Stuart Rosenfeld, Emil Malizia, and Marybeth Dugan

Southern Communities and Workers Benefit When Rural Factories Automate

Many manufacturers need to automate and computerize their operations to compete in both domestic and foreign markets. Rural southern manufacturers that have automated have realized benefits to their bottom lines, generally without reducing their workforce. Most, in fact, expanded. Workers are, however, often asked to take on different tasks than with a manual operation, and many of those tasks require different skills. Based on a survey of 51 rural plants in 12 Southern States.

The manufacturing base of the nonmetro South has evolved away from its traditional industries of textiles and apparel. Production of standardized products in branch plant facilities, however, remains the South's dominant industrial function, although the mix of products and industries has diversified some. Routine production is particularly rooted in the nonmetro South. A third of all nonmetro counties that depend on manufacturing are located in the South. Despite the growth of tourism and retirement communities and spillover growth from metro areas, manufacturing matters to many rural economies in the region. Our research looks at some of these nonmetro areas and our findings may be relevant to other manufacturing-dependent nonmetro counties.

Growth of the manufacturing sector, long the driving force of the rural South's economy, seems to have nearly stopped throughout much of the 1980's. Between 1977 and 1986, the annual growth of manufacturing employment in the nonmetro South was less than 0.5 percent, versus 1.2 percent in the metro South. Intense foreign competition due in part to the strong dollar and business investments emphasizing internal organization, education, and information services, have diminished the importance of cheap labor and have reduced the rural South's competitive advantage. Manufacturing, however, continues to provide a large share of the rural South's economic base and over 30 percent of its employment. The prospects for the rural South to switch from routine production to a service-driven economy, without first establishing a more sophisticated manufacturing base seem very slim.

Southern manufacturers who restructured their operations in the late 1970's and 1980's became more competitive and gained market share as the dollar weakened after 1985. Unfortunately, the changing terms of trade (the relative prices of U.S. competitive exports and imports) have benefited durable goods manufacturers like steel and autos more than producers of nondurable goods, who are still prevalent in the nonmetro South.

To the average person, restructuring a firm's organization and automating the production processes often suggests plant closings, workforce reductions, and lower hourly wages. Indeed, as a result of corporate downsizing and consolidation, many nonmetro factories have closed, sending their communities into decline. But our research, based on a survey of Southern rural manufacturers, suggests that automation can result in an expanded workforce with higher skills. The survey and eight case studies offer some factual evidence about the influences and effects of automation on the factories and their communities (see box "About the Survey").

Although the advantages of automation have been widely touted since mid-century, the rate of adoption of computers and numerical control equipment (CNC) has been slow. The equipment rarely met the expectations of its champions. Further, since the equipment was intended to reduce skills and eliminate jobs, labor opposed it. In recent years, however, new process technologies have turned out to be more flexible, affordable, and promising for both the firm and the worker. Management has discovered that it needs the cooperation and expertise of labor, and has reorganized many factories in ways acceptable to the labor force. We found that:

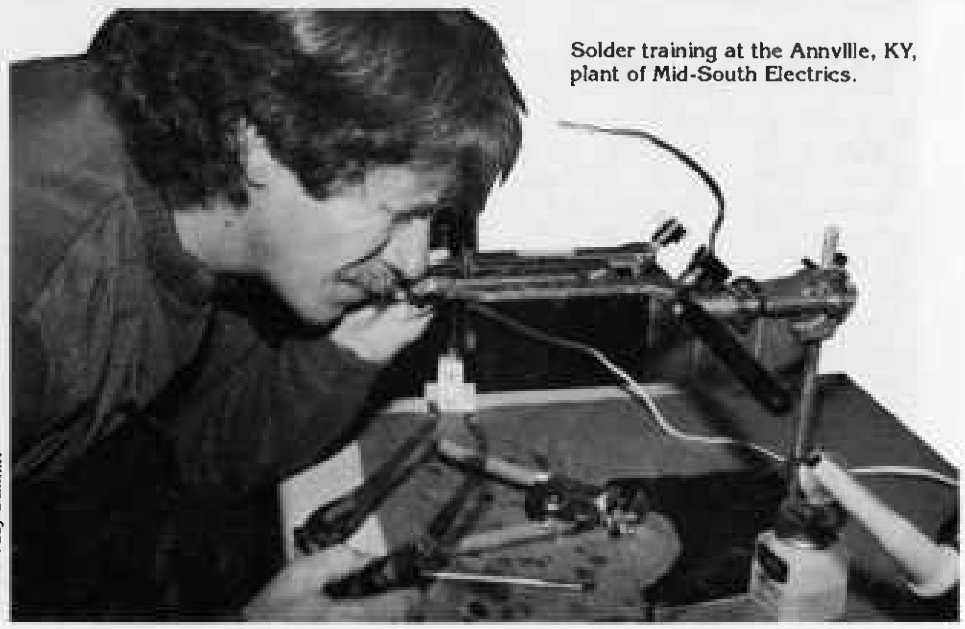

Photo © Judy Schmitt

Solder training at the Annville, KY, plant of Mid-South Electrics.

Stuart Rosenfeld is the director of the Southern Technology Council, Research Triangle Park, North Carolina. Emil Malizia is professor of city and regional planning at the University of North Carolina, Chapel Hill. Marybeth Dugan is a consultant to the Southern Technology Council.

About the Survey

The firms surveyed for this study represent a wide range of current manufacturing activities in the rural South, but they do not represent southern manufacturing in a statistical sense. They do represent a nonrandom, targeted population that introduced automated machinery and equipment into the production process. The population of companies surveyed was identified by a variety of public and private contacts. The resulting distribution of plants across the Southern Technology Council (STC) States is uneven, in part reflecting the actual distribution of automated facilities and in part a function of the extensiveness and responsiveness of contacts and referrals within each State.

Most of the firms we surveyed were branch plants, with a median size of 400 employees. Manufacturers with fewer than 100 employees were underrepresented although they constitute more than 80 percent of all manufacturing firms in the South. Among the automated manufacturers surveyed, smaller manufacturers constituted only 12 percent of the sample. This indicates either that our method for identifying automated facilities failed to reach smaller establishments or, as many experts believe, smaller firms are less likely to invest in new technologies.

Besides the list of plants having some form of automation in place, a second group of manufacturers served as a comparison group. These plants were randomly selected from State directories of manufacturers to reflect the industry profile of automated facilities. We sent an initial survey requesting only summary information on the establishment and its technology to 360 plants to establish a sample of the most automated facilities. Of the 360 plants, 252 had some form of automation, and the other 108 served as the comparison group. The response rate for the study group was 40 percent, versus 8 percent for the comparison group, suggesting that the survey questions were more relevant to the automated plants. Also, over 70 percent of the study group respondents were willing to participate in a second, more detailed survey.

The descriptive survey provided more information on the extent and nature of automation at the plants as well as selection criteria from which to choose the most highly automated sites for further study. We selected the most highly automated facilities in order to survey those plants that had the most experience with automation and ensure that our findings and conclusions reflect the concerns of manufacturers investing in automated technologies in the future.

Our major assumption was that a biased sample of companies will increasingly represent the norm as less innovative firms fail. By studying the minority of companies now, we can gain knowledge about the impacts and influences of automation that will be useful to policymakers now and in the future. The criteria used to select the second group included: the number of engineers employed at the site; the proportion of workers with technical training; the proportion of the production process that respondents consider automated; the degree of automation at the plant relative to the industry as a whole; and the type and amount of automated equipment in use at the sites.

From the pool of survey respondents, we selected 84 plants, most considered significantly automated, to receive a second, more detailed survey. Of the 84 surveys sent, 55 plants responded, and 4 responses were discarded in the final tabulations, one because it was located in a metro area and the others because of insufficient responses. Although the final 51 plants are more automated, on the whole, than those in the descriptive survey, the group still is highly variable in their degree of automation. The numerical results reported in this article are taken from this detailed survey.

Finally, eight case study sites were selected from the 51 respondents to reflect a range of industries, geographical location, community profiles, and ownership status. The industries represented include furniture, consumer electronics, automotive parts, diesel engines, and electrical appliances.

Support for this research came from the Rural Economic Policy Program, a joint project of the Ford Foundation, the Wye Institute, the Aspen Institute for Humanistic Studies, the Hitachi Foundation, and the Southern Education Foundation. Copies of the two-volume report, *Making Connections* and *Reviving the Rural Factory*, are available for $25 from the Southern Growth Policies Board, P.O. Box 12293, Research Triangle Park, NC 27709.

