron foundries	76	81	83	85	77	69
331512: Steel investment foundries	16	17	17	17	16	15
331513: Steel foundries (exc. investment)	27	25	23	24	16	15

Source: U.S. Census Bureau.

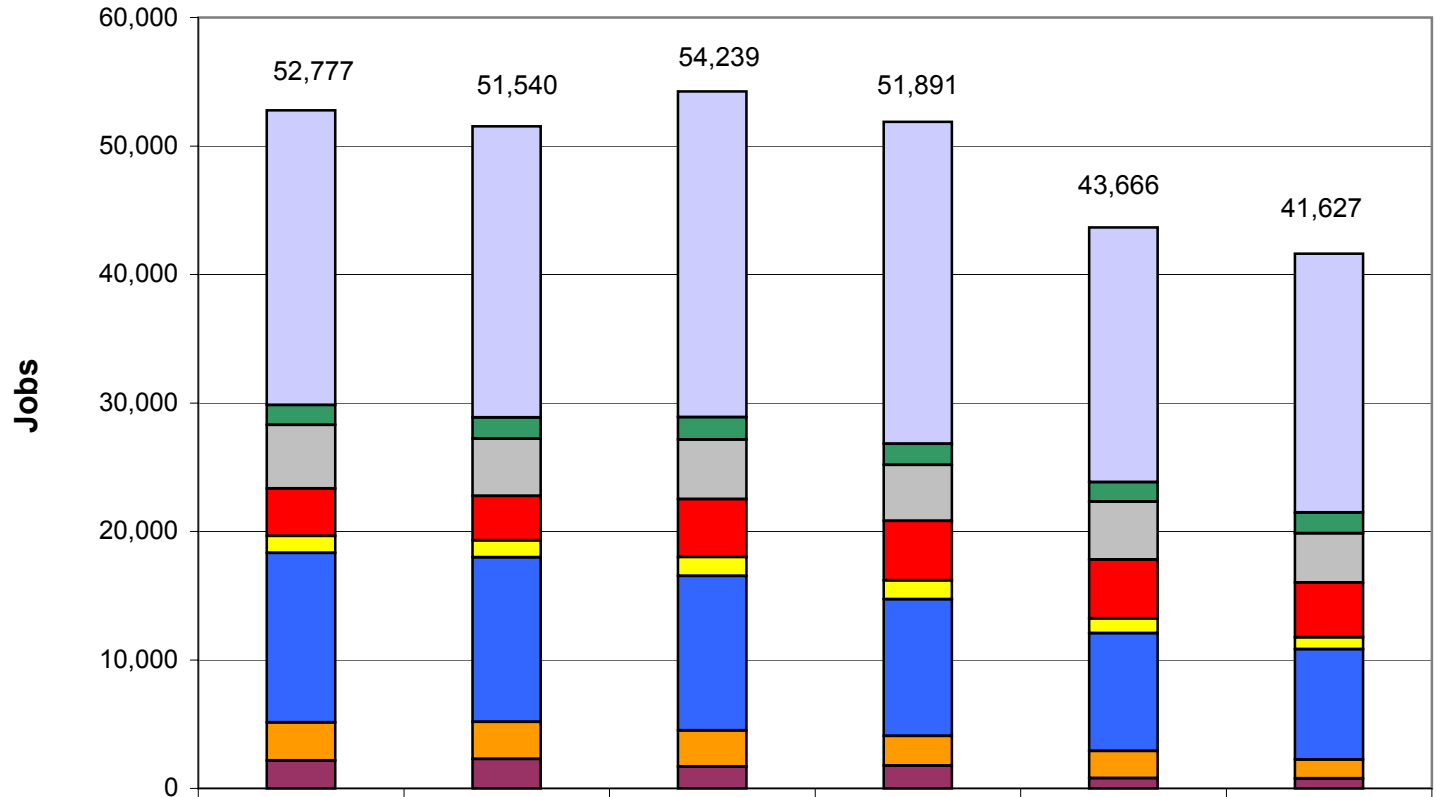
ESTABLISHMENTS

The chart above shows that the number of iron and steel industry establishments in Ohio actually rose from 231 in 1998 to 318 in 2001 before declining to 268 in 2003. This change is due mostly to the vastly increased number of iron and steel mills (NAICS 331111 – from 36 to 106 to 80). The rising counts of establishment in other industries were much smaller (33121, 331221, 331222 – manufacturing steel products from purchased steel), or showed little net change (331112, 331511, 331512 – ferroalloys and some foundries). Only non-investment steel foundries dropped significantly in number.

What was happening in Ohio was roughly akin to what was happening across America. The number of iron and steel mills increased dramatically from 1998 to 2001 with consecutive decreases in 2002 and 2003. The number of electro-metallurgical and ferroalloy plants fluctuated, ending lower in 2003 than in 1998. There was a more modest net increase in the number of establishments manufacturing products from purchased steel. Overall the number of foundries increased from 1998 to 2001, but those gains were more than offset by the losses that occurred in 2002 and 2003.

See Table A6

Employment Trends in Ohio's Iron & Steel Industry: 1998-2003



	1998	1999	2000	2001	2002	2003
331111: Iron & steel mills	22,948	22,669	25,351	25,061	19,822	20,159
331112: Electrometallurgical ferroalloys	1,531	1,637	1,750	1,639	1,531	1,624
33121: Iron, steel pipe & tubes	4,961	4,459	4,617	4,368	4,512	3,837
331221: Rolled steel shapes	3,676	3,466	4,515	4,631	4,583	4,263
331222: Steel wire drawing	1,321	1,338	1,465	1,465	1,139	913
331511: Iron foundries	13,197	12,791	12,037	10,650	9,154	8,579
331512: Steel investment foundries	2,983	2,894	2,805	2,310	2,132	1,488
331513: Steel foundries (exc. investment)	2,160	2,286	1,699	1,767	793	764

Source: U.S. Census Bureau.

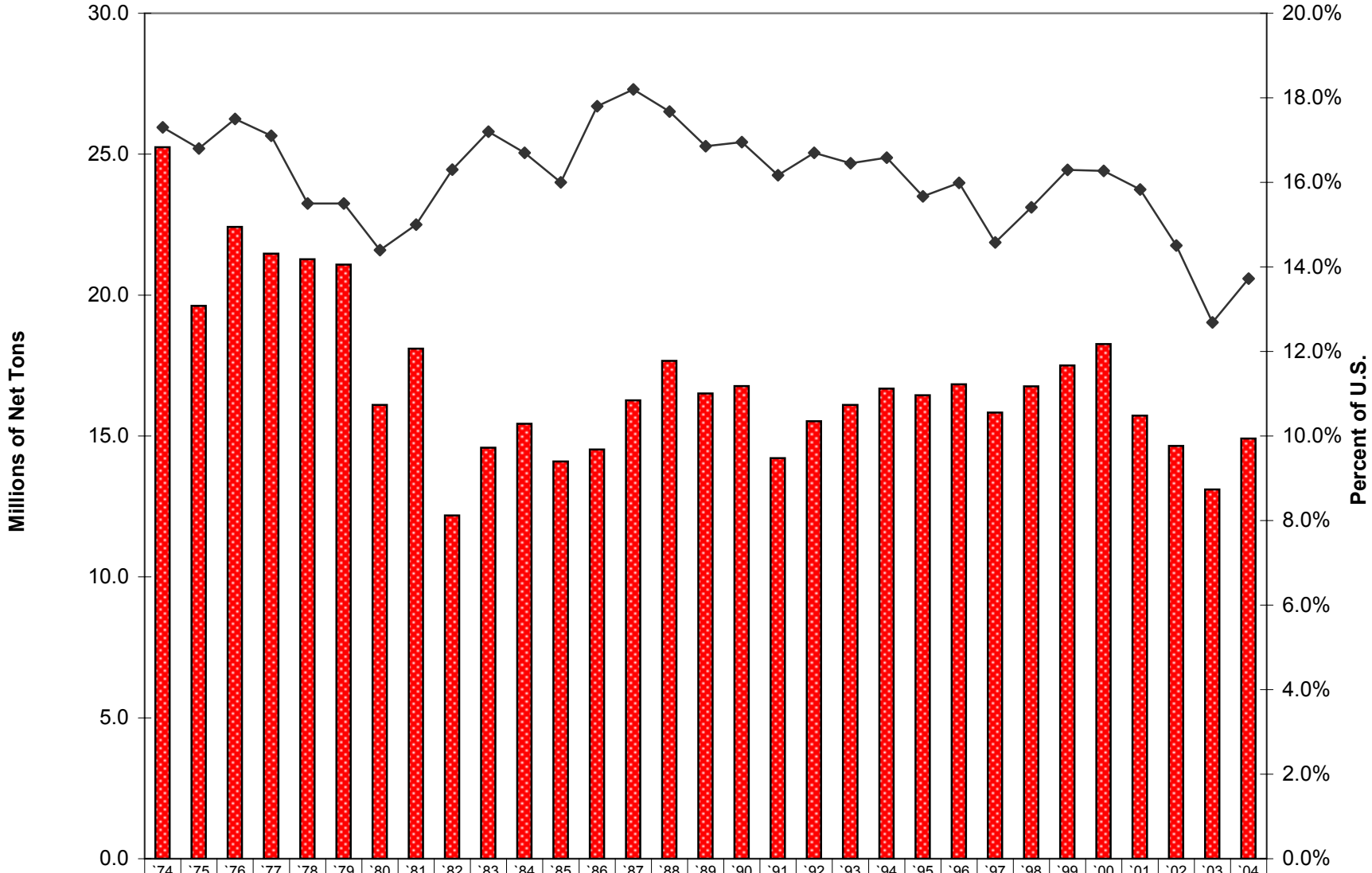
EMPLOYMENT

The chart above shows iron and steel industry employment fluctuated from 1998 to 2001 before dropping in 2002 and 2003. (Another way of interpreting the chart is to note industry employment peaking in 2000 and more or less decreasing every year thereafter.) The net change was a loss of 11,150 jobs. The greatest number of job losses occurred in iron foundries (NAICS 331151), which declined continuously from almost 13,200 to less than 8,600 – a 35 percent decrease. It was followed by a net loss of over 2,700 in iron and steel mills (331111) – a 12.2 percent decline. Other industries with net losses exceeding 1,000 jobs were steel foundries (331512 & 3) and pipe and tube production from purchased steel (33121).[5] However, the news was not uniformly bad for every constituent industry; the numbers of jobs in rolled steel shapes (331221) and electrometallurgical ferroalloy (331112) production fluctuated, but were greater in 2003 than in 1998. Nevertheless, the iron and steel industry as a whole suffered proportionately greater job losses than the encompassing manufacturing sector – 21.2 vs. 15.7 percent.

What happened in Ohio was more or less part of what happened across the country. Employment in every individual iron and steel industry was lower in 2003 than it was than it was in 1998. The proportional decline in the industry as a whole was greater than in manufacturing in general – 22.8 vs. 16.6 percent, and employment fell proportionately greater in foundries than in the other industry groups – 32 vs. 15.4 and 15.5 percent.

See Table A7

Raw Steel Production in Ohio, 1974-2004



	`74	`75	`76	`77	`78	`79	`80	`81	`82	`83	`84	`85	`86	`87	`88	`89	`90	`91	`92	`93	`94	`95	`96	`97	`98	`99	`00	`01	`02	`03	`04
Raw Steel Production	25.3	19.6	22.4	21.5	21.3	21.1	16.1	18.1	12.2	14.6	15.4	14.1	14.5	16.3	17.7	16.5	16.8	14.2	15.5	16.1	16.7	16.4	16.8	15.8	16.8	17.5	18.3	15.7	14.6	13.1	14.9
Percent of U.S.	17.3	16.8	17.5	17.1	15.5	15.5	14.4	15.0	16.3	17.2	16.7	16.0	17.8	18.2	17.7	16.9	17.0	16.2	16.7	16.5	16.6	15.7	16.0	14.6	15.4	16.3	16.3	15.8	14.5	12.7	13.7

Sources: American Iron and Steel Institute, International Iron and Steel Institute, Ohio Steel Industry Advisory Council.

RAW STEEL PRODUCTION

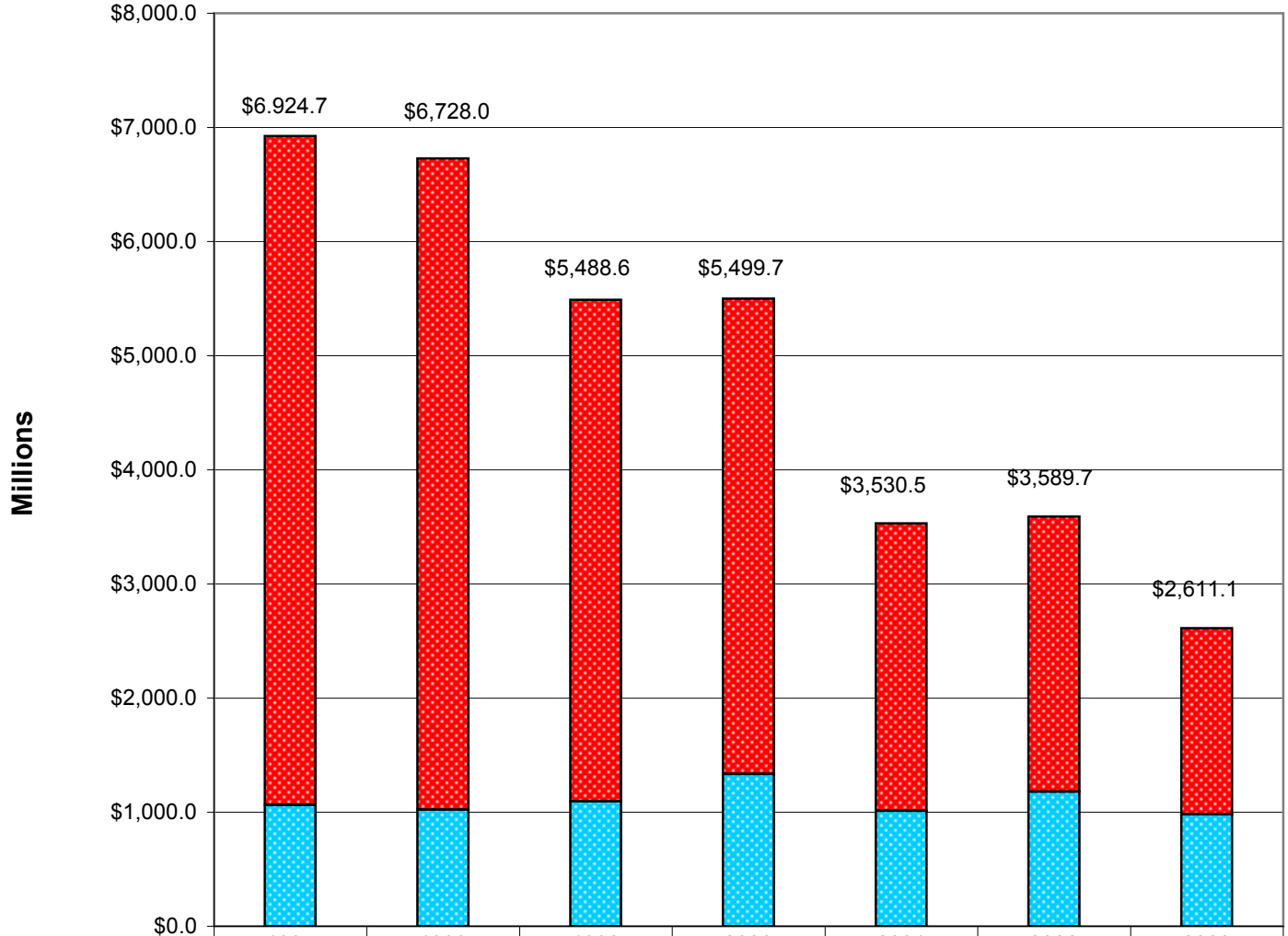
The chart above illustrates the last 31 years of raw steel production in Ohio, and with it, the changes and continuities that characterize the industry. One of these is the highly cyclical nature of the industry. Years associated with recessions – 1975, 1980, 1982, 1991, and 2000 – show notably lower levels of production when compared with the preceding years as well as the following years. Declines in other years, though, may reflect significant changes at individual facilities in the state; for example, a strike at WHX in 1997 or LTV's bankruptcy in 2002 and 2003. Raw steel production rose in the years following the resolution of the problems.

Another change evident above is not cyclical. With the bare exception of 1975, raw steel production in Ohio exceeded 20 million tons (MT) every year before 1980. (Additional data only shown in table A8 extend this back to 1969.) By contrast, production in Ohio has never been above 20MT after 1979. With the exceptions of 1982 and 2003 for reasons previously cited, production here has fluctuated between 14.1MT and 18.3MT from 1980 through 2004. This generally lower level of output is consistent with a structural change in the U.S. economy noted by industry analysts – less consumption of iron and steel. See the Overview of the Industry for further details.

Steel production in Ohio typically ranges from 14 to 17 percent of the national total despite the sometimes dramatic ups and down in tonnage. Only in the last two years has it dipped below that range. Ohio has ranked second only to Indiana in raw steel production since 1982. Bearing that in mind, the data show no definitive long-term trend away from production in Ohio.

See Table A8

Value-Added by Group in Ohio, 1997-2003



	1997	1998	1999	2000	2001	2002	2003
3311: Iron and Steel Mills and Ferroalloys	$5,861.7	$5,705.4	$4,393.5	$4,165.5	$2,517.7	$2,409.5	$1,631.3
3312: Steel Product Mfg. from Purchased Steel	$1,063.0	$1,022.6	$1,095.1	$1,334.1	$1,012.8	$1,180.2	$979.8

Source: U.S. Census Bureau.

VALUE ADDED – A BROADER MEASURE OF ECONOMIC OUTPUT

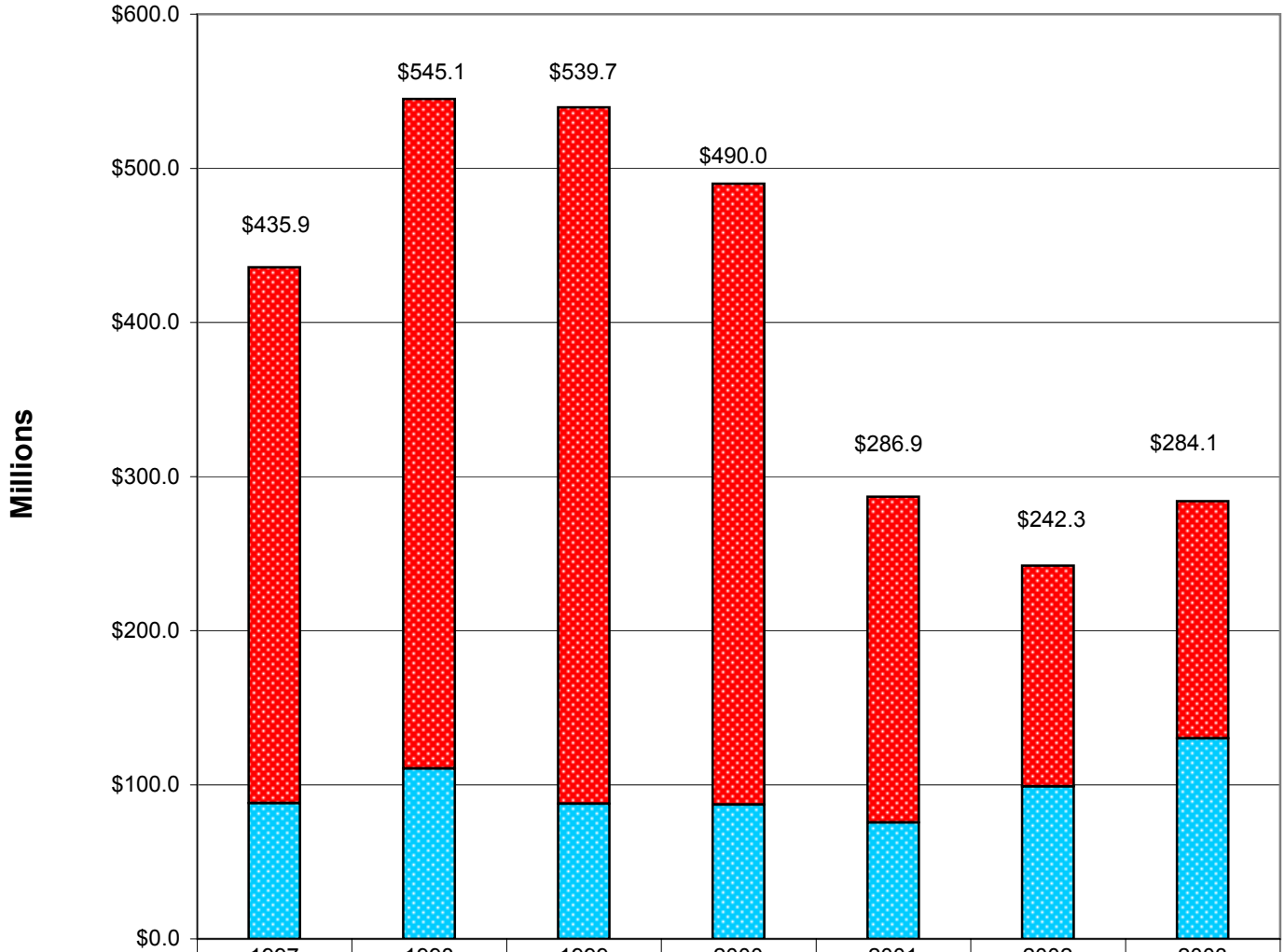
Value-added data are a broader measure of industrial activity than raw steel production alone because the former include iron and steel mill products, whether made at the mill or from purchased steel (NAICS 3311 and 3312, respectively.) (The Annual Survey of Manufactures does not publish annual figures for subgroups, including ferrous metal foundries – 33151.) The chart above shows an unmistakable decline in the value-added of raw steel, iron and steel mill products, and ferro-alloys (3311) in Ohio from 1997 onwards. In particular, this drop probably incorporates the effect of LTV's bankruptcy.

This is a stark contrast to the value-added in steel product manufacturing from purchased steel (3312), which fluctuated, but finished lower in 2003 than in 1997. While it was lower, it was not the 72 percent decline evidenced in iron and steel mills and ferroalloys. (Value-added figures are not adjusted for inflation; consequently the declines may be more serious than indicated.)