Industry Representation

SIC code	Firms	Industry
207	1	Lard & cooking oils
221	1	Cotton weaving mills
228	1	Yarn mills
242	1	Special sawmills
243	1	Structural wood
249	1	Wood products
251	1	Household furniture
252	2	Office furniture
261	2	Paper pulp mills
301	1	Tires & inner tubes
304	1	Rubber/plastic hoses
307	1	Plastic products
323	1	Glass products
331	2	Steel products
335	2	Aluminum products
342	1	Cutlery
344	1	Misc. metal work
346	1	Metal Stampings
351	1	Combustion engines
352	1	Farm & garden equipment
353	2	Industrial machinery
354	4	Metalworking machinery
355	1	Special machinery
356	2	Industrial machinery
359	1	Other machinery
362	3	Electrical apparatus
363	1	Household appliances
365	1	Phonograph records
367	4	Electronic components
371	5	Vehicle parts & access
372	1	Aircraft engines & parts
379	1	Transportation equipment

[1] Industry of one firm not reported.

- Most investments in automation are made incrementally to perform specific functions and address particular business objectives. Of the 51 facilities responding to a more lengthy survey, 86 percent report that their investments are part of a long-term strategy to modernize.

- Three-fourths of the 51 firms we surveyed plan significant investments in new technologies in the next 2 years, and 90 percent increased employment when introducing automation.

- On average, the Japanese-owned firms in the study use more extensive automation than the non-Japanese firms.

- The use of automated equipment made in other countries is quite common, as foreign companies have taken the lead in the production of robotics and other automated equipment.

- The 51 firms revealed that they use automation for a wide variety of functions, but that it is typically limited to one or two lines or stages of production. Assembly (47 percent), materials handling (47 percent), and fabrication (45 percent) are more common applications than finishing, packaging, material processing, or testing. Most firms using new production technologies are also considering new management systems, such as just-in-time inventory.

- The 104 firms that responded to the initial survey indicated that the most widely used forms of automation in the rural South are CNC (62 percent), computer-aided manufacturing (53 percent), robots (33 percent), and computer-aided design (33 percent). Few rural firms have fully automated, computer-integrated manufacturing systems. Respondents perceive their own adoption of new technologies as lagging behind the average of firms in their industry group.

The manufacturers surveyed invest in new technologies for very traditional reasons. Most managers expect their investments to reduce costs (94 percent), improve quality (86 percent), and increase capacity (77 percent). Eight manufacturers we surveyed for indepth case studies emphasized the importance of product quality, suggesting that the major cost savings accrue from less setup time, smaller inventories, fewer rejects, and reduced waste, not primarily from less labor. Almost all respondents realized these expected outcomes. Capacity, output, productivity, and profitability all increased, reflecting success in expanding markets or finding new markets.

The external factors influencing the decision to invest suggest that some manufacturers in the rural South still do not see themselves operating in a global economy. Pressure from domestic competition and the availability of new technologies were the two most common reasons given for automating. Foreign competition was third.

Major obstacles to investments noted in the surveys were generally internal: either the equipment cost too much relative to return (30 percent) or financial capital was lacking (24 percent). More than 20 percent of the firms stated that the right technology did not yet exist for their purposes. External factors such as lack of skilled labor, management expertise, or urban amenities were generally not hindering factors.

Among locational factors most important to the decision to invest, availability of overnight express mail (34 percent), access to telecommunications (28 percent), and proximity to an airport (28 percent) were most important, although no single factor was ranked important by a majority of the respondents. Nor were workforce considerations of major importance. The availability of training programs was important to 36 percent of the firms, a skilled labor force to 33 percent, and professionals and scientists to 30 percent. Thus neither locational nor workforce factors were important to a majority of decisionmakers at the surveyed facilities.

Public sector programs and incentives such as tax breaks, education and training subsidies, and public capital programs likewise do not have much bearing on the decisions. Several of the eight case studies reveal, however, that managers perceive that such incentives are available at most sites. Therefore, differences among States and localities are not great enough to influence location decisions.

Effects on the Workplace: New Skills...