What happened in Ohio during this time was more or less what was happening throughout the American iron and steel industry. Data in the appendix table show drops of 30.8 percent iron and steel and ferroalloy production and 25.4 percent in products made from purchased steel. The net effect of the changes in Ohio and across the nation was that factories in Ohio played a smaller role in iron and steel and ferroalloy production, but manufacturing products from purchased steel became more concentrated here (U.S. Bureau of the Census, 2003a, 2005a). Whether things will return to the way they were with the resumption of production at some of LTV's former facilities remains to be seen.

See Table A9

Capital Expenditures by Group in Ohio, 1997-2003



	1997	1998	1999	2000	2001	2002	2003
3311: Iron and Steel Mills and Ferroalloys	$347.8	$434.6	$451.9	$402.9	$211.4	$143.4	$154.1
3312: Steel Product Mfg. from Purchased Steel	$88.1	$110.5	$87.8	$87.2	$75.5	$98.8	$130.1

Source: U.S. Census Bureau.

CAPITAL EXPENDITURES BY GROUP

Capital expenditures are funds spent for buildings and equipment used in manufacturing. The chart above shows capital expenditures in Ohio first rising from $435.9 million (M) in 1997 to around $540M in 1998 and 1999 before dropping to about $285M in 2001 and 2003. The vast majority of expenditures went for iron, steel, and ferroalloy production (NAICS 3311), and the net change in such group expenditures was a decline of nearly 56 percent. This is a marked contrast with the recent history of steel products made from purchased steel (NAICS 3312); capital expenditures for this group fluctuated but ended 47 percent higher in 2003 than 1997. Again, caution is warranted when interpreting these figures because they have not been adjusted for inflation.

Data in appendix table A10 for the nation as a whole show capital expenditures in the two groups declining each year from 1997 onward – and by larger percentages than characterize Ohio. The net effect is that the proportion of capital expenditures made in Ohio fluctuated, but ended higher in 2003 than in 1997.

Capital expenditures in Ohio by companies have varied by industry group in another way. Those for iron and steel mills and ferroalloys have been, on average, less than proportional to the value-added originating here – 16.7 vs. 19.5 percent, respectively, of national totals. Those for steel products made from purchased steel have been more than proportional to the value-added here, averaging 20.7 vs. 17.5 percent of the national totals. Overall, the proportion of industry expenditures going into Ohio averaged only 92 percent of the proportion of value-added here (U.S. Bureau of the Census, 2003a, 2005a).

As with value-added, annual capital expenditure data for the ferrous metal foundries subgroup (NAICS 33151) are not available from the Annual Survey.

See Tables A9 & A10

OVERVIEW AND FORECASTS

AN OVERVIEW OF THE INDUSTRY

Steel production in 2004 was substantially higher than in 2003, with capacity utilization rates significantly higher. This reflects the strength of key markets and a generally strong economy. However, the supply of steel remained tight for consumers due to the scarcity of raw materials, particularly ferrous scrap (Larkin, 2005).

The strong upswing in 2004 illustrates the cyclical character of the industry and its sensitivity to changes in demand from key markets as well as to the overall strength or weakness of the economy. The key markets for the industry are service/distribution centers[6] (26.9 percent of all shipments in 2003), construction (22.4 percent), motor vehicles (15.0 percent), converting and processing (8.9 percent), containers (2.9 percent), exports (2.7 percent), oil and gas (2.0 percent), appliances (1.9 percent), machinery (1.1 percent), and electrical equipment (1.0 percent). All other uses account for the remaining 15.1 percent of shipments (Larkin, 2005).

Overall, the iron and steel industry tends to experience the most growth in demand late in the business cycle, due to the relatively greater impact of capital goods demand. (The demand for capital goods such as non-residential construction occurs late in the business cycle, and minimills dominate the market for steel used in construction.) Primary producers, though, are more closely tied to consumer durables – particularly cars and light trucks – than are minimills, and consequently are more of an early-cycle industry (Larkin, 2005).

Beyond the business cycle, though, the iron and steel industry of today differs from that of years ago. Iron and steel production was a vertically integrated process dominated by large companies for much of the 20th century. The companies owned the materials and equipment used at each step of the process. These included the mines for iron ores, coal, and flux production, the coke ovens, blast furnaces and breakdown mills, and the service/distribution centers for steel slitting and sales to end users. Today, only U.S. Steel could be described as integrated since all of the remaining companies have divested some of their assets,[7] and the industry plays a smaller role in the economy. Three factors are thought to largely explain this change: the rise of minimills, the rise of imports, and declining demand for steel – particularly by the motor vehicle industry (Larkin, 2003, 2005). How each changed the industry is briefly described below.

Minimills make steel by recycling ferrous scrap in electric arc furnaces. (They may substitute directly reduced iron when scrap prices are high.) Doing so means that they avoid the costs associated with blast furnaces, coke ovens and equipment to handle raw materials. Consequently, their capital costs are much lower than primary producers – about $500 per net ton of capacity vs. $2,000. This, combined with a leaner management structure, and more flexible, less costly labor arrangements, allows minimills to undercut the prices primary producers would charge for the same products. Minimills were initially limited to lower-quality commodity products. However, as their quality improved, they took progressively

larger shares of the overall market from primary producers, forcing the latter to abandon markets for specific steel products and even close facilities. Minimills accounted for about one-twelfth of raw steel production in 1960; by 2004, they accounted for just over one-half (American Iron and Steel Institute, 1970-2004; Larkin, 2005).

Imports began taking a larger share of the American market in the 1960s initially because foreign producers had more efficient equipment and lower labor costs. Other factors contributing to their market share are the subsidies supporting some foreign producers and the relative openness of the U.S. market (Larkin, 2003). Regardless of the reason why, consumers of steel products in America like imports because inexpensive steel helps them compete at home and abroad. Imports have become an integral part of steel supplies, and their elimination would cause problems for steel consumers because domestic steel makers usually lack the capacity to replace imports. Put differently, the consumption of steel mill products has been greater than domestic capacity in eight of the 11 latest years for which data are available (1993-2003). During these same 11 years, imports ranged from 18.7 to 30.0 percent of apparent supply (which is equivalent to consumption), averaging 24.3 percent (Larkin, 2005).[8]

Motor vehicles directly and indirectly comprise about 25 percent of the market for steel products. Two interrelated factors help explain the reduced demand for iron and steel by U.S.-based motor vehicle industry companies: (1) the increase in imported motor vehicles displaced sales of U.S.-brand vehicles, and imported vehicles do not use domestically made iron and steel; and (2) the drive by assemblers to improve fuel efficiency. The easiest way to improve fuel efficiency is to reduce the weights of vehicles. To this end, motor vehicle manufacturers made vehicles smaller and replaced some iron and steel components with ones made from aluminum, plastics, or even ceramics.[9] However, the shift of consumer preferences toward light trucks mitigated the losses of iron and steel makers because trucks use more steel (Larkin, 2005).

Primary iron and steel producers responded to these challenges in a variety of ways. Technological advances improved the efficiency of steel making with associated cost reductions. Steel makers also developed lighter and stronger steel products to compete with alternative materials, and near net shape casting reduced the need for machining parts. (See the Primer on Iron and Steel Production Processes in the Appendix.) Consequently, iron and steel makers regained some of the business lost to manufacturers of alternative materials. Many steel makers have sought to stem steel imports by using tariffs to counter allegedly unfair trade practices. Almost all primary producers have divested some assets such as mines, coke ovens, or distribution/service centers in efforts to reduce fixed costs.[10] Some companies went so far as to largely abandon primary production and concentrate on the production of specialty steels. (Larkin, 2005).

These responses to the challenges primary producers faced have been qualified successes. Technical advances such as intermediate- and thin-slab and strip casting may have benefited minimills even more than primary producers. These innovations eliminated the need for high-cost reducing stands and consequently lowered the capital needed to compete in

markets for higher quality goods such as pipes, plates, strips and sheets. Such items were the last exclusive domain of primary producers. Nevertheless, primary producers remain the source for the highest-grade goods (Larkin, 1994, 1995, 2005).

While U.S.-based steel companies have sought and received tariffs to counter what they claim are unfair trade practices, foreign producers and domestic steel consumers have successfully argued their cases in response. Consequently, the administration has granted tariff requests and subsequently granted exemptions from those tariffs. In addition, at least one international organization has ruled an American steel tariff unjustified. Therefore, it seems that U.S.-based steel companies cannot rely on tariffs alone to deal with foreign competition. The weakening dollar and high demand elsewhere – particularly in China – may have staved off further imports for the time being, but foreign competition remains significant and formidable for domestic producers (Larkin, 2003, 2005).

The divestiture of assets reduced fixed costs for primary producers, but the rising costs of raw materials have some considering acquiring mines to hold down costs.[11] In addition, the closure of excess capacity had an unanticipated consequence: some companies, beginning in the early 1990s, had to import steel slabs for further processing because they lacked the primary production facilities to meet increased demand. This problem was exacerbated when the value of the dollar dropped (Larkin, 2005).

Despite all of the changes by primary producers, the last downturn of the industry – combined with the gains of minimills in the sheet market – forced a number of them into bankruptcy. Some had been in bankruptcy before, but this time a number of companies did not emerge. Instead, their assets were purchased. This was facilitated by the Pension Benefit Guaranty Corp.'s (PBGC's) assumption of their pension plans and health care benefits.[12] The most notable example in Ohio was the purchase of LTV's assets by the International Steel Group (ISG). (ISG also acquired at least some of the assets of Bethlehem and Weirton.) Larkin (2005: 11) emphasizes the significance of the PBGC's move, noting the cost advantages accruing to acquiring companies not assuming the old pension and benefit plans of the acquired companies compared with ones that do. He continues by citing the example of ISG: the company's management structure resembles that of a minimill, and it produces about 90 percent of what LTV did with only about one-fourth the production workers. In these senses, the consolidation of the industry – including minimills as well as primary producers – has resulted in cost reductions and greater competition. Furthermore, financially strong companies may resist both the pressure to maintain high-output during times of weak demand in an effort to keep per-unit operating costs low as well as capacity expansions when demand peaks during the cycle.

Changes of this sort are part of a larger trend of international consolidation of the industry. Again, the most notable example from Ohio was ISG's recent merger with Ispat International NV to form Mittal Steel NV. Fortune (2005) lists Mittal

as one of the largest metal companies in the world, and certainly the most profitable in 2004. Larkin (2005) speculates that the international nature of the mergers may help mitigate trade disputes; if a foreign-based company experiences a weak home market, would it aggressively ship products to America when such shipments would hurt its American operations? Mittal Steel's recent announcement that it will reduce its global steel production by one million tons in the third quarter of this year but will not focus on just one area of the world (AP, 2005) is consistent with this idea.

THE NEAR AND LONG TERM FORECASTS

Industry growth is not expected to be as great in 2005 as it was in 2004 for several reasons. Since industry output closely tracks changes in the economy overall, the lower growth rate forecast for the nation probably means that industry output this year is not expected to rise as much as it did last year. More specific explanations focus on the major markets for steel mill products: service-distribution centers have rebuilt their inventories from unusually low levels, motor vehicle sales are expected to be only slightly greater, and construction activity is expected to rise modestly (Larkin, 2005).

The near-term prospects for primary producers are not bad. The recent rise in scrap steel prices (due in part to the torrid demand from China) limits the ability of minimills to challenge them on the basis of price. Consequently, further gains by minimills at the expense of primary producers are limited at this time. Demand from China, along with the weaker value of the dollar and higher costs of materials and shipping, are also diverting imports from America (Larkin, 2005).

However, the longer-term outlook for primary producers is more problematic because they may not be able to count on high prices – whether of scrap, raw steel, or finished products – to stay in business. Furthermore, imports into the U.S. may rise again because China's import demand may fall in the near future. If China becomes a net exporter of steel as expected, and barring any unforeseen increases in consumption or decreases in production, Chinese steel production may contribute to a global glut, and that would put pressure on domestic producers. Consequently, primary producers will continue to seek cost reductions wherever they can find them: by consolidating operations, adopting more flexible work rules, and reducing the number of employees (AP, 2005; Larkin, 2005).

Other factors previously mentioned will continue to affect the industry over the long term. Producers of plastics and especially aluminum may continue to make inroads into the markets of steel producers, but at a slower rate than in the past because all of the easy substitutions have been made. It is unlikely, though, that aluminum and plastics will further displace iron and steel in motor vehicles in the near term for two reasons: all of the easy substitutions have been made, and steel is easier to recycle than are automotive plastics. Technological improvements may benefit minimills more than primary producers, allowing the former to make further gains in the sheet market (Larkin, 2003, 2005).

These long term challenges may be why Berman (2004) forecasts average annual rates of growth for the two iron and steel groups that are slower than for the U.S. economy as a whole: 1.4 percent for iron, steel, and ferroalloy production (NAICS 3311), and 1.5 percent for products made from purchased steel (3312) vs. 3.3 for the decade of 2002-2012. If these forecasts for the two groups come to pass, they would be an improvement from the preceding decade (1992-2002) during which iron, steel and ferroalloy production grew at an average annual rate of .4 percent, and output of products made from purchased steel was lower in 2002 than in 1992. (The U.S. economy grew at an average annual rate of 3.3 percent dur-

ing the decade.) Nevertheless, the iron and steel industry is expected to play a relatively smaller role in the economy than in the past.

Unfortunately, the improved forecasts for the industry groups are not expected to translate into more industry jobs. Berman (2004) predicts employment in iron and steel mills and ferroalloys will fall from 107,000 in 2002 to 76,000 in 2012 – a 29.0 percent drop, and employment in products made from purchased steel will decline by 3,000 to 60,000 – or 4.8 percent – during the same time. The Ohio Dept. of Job and Family Services' Bureau of Labor Market Information (ODJFS-BLMI, 2004) predicts proportionally similar declines for the same time period. Employment in iron and steel mills and ferroalloys is forecast to fall from 15,200 to 11,600 – or 23.7 percent, and employment in products made from purchased steel will decline by 700 to 10,400 – about 6.3 percent.

Although some e-commerce sites have failed, over the long term the Internet is expected to make the metals markets more transparent with the abundant information provided to buyers and sellers. Use of the Internet may reduce administrative and sales expenses. E-commerce probably will diminish the role of warehouses, but the distribution centers that add value will remain (Larkin, 2005).

See Table A11

APPENDICES

DETAILED TABLES

Table A1: Expansion and Attraction Announcements in Ohio's Iron and Steel Industry, 2002-2004

Year	Parent/Company/Division	County	NAICS Code	Product	New or Expansion	Amount Investment	Anticipated New Jobs	Space (Sq.Ft.)
2002	AK Steel Holding Corp./AK Steel Corp.	Muskingum	331111	Steel coils	Expansion	$4,500,000		
2002	Charter Manufacturing Co./Charter Steel	Cuyahoga	331111	Steel rod & wire	Expansion	$26,000,000	64	
2002	Cold Metal Products	Putnam	331111	Steel processing	Expansion	$2,200,000	24	
2002	J&L Specialty Steel	Stark	331111	Steel	Expansion	$2,800,000		
2002	Mittal NV	Cuyahoga	331111	Steel	Expansion	$38,200,000		
2002	Renco Group, Inc./WCI Steel, Inc.	Trumbull	331111	Steel	Expansion	$5,100,000		
2002	Wheeling-Pittsburgh Steel Corp.	Jefferson	331111	Steel	Expansion	$119,000,000		
2002	John Maneely Co.	Trumbull	33121	Steel tubes	Expansion	$6,081,000	10	
2002	Sawmill Tubular	Trumbull	33121	Steel tubes	Expansion	$10,000,000	25	
2002	Sharon Tube Co.	Trumbull	33121	Steel tubes	Expansion	$10,500,000	10	
2002	Ferrous Metal Processing Co.	Cuyahoga	331221	Steel finishing	Expansion	$5,500,000	50	25,000
2002	Marion Steel Co.	Marion	331221	Steel bar	Expansion	$3,000,000		
2002	Republic Engineered Products	Lorain	331221	Steel bar	Expansion	$16,500,000		
2002	Subtotals					$249,381,000	183	25,000
2003	Nissho Iwai-Nichimen Holdings Corp./BCS Cuyahoga LLC	Cuyahoga	331111	Steel wire	New	$13,200,000	110	
2003	Steel Technologies Corp.	Putnam	331111	Steel	Expansion	$3,500,000	35	
2003	Eramet SA/Eramet Marietta, Inc.	Washington	331112	Ferro Manganese	Expansion	$20,000,000		
2003	Dofasco/Dofasco Marion, Inc.	Marion	33121	Steel tubes	Expansion	$7,700,000	18	120,000
2003	U.S. Steel/Lorain Tubular	Lorain	33121	Steel tubes	Expansion	$7,600,000		
2003	General Motors Corp.	Defiance	331511	Engine blocks	Expansion	$22,100,000		
2003	Liberty Casting Co. LLC	Delaware	331511	Foundry	Expansion	$1,000,000	60	
2003	Technocast	Wayne	331511	Metal casting	Expansion	$2,600,000	38	
2003	Alliance Castings	Stark	331513	Rail castings	New	$14,000,000	400	
2003	Columbus Steel Castings	Franklin	331513	Steel castings	Expansion	$13,500,000	200	
2003	Subtotals					$105,200,000	861	120,000
2004	AK Steel Holding Corp./AK Steel Corp.	Butler	331111	Steel	Expansion	$65,000,000		
2004	Charter Manufacturing Co./Charter Steel	Cuyahoga	331111	Steel rods/wire	Expansion	$90,000,000		
2004	Mittal NV	Cuyahoga	331111	Steel	Expansion	$10,000,000	140	
2004	Mittal NV	Cuyahoga	331111	Galvanized steel	Expansion	$40,000,000	50	
2004	New Dimension Metals Corp.	Montgomery	331111	Steel	Expansion	$1,200,000		
2004	Republic Engineered Products	Stark	331111	Steel	Expansion	$54,000,000		
2004	Salzgitter AG & Sumitomo/V & M Star LP	Mahoning	331111	Steel	Expansion	$5,000,000		
2004	Steel Technologies Corp.	Putnam	331111	Steel processing	Expansion	$6,000,000	10	70,000
2004	Ambassador Steel	Marion	33121	Steel pipe	New	$1,200,000	16	27,000
2004	Parker Hannifin Corp.	Franklin	33121	Steel tubes	Expansion	$1,500,000		12,000
2004	CANDO	Marion	331511	Steel foundry	New	$4,000,000	75	
2004	Columbus Steel Castings	Franklin	331511	Steel castings	Expansion	$4,800,000	25	
2004	General Motors Corp.	Defiance	331511	Iron castings	Expansion	$58,400,000		
2004	Subtotals					$341,100,000	316	109,000
Grand totals 2002-2004						$695,681,000	1,360	254,000

Source: Office of Strategic Research (2005b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (JK, DL, 7/05).

Table A2a: Distribution of Iron and Steel Value-Added in Ohio, 2002

NAICS Code	Industries	Value Added (in millions)	Percent Distri-bution
	Iron & steel industry	$4,412.9	100.0%
3311	Iron & steel mills & ferroalloys	$2,409.5	54.6%
331111	Iron & steel mills	$2,214.7	50.2%
331112	Electrometallurgical ferroalloy products	$194.8	4.4%
3312	Steel product mfg. from purchased steel	$1,180.2	26.7%
33121	Iron, steel pipe & tube mfg. from purchased steel	$423.0	9.6%
33122	Rolling & drawing of purchased steel	$757.2	17.2%
331221	Rolled steel shapes	$633.5	14.4%
331222	Steel wire drawing	$123.7	2.8%
33151	Ferrous metal foundries	$823.2	18.7%
331511	Iron foundries	$569.2	12.9%
331512	Steel investment foundries	$152.3	3.5%
331513	Steel foundries (exc. investment)	$101.6	2.3%

Abbreviations: exc. - except; mfg. - manufacturing.

Source: U.S. Bureau of the Census (2005c).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 8/05).

Table A2b: Value-Added in Iron and Steel Industries in Ohio and the U.S., 2002

NAICS Code	Industry Title	Value-added ($1,000,000s) Ohio	U.S.	Ohio as Percent-age of U.S.	Ohio's Apparent^ Rank	Top 5 States
331111	Iron and steel mills	$2,352.3	$18,276.9	12.9%	2	IN, **OH**, TX, TN*
331112	Electrometallurgical ferroalloy product mfg.	$194.8	$288.3	67.6%	1	**OH***
33121	Iron and steel pipe and tube mfg. from purchased steel	$423.0	$2,509.9	16.9%	2	PA, **OH**, IL, CA, AR
331221	Rolled steel shape mfg.	$590.2	$1,622.2	36.4%	1	**OH**, PA, IN, NY, MI
331222	Steel wire drawing	$123.7	$1,559.5	7.9%	3	CA, MO, **OH**, PA, IN
331511	Iron foundries	$1,087.5	$6,205.2	17.5%	1	**OH**, WI, IN, MI, AL
331512	Steel investment foundries	$152.3	$1,429.4	10.7%	2	MI, **OH**, CA, TX, WI
331513	Steel foundries (exc. investment)	$101.6	$1,367.7	7.4%	5	WI, OR, MI, TX, **OH**

Notes: ^ - Data for one or more states may have been suppressed, and, if available, could change the rank.
* - No additional states were ranked. Abbreviations used: exc. - except or excluding; mfg. - manufacturing.

Source: U.S. Bureau of the Census (2005d).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 6/05).