Effects on the workplace and employment are perhaps the most widely debated aspect of automation. Since the Luddites fought the introduction of the power loom in 19th century England, automation has been seen as a threat rather than as a liberating technology. Debates still rage between pessimists, concerned that technology will degrade and deskill work, rendering the operator obsolete, and optimists who foresee an improved workplace with operators in control of their equipment instead of controlled by it. The latter base their optimism on the knowledge that automation is imperfect and requires frequent correction by operators; that manufacturing is becoming more flexible, requiring quicker responses to changes in production requirements; and that operators are better educated and their experience and expertise more highly valued in new management systems.

The results of our surveys and case studies suggest that automation does in fact require more skills and flexibility from the workforce using the new equipment and does provide for greater participation by and autonomy among the workers. Production workers dealing with new technologies must be able to use their heads as much as their hands and be willing to continually learn new skills. As one manager puts it, "We're asking for the capability to think, the capability to reason, and the capability to get along with people."

Rather than increasing or decreasing skills, automation seems to require a reskilling. Automation simplifies some functions, and makes others more complex, but also requires very different and, often, very general skills, such as understanding statistical process control, programming, problem-solving, and communicating effectively. All the new skills require a better understanding of math than

What is Automation?

For the purpose of this study, the terms "automation" or "high-tech" denote *advanced technology used to manufacture any products or parts.* The technological sophistication of the process, not the product, is important. Definitions of automation include a variety of technologies, which are sometimes referred to as advanced manufacturing technologies (AMT). The critical ingredient of AMT is the computer, and the key characteristics are programmability and flexibility. "Automation" in this study refers to programmable, computerized equipment and networks that manage and analyze information. It includes individual machines, such as industrial robots, computer numerically controlled machines, sensory systems, computer-aided manufacturing (CAM) and design (CAD), computerized materials handling systems, and computerized inventory control systems.

Robots are a unique form of automation in which human capabilities are ascribed to the machine, thus robotics is a subset of automated processes. Unlike most computer-assisted tools designed to enhance the productivity of the individual, the robot was intended to replace the individual. About a third of all industrial robots are in use in the auto industry, primarily for welding, painting, and machine loading. The greatest opportunities for use, however, as accuracy and control improve, may be in assembly and materials handling.

More extensive automation occurs when individual automated functions are linked together and integrated with the use of computers. Flexible manufacturing systems (FMS) are fully integrated and automated complete production processes.

most current workers have. As a result, most plants invest heavily in adult basic education before further technical training. The preference for basic skills partly explains why the hiring of workers with technical degrees increased only slightly after automation.

These observations thus suggest that automation is indeed associated with higher order thinking and more education, although this association often results more from management's new expectations than the minimum technical requirements of the equipment. In most factories, for example, operators adjust computer programs and perform minor maintenance and repairs, and such tasks are much more intellectually challenging than in a less automated process. Employees were also given more autonomy and responsibility, usually through controlling the rate of production and providing input to decisions through some variation of quality circles. Yet very few employees directly influenced strategic operating decisions.

Good attitudes, a strong work ethic, and relatively low wages remain among the most important attributes management seeks in workers, with automated or traditional equipment. Some managers interviewed cited the agriculture tradition as a positive and unique factor in both the work habits and technical aptitude of rural workers.

Investments in new technologies typically lead to increases in total employment, usually because the investments are associated with expanded or new facilities. Only four of 51 sites actually reduced employment, and then only slightly. In about a third of the cases, however, automation was associated with a corporate consolidation, and jobs at other locations not studied may have been eliminated.

Although we found few displacements attributed to technology, we were told of numerous examples of employees who turned down opportunities to learn new skills out of an unwillingness to assume added responsibility or a lack of confidence. Most were given a chance to be reassigned to less demanding work.

The surveys document the extensive effects of the new technologies on management and supervisory personnel. Top managers often introduce new labor relations and new organizational responsibilities simultaneously with new technologies. As production workers become increasingly responsible for shop floor production decisions, management can flatten the organizational chart. The computer also tends to allow for more centralized control, further eliminating the need for middle management oversight. The growing need for more technical skills and a better understanding of new technologies among higher level management also influence their organizational decisions. The gradual changes in organization and the incremental introduction of new technologies that we found may be explained by the inherent threats middle managers perceived to their positions.