Table A2c: Value of Shipments for Selected Iron and Steel Product Classes in Ohio and the U.S., 2002

NAICS Code	Product Class Title	Value of Shipments ($1,000,000s) Ohio	U.S.	Ohio as Percentage of U.S.	Ohio's Apparent^ Rank	Top 5 States
3311111	Coke oven and blast furnace products, made in steel mills	$6.0	$1,352.0	0.4%	2	IN, **OH***
3311113	Steel ingots and semifinished shapes and forms, made in steel mills	$687.3	$3,922.2	17.5%	1	**OH**, IN*
3311115	Hot rolled steel sheet and strip (inc. tin mill products, tin plate, blackplate, temeplate, and tin-free steel), made in steel mills	$2,819.9	$17,374.0	16.2%	2	IN, **OH***
3311117	Hot rolled steel bars and bar shapes, plates, structural shapes, and piling (inc. concrete reinforcing and tool steel bars), made in steel mills	$1,267.7	$10,690.2	11.9%	1	**OH**, IN, TX*
331111B	Steel pipes and tubes, made in steel mills producing semifinished shapes or plate	$758.2	$1,857.1	40.8%	1	**OH**, IN*
331111D	Cold rolled steel sheet and strip, made in steel mills producing hot rolled sheet or strip	$492.1	$8,051.7	6.1%	2	IN, **OH***
3311125	Other ferroalloys	$494.1	$651.3	75.9%	1	**OH***
3312211	Colded rolled sheet and strip, made from purchased steel	$1,329.9	$3,583.5	37.1%	1	**OH**, MI, IN, NY, CT
3312213	Cold finished steel bars and bar shapes, made from purchased steel	$136.1	$1,024.5	13.3%	2	MI, **OH**, IN, PA*
3312221	Noninsulated ferrous wire rope, cable, and fabricated wire rope assemblies (inc. lifting slings), made in plants that draw wire	$26.7	$943.4	2.8%	4	MO, PA, TX, **OH***
3312225	Steel wire, including galvanized and other coated wire, made in plants that draw wire	$94.2	$1,559.8	6.0%	3	CA, IN, **OH**, IL, PA
331222B	Other ferrous wire products (exc. springs), made in plants that draw wire	$158.9	$567.3	28.0%	1	**OH**, CA, PA, MO*
3315113	Other ductile iron castings	$360.4	$2,948.4	12.2%	2	WI, **OH**, IN, MI, IL
3315119	Other gray iron castings	$1,107.6	$4,643.3	23.9%	1	**OH**, IN, MI, WI, IL
3315131	Other carbon steel castings, exc. investment	$106.4	$1,063.4	10.0%	1	**OH**, MI, WI, PA, TX
3315133	High alloy steel castings, exc. investment	$26.9	$600.6	4.5%	6	WI, OR, MI, PA, TX
3315135	Other alloy steel castings, exc. investment	$18.6	$554.6	3.4%	4	TX, PA, MI, **OH**, WI

Notes: ^ - Data for one or more states may have been suppressed, and, if available, could change the rank; * - No additional states were ranked.
Abbreviations used: exc. - except or excluding; inc. - including.

Source: U.S. Bureau of the Census (2005d).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 6/05).

Table A2d: Value-Added in the Iron and Steel Industry by Group, 2003 (in millions)

Area	Subtotal	Industry Group* 3311	3312
U.S.	$22,648.3	$17,600.3	$5,047.9
Alabama	$728.8	$728.8	$0.0
Alaska	$0.0	$0.0	$0.0
Arizona	$0.0	$0.0	$0.0
Arkansas	$772.9	$622.3	$150.6
California	$1,081.3	$917.7	$163.6
Colorado	$295.5	$295.5	$0.0
Connecticut	$0.0	$0.0	$0.0
Delaware	$0.0	$0.0	$0.0
District of Columbia	$0.0	$0.0	$0.0
Florida	$0.0	$0.0	$0.0
Georgia	$0.0	$0.0	$0.0
Hawaii	$0.0	$0.0	$0.0
Idaho	$0.0	$0.0	$0.0
Illinois	$1,299.5	$935.5	$363.9
Indiana	$4,392.3	$4,075.8	$316.5
Iowa	$0.0	$0.0	$0.0
Kansas	$0.0	$0.0	$0.0
Kentucky	$771.2	$771.2	$0.0
Louisiana	$0.0	$0.0	$0.0
Maine	$0.0	$0.0	$0.0
Maryland	D	D	$0.0
Massachusetts	$0.0	$0.0	$0.0
Michigan	$795.2	$549.8	$245.4
Minnesota	$0.0	$0.0	$0.0
Mississippi	$0.0	$0.0	$0.0
Missouri	$165.7	$0.0	$165.7
Montana	$0.0	$0.0	$0.0
Nebraska	$0.0	$0.0	$0.0
Nevada	$0.0	$0.0	$0.0
New Hampshire	$0.0	$0.0	$0.0
New Jersey	$0.0	$0.0	$0.0
New Mexico	$0.0	$0.0	$0.0
New York	$550.4	$412.1	$138.3
North Carolina	$0.0	$0.0	$0.0
North Dakota	$0.0	$0.0	$0.0
Ohio	$2,611.1	$1,631.3	$979.8
Oklahoma	$178.5	$0.0	$178.5
Oregon	$0.0	$0.0	$0.0
Pennsylvania	$4,184.4	$3,335.2	$849.2
Rhode Island	$0.0	$0.0	$0.0
South Carolina	$538.3	$538.3	$0.0
South Dakota	$0.0	$0.0	$0.0
Tennessee	$211.6	$0.0	$211.6
Texas	$795.7	$655.3	$140.4
Utah	$0.0	$0.0	$0.0
Vermont	$0.0	$0.0	$0.0
Virginia	$144.0	$144.0	$0.0
Washington	$0.0	$0.0	$0.0
West Virginia	$432.1	$432.1	$0.0
Wisconsin	$149.9	$0.0	$149.9
Wyoming	$0.0	$0.0	$0.0

Notes: D - Suppressed to maintain confidentiality. $0.0. - may only indicate that the state and industry combination was too small to be covered by the survey. * - No data available for ferrous metal foundries (NAICS 33151).

Source: U.S. Bureau of the Census (2005a).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 6/05).

Table A3: Iron and Steel Industry Establishments and Employment, 2003 Means and Percentages

NAICS Code	Industries	Ohio			U.S.			Ohio as a Percentage of U.S.	
		Number of Establishments	Number of Employees	Mean per Establishment	Number of Establishments	Number of Employees	Mean per Establishment	Establishments	Employment
	Total Covered Employment	270,255	4,770,283	17.7	7,254,745	113,398,043	15.6	3.7%	4.2%
	Iron & steel industry	268	41,627	155.3	2,708	270,090	99.7	9.9%	15.4%
3311	Iron & steel mills & ferroalloys	87	21,783	250.4	876	125,871	143.7	9.9%	17.3%
331111	Iron & steel mills	80	20,159	252.0	853	123,543	144.8	9.4%	16.3%
331112	Electrometallurgical ferroalloy products	7	1,624	232.0	23	2,328	101.2	30.4%	69.8%
3312	Steel product mfg. from purchased steel	82	9,013	109.9	828	52,401	63.3	9.9%	17.2%
33121	Iron, steel pipe & tube mfg. from purchased steel	31	3,837	123.8	221	20,181	91.3	14.0%	19.0%
33122	Rolling & drawing of purchased steel	51	5,176	101.5	607	32,220	53.1	8.4%	16.1%
331221	Rolled steel shapes	34	4,263	125.4	226	13,079	57.9	15.0%	32.6%
331222	Steel wire drawing	17	913	53.7	381	19,141	50.2	4.5%	4.8%
33151	Ferrous metal foundries	99	10,831	109.4	1,004	91,818	91.5	9.9%	11.8%
331511	Iron foundries	69	8,579	124.3	623	62,382	100.1	11.1%	13.8%
331512	Steel investment foundries	15	1,488	99.2	147	15,036	102.3	10.2%	9.9%
331513	Steel foundries (exc. investment)	15	764	50.9	234	14,400	61.5	6.4%	5.3%

Abbreviations: exc. - except; mfg. - manufacturing.

Source: U.S. Bureau of the Census (2005b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 8/05).

Table A4: Iron and Steel Industry Employment and Payroll, 2003 Means and Ratios

NAICS Code	Industries	Ohio			U.S.			Ratio: Ohio to U.S. Means
		Number of Em-ployees	Annual Payroll ($millions)	Mean per Employee	Number of Em-ployees	Annual Payroll ($millions)	Mean per Employee	
	Total Covered Employment	4,770,283	$157,464.9	$33,010	113,398,043	$4,040,888.8	$35,635	92.6%
	Iron & steel industry	41,627	$1,968.8	$47,295	270,090	$12,513.0	$46,329	102.1%
3311	Iron & steel mills & ferroalloys	21,783	$1,001.2	$45,963	125,871	$6,627.6	$52,654	87.3%
331111	Iron & steel mills	20,159	$918.9	$45,583	123,543	$6,507.4	$52,673	86.5%
331112	Electrometallurgical ferroalloy products	1,624	$82.3	$50,678	2,328	$120.1	$51,598	98.2%
3312	Steel product mfg. from purchased steel	9,013	$388.1	$43,062	52,401	$2,042.5	$38,978	110.5%
33121	Iron, steel pipe & tube mfg. from purchased steel	3,837	$149.2	$38,894	20,181	$818.0	$40,533	96.0%
33122	Rolling & drawing of purchased steel	5,176	$238.9	$46,152	32,220	$1,224.5	$38,004	121.4%
331221	Rolled steel shapes	4,263	$202.8	$47,573	13,079	$583.4	$44,606	106.7%
331222	Steel wire drawing	913	$36.1	$39,519	19,141	$641.1	$33,493	118.0%
33151	Ferrous metal foundries	10,831	$579.4	$53,497	91,818	$3,842.9	$41,854	127.8%
331511	Iron foundries	8,579	$493.3	$57,500	62,382	$2,722.3	$43,640	131.8%
331512	Steel investment foundries	1,488	$56.7	$38,099	15,036	$554.6	$36,885	103.3%
331513	Steel foundries (exc. investment)	764	$29.4	$38,539	14,400	$566.0	$39,304	98.1%

Abbreviations: exc. - except; mfg. - manufacturing.

Source: U.S. Bureau of the Census (2005b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 8/05).

Table A5: Establishments and Employment in the Iron and Steel Industry, by County, 2003

Area Name	Establishments	Employees	Area Name	Establishments	Employees	Area Name	Establishments	Employees
Ohio	268	41,627	Greene*	1	15	Morrow	0	0
			Guernsey*	1	66	Muskingum*	2	476
Adams*	1	7	Hamilton*	5	448	Noble	0	0
Allen*	3	173	Hancock*	1	143	Ottawa*	1	666
Ashland	0	0	Hardin*	2	56	Paulding	0	0
Ashtabula*	2	158	Harrison	0	0	Perry*	1	333
Athens	0	0	Henry*	1	28	Pickaway	0	0
Auglaize*	1	66	Highland	0	0	Pike	0	0
Belmont*	1	3	Hocking	0	0	Portage*	2	22
Brown	0	0	Holmes*	2	18	Preble*	1	3
Butler*	5	3,983	Huron	0	0	Putnam*	1	143
Carroll	0	0	Jackson*	2	171	Richland*	5	729
Champaign	0	0	Jefferson*	3	2,166	Ross	0	0
Clark*	2	6	Knox*	3	80	Sandusky*	1	7
Clermont*	2	6	Lake*	9	864	Scioto*	3	336
Clinton*	1	28	Lawrence	0	0	Seneca*	2	56
Columbiana*	12	319	Licking	0	0	Shelby*	1	28
Coshocton*	3	1,027	Logan*	1	66	Stark	21	9,005
Crawford*	1	7	Lorain*	8	2,062	Summit*	10	78
Cuyahoga*	31	4,704	Lucas*	8	319	Trumbull*	14	2,952
Darke	0	0	Madison*	2	209	Tuscarawas*	4	158
Defiance	1	3,000	Mahoning*	13	1,007	Union	0	0
Delaware*	4	138	Marion*	4	442	Van Wert	0	0
Erie*	2	146	Medina*	5	69	Vinton	0	0
Fairfield*	2	10	Meigs	0	0	Warren*	1	28
Fayette	0	0	Mercer*	1	15	Washington*	7	615
Franklin*	12	792	Miami*	7	1,044	Wayne*	7	986
Fulton*	3	491	Monroe	0	0	Williams*	2	73
Gallia	0	0	Montgomery*	9	388	Wood*	3	347
Geauga	0	0	Morgan	0	0	Wyandot*	1	66

Note: * - Employment figure is, or contains, an estimate - which is why the county employment figures sum to 41,847. That in turn means that the estimates tend to be slightly high. There also is one industry establishment that was not assigned to any county.

Sources: Harris (2003), U.S. Bureau of the Census (2005b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 8/05).

Table A6: Iron and Steel Industry Establishment Trends, Ohio and the U.S.: 1998-2003

NAICS Code	Shorter Industry Title	1998	1999	2000	2001	2002	2003	Changes: 1998-2003 Number	Percent
Ohio	Total	270,343	270,766	270,509	269,944	271,181	270,255	-88	0.0%
31-33	Manufacturing	18,052	17,930	17,704	17,597	17,189	17,082	-970	-5.4%
3311-2-51	Iron & steel industry	231	248	279	318	293	268	37	16.0%
3311	Iron & steel mills & ferroalloys	41	59	84	111	100	87	46	112.2%
331111	Iron & steel mills	36	54	79	106	95	80	44	122.2%
331112	Electrometallurgical ferroalloys	5	5	5	5	5	7	2	40.0%
3312	Steel products from purchased steel	71	66	72	81	84	82	11	15.5%
33121	Iron, steel pipe & tubes	28	26	29	31	34	31	3	10.7%
33122	Rolling & drawing	43	40	43	50	50	51	8	18.6%
331221	Rolled steel shapes	30	28	29	32	35	34	4	13.3%
331222	Steel wire drawing	13	12	14	18	15	17	4	30.8%
33151	Ferrous metal foundries	119	123	123	126	109	99	-20	-16.8%
331511	Iron foundries	76	81	83	85	77	69	-7	-9.2%
331512	Steel investment foundries	16	17	17	17	16	15	-1	-6.3%
331513	Steel foundries (exc. investment)	27	25	23	24	16	15	-12	-44.4%
U.S.	Total	6,941,822	7,008,444	7,070,048	7,095,302	7,200,770	7,254,745	312,923	4.5%
31-33	Manufacturing	366,249	360,244	354,498	352,619	344,341	341,849	-24,400	-6.7%
3311-2-51	Iron & steel industry	2,321	2,726	3,134	3,525	3,205	2,708	387	16.7%
3311	Iron & steel mills & ferroalloys	410	702	1,003	1,374	1,259	876	466	113.7%
331111	Iron & steel mills	381	672	970	1,345	1,242	853	472	123.9%
331112	Electrometallurgical ferroalloys	29	30	33	29	17	23	-6	-20.7%
3312	Steel products from purchased steel	762	824	933	939	870	828	66	8.7%
33121	Iron, steel pipe & tubes	252	265	290	281	281	221	-31	-12.3%
33122	Rolling & drawing	510	559	643	658	589	607	97	19.0%
331221	Rolled steel shapes	213	242	286	295	230	226	13	6.1%
331222	Steel wire drawing	297	317	357	363	359	381	84	28.3%
33151	Ferrous metal foundries	1,149	1,200	1,198	1,212	1,076	1,004	-145	-12.6%
331511	Iron foundries	683	731	739	747	655	623	-60	-8.8%
331512	Steel investment foundries	162	159	160	156	143	147	-15	-9.3%
331513	Steel foundries (exc. investment)	304	310	299	309	278	234	-70	-23.0%

Sources: U.S. Census Bureau (2000, 2001, 2002, 2003b, 2004, 2005b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 8/05).

Table A7: Iron and Steel Industry Employment Trends, Ohio and the U.S.: 1998-2003

NAICS Code	Shorter Industry Title	1998	1999	2000	2001	2002	2003	Changes: 1998-2003 Number	Percent
Ohio	Total	4,806,046	4,867,368	5,001,980	4,932,943	4,743,151	4,770,283	-35,763	-0.7%
31-33	Manufacturing	994,788	982,853	988,612	936,161	829,456	838,725	-156,063	-15.7%
3311-2-51	Iron & steel industry	52,777	51,540	54,239	51,891	43,666	41,627	-11,150	-21.1%
3311	Iron & steel mills & ferroalloys	24,479	24,306	27,101	26,700	21,353	21,783	-2,696	-11.0%
331111	Iron & steel mills	22,948	22,669	25,351	25,061	19,822	20,159	-2,789	-12.2%
331112	Electrometallurgical ferroalloys	1,531	1,637	1,750	1,639	1,531	1,624	93	6.1%
3312	Steel products from purchased steel	9,958	9,263	10,597	10,464	10,234	9,013	-945	-9.5%
33121	Iron, steel pipe & tubes	4,961	4,459	4,617	4,368	4,512	3,837	-1,124	-22.7%
33122	Rolling & drawing	4,997	4,804	5,980	6,096	5,722	5,176	179	3.6%
331221	Rolled steel shapes	3,676	3,466	4,515	4,631	4,583	4,263	587	16.0%
331222	Steel wire drawing	1,321	1,338	1,465	1,465	1,139	913	-408	-30.9%
33151	Ferrous metal foundries	18,340	17,971	16,541	14,727	12,079	10,831	-7,509	-40.9%
331511	Iron foundries	13,197	12,791	12,037	10,650	9,154	8,579	-4,618	-35.0%
331512	Steel investment foundries	2,983	2,894	2,805	2,310	2,132	1,488	-1,495	-50.1%
331513	Steel foundries (exc. investment)	2,160	2,286	1,699	1,767	793	764	-1,396	-64.6%
U.S.	Total	108,117,731	110,705,661	114,064,976	115,061,184	112,400,654	113,398,043	5,280,312	4.9%
31-33	Manufacturing	16,945,834	16,659,930	16,473,994	15,950,424	14,393,609	14,132,020	-2,813,814	-16.6%
3311-2-51	Iron & steel industry	349,739	338,509	343,299	330,496	287,205	270,090	-79,649	-22.8%
3311	Iron & steel mills & ferroalloys	148,969	144,194	149,128	148,381	126,969	125,871	-23,098	-15.5%
331111	Iron & steel mills	145,386	140,417	145,232	144,938	124,703	123,543	-21,843	-15.0%
331112	Electrometallurgical ferroalloys	3,583	3,777	3,896	3,443	2,266	2,328	-1,255	-35.0%
3312	Steel products from purchased steel	65,827	64,799	68,030	65,597	58,699	52,401	-13,426	-20.4%
33121	Iron, steel pipe & tubes	27,759	26,759	27,681	27,490	25,191	20,181	-7,578	-27.3%
33122	Rolling & drawing	38,068	38,040	40,349	38,107	33,508	32,220	-5,848	-15.4%
331221	Rolled steel shapes	14,169	13,268	15,521	14,349	13,962	13,079	-1,090	-7.7%
331222	Steel wire drawing	23,899	24,772	24,828	23,758	19,546	19,141	-4,758	-19.9%
33151	Ferrous metal foundries	134,943	129,516	126,141	116,518	101,537	91,818	-43,125	-32.0%
331511	Iron foundries	85,684	83,760	82,106	75,053	66,380	62,382	-23,302	-27.2%
331512	Steel investment foundries	24,251	22,315	21,166	20,260	17,252	15,036	-9,215	-38.0%
331513	Steel foundries (exc. investment)	25,008	23,441	22,869	21,205	17,905	14,400	-10,608	-42.4%

Sources: U.S. Census Bureau (2000, 2001, 2002, 2003b, 2004, 2005b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 8/05).

Table A8: Raw Steel Production in Ohio and the U.S., 1969-2004
(in thousands of net tons, except ranks and percentages)

	Ohio		U.S.					Ohio		U.S.			
Year	Raw Steel Output	Percent Change from Prior Year	Raw Steel Output	Percent Change from Prior Year	Ohio as Percent of U.S. Output	**Ohio's Rank in U.S.**	Year	Raw Steel Output	Percent Change from Prior Year	Raw Steel Output	Percent Change from Prior Year	Ohio as Percent of U.S. Output	**Ohio's Rank in U.S.**
1969	24,202	n.a.	141,262	n.a.	17.1%	2	1988	17,662	8.6%	99,924	12.1%	17.7%	2
1970	21,684	-10.4%	131,514	-6.9%	16.5%	2	1989	16,506	-6.5%	97,943	-2.0%	16.9%	2
1971	20,064	-7.5%	120,443	-8.4%	16.7%	2	1990	16,769	1.6%	98,906	1.0%	17.0%	2
1972	23,851	18.9%	133,241	10.6%	17.9%	2	1991	14,210	-15.3%	87,896	-11.1%	16.2%	2
1973	26,510	11.1%	150,799	13.2%	17.6%	2	1992	15,524	9.2%	92,949	5.7%	16.7%	2
1974	25,251	-4.7%	145,720	-3.4%	17.3%	2	1993	16,101	3.7%	97,877	5.3%	16.5%	2
1975	19,620	-22.3%	116,642	-20.0%	16.8%	3	1994	16,683	3.6%	100,579	2.8%	16.6%	2
1976	22,419	14.3%	128,000	9.7%	17.5%	2	1995	16,444	-1.4%	104,930	4.3%	15.7%	2
1977	21,466	-4.3%	125,333	-2.1%	17.1%	3	1996	16,837	2.4%	105,309	0.4%	16.0%	2
1978	21,268	-0.9%	137,031	9.3%	15.5%	3	1997	15,827	-6.0%	108,561	3.1%	14.6%	2
1979	21,082	-0.9%	136,341	-0.5%	15.5%	3	1998	16,758	5.9%	108,752	0.2%	15.4%	2
1980	16,100	-23.6%	111,835	-18.0%	14.4%	3	1999	17,499	4.4%	107,395	-1.2%	16.3%	2
1981	18,096	12.4%	120,828	8.0%	15.0%	3	2000	18,263	4.4%	112,242	4.5%	16.3%	2
1982	12,181	-32.7%	74,577	-38.3%	16.3%	2	2001	15,726	-13.9%	99,321	-11.5%	15.8%	2
1983	14,586	19.7%	84,615	13.5%	17.2%	2	2002	14,646	-6.9%	100,958	1.6%	14.5%	2
1984	15,438	5.8%	92,528	9.4%	16.7%	2	2003	13,100	-10.6%	103,261	2.3%	12.7%	2
1985	14,094	-8.7%	88,259	-4.6%	16.0%	2	2004*	14,907	13.8%	108,627	5.2%	13.7%	n.a.
1986	14,522	3.0%	81,606	-7.5%	17.8%	2	2004: 1st qtr.*	3,628	n.a.	26,214	n.a.	13.8%	n.a.
1987	16,267	12.0%	89,151	9.2%	18.2%	2	2005: 1st qtr.*	3,774	4.0%	26,494	1.1%	14.2%	n.a.

Notes: * - preliminary figures from web sites, subject to revision; n.a. - not available.

Sources: American Iron and Steel Institute (1970, 1974, 1978, 1982, 1987, 1989, 1992, 1996, 1998, 2000, 2002, 2004), International Iron and Steel Institute (2005), Ohio Steel Industry Advisory Council (2005).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 8/05).