... More Worker Participation

Indeed, we found that 58 percent of the sites reported greater production worker participation in decisionmaking and concurrent organizational changes. Moves to reduce the number of job classifications, provide workers new titles such as "technician," and pay salaries rather than hourly wages often lead to less hierarchical, more flexible manufacturing processes. Among the survey respondents, the presence of a union—often perceived as the champion of strict job classification schemes—did not appear to affect the success or failure of technological change. Whether or not a plant was unionized had no bearing on its ability to respond flexibly to automation.

Thus, automation had both positive and negative effects on the workplace. The automated factories studied generally were more pleasant working environments than traditional factories. They were cleaner and posed fewer hazards, and social relationships appeared less hierarchical and formal. Automated production facilities generally improved the intrinsic aspects of production jobs; production workers had more control over and greater flexibility in their work. They were better trained and more respected and often called "technicians" rather than "hired hands." Automation was often introduced with other changes in personnel policies, and emphasized broad-based, general education as opposed to occupation-specific skills.

Automation did not always eliminate the worst or most repetitive jobs; many coexisted with the automated

Mid-South Industries to Annville, KY: Decision from the Heart Makes Good Business Sense

Annville, Kentucky, is not the kind of place expected to attract highly sophisticated manufacturing operations that require a skilled workforce. At least, that is what the literature on plant locations would say. The village of at most 300 people is in Jackson County (pop. about 12,400), one of the State's most rural and poorest counties. A researcher at the University of Kentucky recently ranked Jackson last among the State's counties on a scale devised to measure "quality of life." Only 25 percent of the county's adults have completed high school, per capita income is about 43 percent of the national mean, and average wages only 38 percent of the national mean. The county has one incorporated town and no movie theater, no shopping center, no fast food restaurants, no department store, no hospital, no college, no television station, no radio station, and no tavern. The nearest interstate access is 25 miles away and the nearest commercial airport 80 miles.

Despite the odds, Annville was selected in 1987 by Mid-South Industries, headquartered in Gadsden, AL, as the site of its new multimillion dollar, high-tech manufacturing facility. The new facility replaced an older, outmoded plant that had burnt down in 1984 in nearby Clay County. Once fully operational, the new plant will employ 500 people and produce high-tech components—electromechanical assemblies, plastic molded components, and electronic parts—for consumer electronics using some of the most sophisticated production equipment available.

Although much of the decision to locate the new plant in Annville stems from the desire of Jerry Weaver, chairman of Mid-South, to give something back to the community in which he grew up, it was also the result of a detailed site selection analysis conducted by three outside consultants working independently to evaluate four potential sites in Kentucky. The strengths of Jackson County's proposal, according to Weaver, were traditional—the very low cost of the land and labor and the strong work ethic of the people. Federal, State, and local funds were also packaged to help entice the plant, but these government funds were less important since, according to Weaver, they can be had at just about any location and they make little difference in the overall cost of the project.

Annville's local leaders hope their new Mid-South plant, with its sophisticated manufacturing processes, will attract other employers, by showing the kinds of advanced industrialization their town is capable of supporting.

"The ultimate drive, of course, was economic," explains Weaver. "If you can't make the thing go, there's no reason to be there in the first place. But once you get past that, sure, there's a good feeling about being in the area."

Mid-South's ability to make a go of it rests in the company's commitment to training and its conviction that the local workforce can be trained to operate, understand, and maintain computer-controlled equipment in a modern, flexible, and team-oriented production environment. Mid-South owns and operates the Academy of Precision Arts in Gadsden, a training institution that supplies skilled workers to and other firms and where trainers for the Annville facility received preliminary training. But a fine training center 300 miles away is of limited value to rural Kentucky, so Mid-South decided to establish a new training facility in the county, at the site of the Annville Institute, which closed in 1978. Education and training programs began well before the first brick was laid for the plant.

Training was 40 hours a week and lasted for 6 months. The end result was quite impressive. From a group of people undereducated, unemployed, and with little self-confidence emerged a group with an understanding of manufacturing concepts, technical and mathematical skills, and the ability to communicate those skills.