Table A9: Value-Added by Group in the Iron and Steel Industry for Ohio and the U.S., 1997-2003
(in millions of current dollars, except percentages)

Industry Titles	Value-Added							Percent Change (or Difference) 1997-2003
	1997	1998	1999	2000	2001	2002	2003	
Ohio: Industry Subtotal	$6,924.7	$6,728.0	$5,488.6	$5,499.7	$3,530.5	$3,589.7	$2,611.1	-62.3%
3311: Iron and Steel Mills and Ferroalloys	$5,861.7	$5,705.4	$4,393.5	$4,165.5	$2,517.7	$2,409.5	$1,631.3	-72.2%
3312: Steel Product Mfg. from Purchased Steel	$1,063.0	$1,022.6	$1,095.1	$1,334.1	$1,012.8	$1,180.2	$979.8	-7.8%
U.S.: Industry Subtotal	$32,194.4	$30,989.0	$28,277.4	$27,308.6	$20,426.6	n.a.	$22,648.3	-29.7%
3311: Iron and Steel Mills and Ferroalloys	$25,432.0	$24,416.1	$21,859.9	$20,629.1	$14,748.7	n.a.	$17,600.3	-30.8%
3312: Steel Product Mfg. from Purchased Steel	$6,762.4	$6,572.9	$6,417.5	$6,679.5	$5,677.9	n.a.	$5,047.9	-25.4%
Ohio as Percentage of U.S.: Industry Subtotal	21.5%	21.7%	19.4%	20.1%	17.3%	n.a.	11.5%	-10.0%
3311: Iron and Steel Mills and Ferroalloys	23.0%	23.4%	20.1%	20.2%	17.1%	n.a.	9.3%	-13.8%
3312: Steel Product Mfg. from Purchased Steel	15.7%	15.6%	17.1%	20.0%	17.8%	n.a.	19.4%	3.7%

Note: n.a. - not available.

Source: U.S. Bureau of the Census (2003a, 2005a).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 7/05).

Table A10: Capital Expenditures by Group in the Iron and Steel Industry for Ohio and the U.S., 1997-2003
(in millions of current dollars, except percentages)

Industry Titles	Capital Expenditures							Percent Change (or Difference) 1997-2003
	1997	1998	1999	2000	2001	2002	2003	
Ohio: Industry Subtotal	$435.9	$545.1	$539.7	$490.0	$286.9	$242.3	$284.1	-34.8%
3311: Iron and Steel Mills and Ferroalloys	$347.8	$434.6	$451.9	$402.9	$211.4	$143.4	$154.1	-55.7%
3312: Steel Product Mfg. from Purchased Steel	$88.1	$110.5	$87.8	$87.2	$75.5	$98.8	$130.1	47.6%
U.S.: Industry Subtotal	$3,207.3	$3,149.5	$2,705.6	$2,572.7	$1,778.1	n.a.	$1,359.6	-57.6%
3311: Iron and Steel Mills and Ferroalloys	$2,673.7	$2,632.2	$2,265.5	$2,104.0	$1,365.0	n.a.	$937.9	-64.9%
3312: Steel Product Mfg. from Purchased Steel	$533.5	$517.3	$440.1	$468.7	$413.1	n.a.	$421.8	-20.9%
Ohio as Percentage of U.S.: Industry Subtotal	13.6%	17.3%	19.9%	19.0%	16.1%	n.a.	20.9%	7.3%
3311: Iron and Steel Mills and Ferroalloys	13.0%	16.5%	19.9%	19.1%	15.5%	n.a.	16.4%	3.4%
3312: Steel Product Mfg. from Purchased Steel	16.5%	21.4%	19.9%	18.6%	18.3%	n.a.	30.8%	14.3%

Note: n.a. - not available.

Source: U.S. Bureau of the Census (2003a, 2005a).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 7/05).

Table A11: Projections of Iron and Steel Employment by Group*, Ohio and the U.S.: 2002-2012

NAICS Code	Shorter Industry Title	Jobs		Changes: 2002-2012	
		Actual 2002	Projected 2012	Number	Percent
Ohio	Total	5,813,800	6,376,100	562,300	9.7%
31-33	Manufacturing	884,100	842,700	-41,400	-4.7%
3311-2	Iron & Steel Subtotal	26,300	22,000	-4,300	-16.3%
3311	Iron & Steel Mills & Ferroalloys	15,200	11,600	-3,600	-23.7%
3312	Steel Products from Purchased Steel	11,100	10,400	-700	-6.3%
U.S.	Total Non-agricultural Wage & Salary Employment	144,014,000	165,319,000	21,305,000	14.8%
31-33	Manufacturing	15,307,000	15,149,000	-158,000	-1.0%
3311-2	Iron & Steel Subtotal	170,000	136,000	-34,000	-20.0%
3311	Iron & Steel Mills & Ferroalloys	107,000	76,000	-31,000	-29.0%
3312	Steel Products from Purchased Steel	63,000	60,000	-3,000	-4.8%

Note: * - Projections have not been made for ferrous metal foundries (NAICS 33151).

Sources: Berman (2004), ODJFS-BLMI (2004).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Telephone 614/466-2116 (DL, 7/05).

Industry Definition and Examples of Products

Beginning in 1997, the nation's industry statistics have been collected under the North American Industry Classification System (NAICS) (Office of Management and Budget, 1998). Establishments producing goods or services sufficiently alike are classified in the same *industry*, and assigned a six-digit code number. Closely related industries form an *industry group*. The first four digits of the industry code indicate the group to which the industries belong. In this report the iron and steel industry is defined as the combination of two groups and a subgroup: *iron and steel mill and ferroalloy manufacturing* (NAICS 3311), *steel product manufacturing from purchased steel* (3312), and *ferrous metal foundries* (33151). (A five-digit code defines a *subgroup* when it subsumes more than one six-digit code; otherwise, it defines an industry.) Definitions and examples of specific industry products follow.

3311	Iron & Steel Mills & Ferroalloys.
33111	Iron & Steel Mills & Ferroalloys.
331111	Iron & Steel Mills. Activities include the direct reduction of iron ore, producing pig iron, and/or converting pig iron into steel. Steel products such as bars, pipes, plates, rods, sheets, strips, tubes, and wire are included if they are made at the same establishment where the steel is produced are included. Likewise, coke ovens may be included if they are part of the same establishment; otherwise, they are classified elsewhere.
331112	Electrometallurgical Ferroalloy Products. Activities include the production of elements added to molten steel to alter or improve the characteristics of steel. (See alloy steels in the glossary.) Non-ferrous alloy manufacturing is classified elsewhere. Electrometallurgical refers to either the application of electric current for electrolytic deposition or the use of electric current as a source of heat in smelting or refining metals. The actual production of electrometallurgical steel is classified in 331111.
3312	Steel Products from Purchased Steel. Products in this group are not made at the same establishment where the raw iron or steel is produced.
33121	Iron & Steel Pipes & Tubes from Purchased Steel. Examples include welded, riveted, and seamless pipes and tubes.
33122	Rolling & Drawing Purchased Steel.
331221	Rolled Steel Shapes. Activities include rolling and drawing shapes such as plates, sheets, strips, rods and bars from purchased steel. Drawing wire is classified in 331222.
331222	Steel Wire Drawing. Establishments in this industry draw wire from purchased steel. Making wire products such as nails, spikes, and paper clips from purchased steel is classified in fabricated metal products (332).
33151	Ferrous Metal Foundries. Establishments in this sub-group pour molten iron and steel (that they purchased) into molds of a desired shape to make castings. They may also perform further operations such as cleaning and deburring, but activities such as threading or machining that transform castings into more-finished pro-

ducts would lead to classification outside of the industry. Foundry operations at the same establishment where the iron or steel is first made – i.e., with iron and steel not purchased – are classified in 331111.

331511 Iron Foundries. Establishments in this industry melt and pour into molds the pig iron or iron alloys that they have purchased. Examples of products include manhole covers, cast-iron pipes, and cast-iron skillets.

331512 Steel Investment Foundries. Investment foundries create seamless molds by covering a wax shape with refractory slurry. The wax is melted and drained after the slurry hardens. Highly detailed and consistent castings may be made from such molds.

331513 Steel Foundries (exc. Investment). Non-investment castings of purchased steel.

Glossary

Iron and steel terms, presented in approximate order of the primary production process:

Iron ore – rocks or deposits of iron (Fe) compounds. Hematite (Fe_2O_3) is an example.

Directly reduced iron (DRI) – iron ore reduced to the solid metallic state by heating it without melting it. Natural gas usually is the refining agent. Ninety to 95 percent iron, it is an expensive substitute for scrap. Iron carbide (Fe_3C) and hot briquetted iron are other examples of scrap substitutes.

Coke – derived by baking coal (petroleum-related material may also be used), it is primarily carbon (C); however, other matter and minerals may still be present. Coke supplies the carbon monoxide (CO) to reduce iron ore in a blast furnace and is a heat source for melting the iron. Coke burns hotter than coal.

Fluxes – substances used to promote the reduction of metals. Examples include, but are not limited to, limestone (primarily calcium carbonate ($CaCO_3$), secondarily magnesium carbonate ($MgCO_3$)), dolomite ($CaMg(CO_3)$), lime (an oxide of calcium) and fluorite (CaF_2).

Blast furnace – a furnace operating at $3{,}000^0$F (or higher) for reducing iron ore to pig iron. Air blasted through the fuel increases the combustion rate.

Pig iron – an iron-based product with a carbon content greater than 1.7 percent but less than five percent.

Slag – a non-metallic product resulting from the interaction of fluxes and impurities in the smelting and refining of metals. Slag is separated from molten steel and solidified outside the mill. It may eventually be recycled into things such as concrete building blocks.

Basic oxygen process (BOP) – making steel from molten pig iron and scrap with fluxes and oxygen (O_2) that is 99 percent pure to reduce carbon, phosphorus (P) and Sulfur (S) to specified levels without introducing nitrogen (N_2) or hydrogen (H_2).

Electric arc (EA) furnace – a furnace wherein materials are melted by passing an electric current through them, permitting the close control and addition of alloying elements.

Steel – an iron-based product with a carbon content of 1.7 percent or less.

Carbon steel – the world's most common steel; its properties depend on the specific carbon content and microstructure. Steel with a carbon content greater than .5 percent is considered high-carbon steel.

Alloy steels – steels with elements added to alter or improve their properties. Examples include chromium (Cr – at least 10 percent) and nickel (Ni) to produce stainless steel (which resists corrosion), and silicon (Si) to reduce energy loss in electrical steel. Other important elements used in alloy steel and high-strength-low-alloy steels are molybdenum (Mo), niobium (Nb), tungsten (W) and vanadium (V) for luster, strength, toughness, wear and/or corrosion resistance.

Raw steel – molten steel before it has been shaped or rolled, including the primary production of steel from iron ore with the BOP and steel produced by recycling in EA furnaces.

Net ton – 2000 pounds; a long ton is a metric ton (1,000 kg.), or about 2,240 pounds.
Semi-finished steel – the unrolled basic shapes of billets, blooms and slabs.
- **Billet** – a square or rectangular shape.
- **Bloom** – a square or rectangular shape larger than a billet.
- **Slab** – usually 8-to-10 inches thick, and wider than a bloom. An intermediate slab may be 4-to-6 inches thick, while a thin slab may be 1.5-to-2 inches thick.