In addition to its dramatic effect on the local labor force, Mid-South's choice of Annville has also sparked community leadership and the desire to provide more economic opportunity in this rural community. The group responsible for putting together the proposal for Mid-South—the Jackson County Development Association—has coalesced into a permanent group. The proposal included a commitment to incorporate the town of Annville, and a group of citizens is working on that effort. Such a move would give Annville a more formal mechanism for planning its own growth as well as for providing services not otherwise available.

processes. The automated jobs were not always more interesting or more remunerative either. In most plants, wages remained low compared with national scales even for upgraded jobs. Workers remained in highly competitive industries vulnerable to cyclical swings.

Community Effects Seen as Slight, Predictable

Eight case studies gave us the opportunity to examine individual plants in the context of the communities. The introduction of new technologies per se did not significantly affect the community. Introducing automated facilities had effects similar to any expansion—increased tax revenues, often greater employment, and a stronger sense of security among the community that their employer was there to stay (at least long enough to receive returns on the investment). Community institutions most directly involved with the plant (the community colleges and often the local chambers of commerce or economic development commissions) adapted their operations to better serve the automating plant and the changing needs of the community. See box on "Mid-South Industries" for more.

Strategies for Rural Firms

Most rural manufacturers have few alternatives: automate, emigrate, or fold. For the establishments we surveyed, the benefits of automation appeared to outweigh the costs. The quality of work improved for many workers although pay did not. Many automating companies also appeared to implement more progressive worker resource policies and programs. Certain middle management positions may have been threatened, but effects on the overall labor market appeared to be positive. More important, the technologies give rural manufacturers the means to survive in an increasingly competitive global economy. Thus, automation of rural manufacturers seems a desirable goal.

Effective government policies and programs would, presumably, improve the ability of (southern) manufacturers to compete in world markets. The public sector may choose to establish and support conditions that foster modernization, innovation, and productivity. The information gathered though the surveys and case studies suggests possible strategies for public sector intervention. Nine are outlined below.

Strategy No. 1: Provide better information about new technologies targeted at small and medium-size firms: Independent and small- and medium-sized manufacturers would benefit from better information about new process technologies. Dissemination of such information is a legitimate function of the public sector.

Strategy No. 2: Invest in manufacturing and engineering research: R&D needs to be directed toward industries that are heavily concentrated in the rural South. These industries may not be the most glamorous and "high-tech," but are vital to many rural economies.

Strategy No. 3: Encourage local colleges to provide technical resources as well as education and training. Community and technical colleges are community-based institutions that have as part of their mission the economic development of their service area. They are an underutilized resource that, because of their accessibility to rural communities, could do much more than provide customized training. They could act as manufacturing technology resource centers and spread new technologies to rural small and medium-sized firms.

Strategy No. 4: Support "train-the-trainer" programs. One of the most exciting new programs is the training of a small number of company employees, either onsite or at the vendor, to learn how to operate the equipment and how to teach their coworkers. Such programs should be encouraged and expanded in rural areas, where there are fewer private training alternatives.

Strategy No. 5: Provide worker education programs that emphasize the basics needed by manufacturers, such as mathematics, communications, and scientific methods. Much of the labor force serving existing rural manufacturers lacks the basic skills needed to implement new technologies. Programs to provide these skills to rural workers before a company invests in new machinery could make the investment less costly and less risky.

Strategy No. 6: Retrain and assist workers dislocated by changing technologies. Some workers, unable to adjust to the new technologies, will require special attention. While most training prepares workers to understand and use new technologies, it is also needed to prepare others for new occupations, many in service industries.

Strategy No. 7: Educate rural management. The success of automation depends as much on the capabilities of management as on the skills of the workforce, yet rural managers lack ready access to existing private programs. Programs offered locally or via computer hookups on the management of technology and management sciences are inexpensive and would prove effective if offered in small, regular doses to isolated managers and small shop owners.

Strategy No. 8: Take stock of local producers and work with them to develop linkages to quality suppliers and component manufacturers. Increased outsourcing of parts and quicker response times are leading to tighter relationships between producers and suppliers. Understanding and articulating the new relationships and aiming resources at developing regional networks is a new and important function for State and local development agencies.

Strategy No. 9: Establish networks among manufacturers to share the costs of information and services. One way to overcome diseconomies of scale among small and often rural firms is to share the costs of programs that are too expensive for individual independent firms. Joint applied research in production processes, technical training programs, and market information services are just a few of the services that could be shared by small firms in the same industrial sector, which may be too distant from universities or established sources of technical assistance to make use of their services. RDP