Rolling – reducing or changing the cross-sectional area of a work-piece by the compressive forces of rotating rolls. The process is similar to squeezing clothes through the wringers of an old fashion washing machine.
- **Flat rolled** – processed on rolls with smooth faces, as opposed to grooved or cut faces used for structural or shaped products. Common products include sheets, strips and plates.
- **Cold rolled** – processed without first reheating the steel. Cold rolling produces a smooth surface and makes the piece easier to machine.
- **Hot rolled** – processed after it has been reheated.

Finished steel products include, but are not limited to:
- **Bars** – shaped and rolled into various forms from billets, one of the industry's highest volume class of products.
- **Structural shapes** – one example is an I-beam rolled and shaped from a bloom.
- **Sheets** – flat rolled from slabs, wider than 12 inches, far and away the single largest class of products (by volume) of the industry.
- **Strips** – flat rolled from slabs, less than 12 inches wide, but with a more precise control of thickness.
- **Plates** – flat rolled from slabs, thicker and heavier than sheets, a higher-volume class of products, primarily used in the construction and heavy machinery industries.

Near net shape casting – casting iron or steel in a thin and intricate-but-strong form that eliminates or reduces machining requirements before use or installation of the product.
Annealing* – heating and cooling steel to improve formability and surface durability.
Pickling* – removing oxide or mill scale from the surface by immersion in an acidic or alkaline solution in preparation for further processing.
Galvanizing* – coating steel with a layer of zinc (Z) for corrosion resistance.
Slitting* – passing a sheet or strip of steel through rotary knives as part of further processing; often performed at steel service/distribution centers.

* - These activities are not classified under NAICS codes 3311, 3312, or 33151.

A Primer on Iron and Steel Production Processes

There are two basic types of steel mills: primary producers and minimills. Producing pig iron is the first step of the primary steel making process. Iron ore pellets, limestone and coke are loaded into a blast furnace. The heat melts the ore and the limestone. Two general chemical reactions occur: the carbon from the coke removes the oxygen from the ore, and the limestone removes some impurities. (The result of the latter is called slag, and is removed from the blast furnace.[13]) The molten pig iron is transferred to a basic oxygen process (BOP) furnace where contaminants such as phosphorus and sulfur are removed, and carbon, manganese and silicon are either removed or reduced to specified levels. Ferrous scrap, directly reduced iron (DRI), and fluxes may be combined with molten pig iron in this stage of steel making. The defining characteristic of steel is that carbon content is no greater than 1.7 percent. Annual production capacities of primary producers typically range from two to four million net tons (Gnidovec, 2003; Larkin, 1994, 1995, 2005; Miller, 1984).

By contrast, minimills neither produce pig iron nor use it as a raw material. They melt ferrous scrap (and, occasionally, DRI) with fluxes in electric arc (EA) furnaces.[14] The capacities of minimills are usually far less than two million net tons per year. Historically, primary producers located near their raw material. Minimills locate near their clients because ferrous scrap is ubiquitous (Larkin, 1994, 1995; Miller, 1984). EA furnaces (whether those of primary producers or minimills) also are used for closely controlling the direct addition of various elements to create alloy steels (Parker, 1984). Alloy steels contain varying percentages of other elements that add desired characteristics such as luster, strength, toughness, wear and/or corrosion resistance.

The technology of iron and steel production has changed over the decades. By 1992, BOP furnaces completely replaced the less efficient open-hearths for primary steel production, and the majority of all raw steel production in America now comes from minimills (American Iron and Steel Institute, 1970-2004). The practice of pouring molten iron or steel into ingots for cooling – and then sending the ingots to a breakdown mill for reheating and further processing – has almost disappeared. Nowadays, almost all raw steel is poured into machines continually casting it into slabs, billets and blooms. This saves time, energy and money. Rolling mill machinery is used to further work such semi-finished steel into finished products: slabs are processed into plates, sheets and strips; billets into bars, rods, and tube rounds; and blooms into structural shapes and rails (Larkin, 1994, 1995; Miller, 1984).

NOTES:

1 Other motor vehicle companies may have foundry operations in the state, but the final product of their establishments is an engine. Such establishments are classified in NAICS 336312 if they make gasoline engines or 333618 if they make diesel engines. Classifying establishments with foundries based on their end products – i.e., castings that have been are subject to further manufacturing technologies after emerging from the foundries – underestimates the importance of foundry operations in the economy.

2 Some companies such as Dentsply and Sonoco are included in the 17 Fortune companies, but not listed because their establishments employ fewer than 50 people (Fortune, 2005; Harris, 2004).

3 Value-added is approximately equal to the value of shipments minus the cost of materials and labor. Although value-added still includes the costs of services purchased by the establishment, it is a more accurate estimate of the industry's net contribution to the economy. The value-added figures from the Census Bureau's Geographic Area Series – the ones on which the pie chart are based – may not be the same as some of the value-added figures from the Bureau's Industry Series – the ones used for calculating the percentage of national output from Ohio and ranking the states. The Bureau plans to reconcile the differences in a forthcoming publication.

4 Employment figures for all of the counties with industry establishments should be regarded as more or less rough estimates because the U.S. Bureau of the Census (2005b) does not disclose precise figures if doing so would violate the confidentiality of respondents. The Bureau merely provides range(s) encompassing the jobs figure(s) for the establishment(s) in the county under such circumstances. The figures in the text and table A5 are the result, at least in part, of an estimation technique thought to be fairly accurate on average. The only possible exceptions to this generalization are the figures for Defiance and Stark Counties; they are believed to be reliable.

5 Undoubtedly LTV's bankruptcy played a significant role in the industry's job losses in Ohio as well as across the nation. Employment reductions at Ford's and General Motors' casting plants were part of the net loss in iron foundries. Ford's Brook Park plant dropped 96 jobs, and GM's Defiance plant fell by 1,000 (Harris, 1998, 2003).

6 Service/distribution centers are largely wholesale and warehouse operations that slit and sell steel mill products to a variety of customers (Office of Management and Budget, 1998).

7 For that reason, it is no longer entirely accurate to refer to the companies as integrated; "primary producers" is probably a more accurate description because their product is steel smelted from iron ore.

8 Larkin (2005) claims that foreign-based companies now own about 35 percent of the domestic market. It is not clear whether this refers to tonnage or the value of products, but probably combines imports with ownership of domestic establishments in some way.

9 The choice between iron, steel, aluminum, plastics or ceramics turns on the consideration of many factors: costs (of the material, the tooling, and the labor to make the product), weight, aerodynamic qualities, production speed, surface finish and paintability, ease of recycling, operating temperature, and corrosion resistance. The advantages of iron and steel are ease of recycling, the ability to operate in high temperature environments, surface finish, and paintability. Steel can be made corrosion resistant, but that increases costs (Larkin, 2005).

10 Larkin (2005) states that companies divesting their coke ovens did so because they were unwilling to make the financial investments to meet the 1990 Clean Air Act Amendment requirements.

11 Some minimill companies are thinking about buying scrap suppliers as part of their efforts to control costs, and one has formed a joint venture with a company making directly reduced iron (Larkin, 2005).

12 In the past, companies such as LTV and Wheeling-Pittsburgh Steel that entered bankruptcy were not acquired by other steel companies because they retained their liabilities for pension and health care benefits (Larkin, 2005).

13 Slag is mostly lime, silica, and alumina. While it is a byproduct of smelting and refining metals, it becomes an ingredient for other things – mostly road bases and concrete products for road surfaces. It is also spun into mineral wool for insulation, and used in sandblasting, railroad ballast, highway fill, and filters at sewage treatment plants (Gnidovec, 2003).

14 Slag is also produced in BOP and EA furnaces. Again, it is a byproduct of flux use (Gnidovec, 2003).

SOURCES AND REFERENCES CITED

American Business Directories, 2003
2004 Ohio Business Directory (Vols. 1 & 2). Omaha Nb.: the company.

American Iron and Steel Institute (AISI), 1970, 1974, 1978, 1982, 1987, 1989, 1992, 1996, 1998, 2000, 2002, 2004
Annual Statistical Report. Washington, D.C.: the Institute. Various tables.

AP, 2005
"Steel company to cut production," the Columbus Dispatch, June 30, p. E2.

Berman, Jay, 2004
"Industry output and employment projections to 2012," Monthly Labor Review 127:2 (February), pp. 58-79.

Fortune, 2005
See <http://www.fortune.com> for the U.S. 1,000 and the Global 500.

Gnidovec, Dale, 2003
"Byproduct of ore-processing is valuable commodity itself," the Columbus Dispatch, June 10, p. A7.

Harris, 1998, 2003, 2004
1999, 2004, and 2005 Harris Ohio Industrial Directories. Twinsburg, Oh.: the company. The electronic version is Ohio Industrial Directory: 2005 [machine-readable database] / prepared by company. Twinsburg, Oh.: the company [producer and distributor].

International Iron and Steel Institute, 2005
See <http://www.worldsteel.org>, various tables.

Larkin, Leo J., 1994
"Steel and Heavy Machinery: Basic Analysis," Standard & Poor's Industry Surveys, January 6, pp. s28-s45.

_____, 1995
"Steel and Heavy Machinery: Basic Analysis," Standard & Poor's Industry Surveys, February 16, Sec. 4, pp. s15-s31.

_____, 2003
"Metals: Industrial," Standard & Poor's Industry Surveys, January 23.

_____, 2005
"Metals: Industrial," Standard & Poor's Industry Surveys, January 20.

Lexis-Nexis, 2005
Directory of Corporate Affiliations (2005 ed.). New Providence, NJ: Reed Elsevier, Inc.

Miller, 1984
"Steel Minimills," Scientific American 250:5 (May), pp. 32-39.

Office of Management and Budget, 1997
North American Industry Classification System. Lanham, Md.: Bernan Press.

Office of Strategic Research (OSR), 2005a
Foreign Companies with Operations in Ohio. Columbus, Oh.: Ohio Dept. of Development.

_____, 2005b
Private Investment Survey. Columbus, Oh.: Ohio Dept. of Development.

Ohio Dept. of Job and Family Services-Bureau of Labor Market Information (ODJFS-BLMI), 2004
"Industry Employment Projections Report, 2002-2012," found at
<http://lmi.state.oh.us/proj/projections/ohio/industry.pdf>.

Ohio Steel Industry Advisory Council, 2005
See <http://www.ohiosteel.org>.

Parker, Sybil P. (Ed.), 1984
McGraw-Hill Dictionary of Scientific and Technical Terms (3rd ed.). New York: the company.

U.S. Bureau of the Census, 2003a, 2005a
Annual Survey of Manufactures: Geographic Area Statistics M(AS) 2001 & 2003. Washington, D.C.: U.S. Government Printing Office. Table 2. Found at <http://www.census.gov>; look in the subject index for the PDF.

_____, 2000, 2001, 2002, 2003b, 2004, 2005b
County Business Patterns (Ohio & U.S.) 1998-2003. Washington, D.C.: U.S. Government Printing Office. Tables 1b & 2, respectively. PDF and machine-readable data files found at <http://www.census.gov>.

_____, 2005c
2002 Census of Manufactures Geographic Area Series. Washington, D.C.: U.S. Government Printing Office. Tables 2 and 6b. PDF files found at <http://www.census.gov/prod/ec02/ec0231aoht.pdf>.

_____, 2005d
2002 Census of Manufactures Industry Reports. Washington, D.C.: U.S. Government Printing Office. Tables 2 and 6b. PDF files found at <http://www.census.gov/econ/census02/guide/INDRPT31.HTM>.