CHAPTER – III

REVIEW OF LITERATURE
All researches are part of a broad endeavor for search and generation of knowledge in which each individual research has a contributory role. Therefore, before undertaking research, it is necessary to review studies that are relevant to the present investigation. This is important to enable the researcher to evaluate the status of the present knowledge, methodology and technique used and appropriate research questions that should be administered. In the paragraphs that follow, literature review is being undertaken to bring out salient features of knowledge in this area. In this chapter various empirical studies related to the present study have been reviewed. Four main dimensions of the review were considered important,

(1) The Employment Effects of Technological Change

(2) The Skill-Bias Effect of Technological Change

(3) The Role of Technology in Downsizing, and

(4) The Psychological Aspects of Change.

The above four dimensions have been considered both in the Indian as well as international context.
Studies on The Employment Effects of Technological Change

Hoos (1960), on the basis of a study on computerization of 19 organizations in San Francisco Bay noted that a number of classifications that were on the upper level of the office rooster were disappearing as automation took over.

In a study of commercial banking to assess the impact of automated office equipment on clerical employment, Yavitz (1967) estimated that there was a reduction of 42.5 per cent of the affected personnel.

Papola (1971) in his study of over a 100 cases of the Ahmedabad cotton textile industry on introducing technological change found that hardly any retrenchment had taken place, although there had clearly been reduction in employment.

Pylee and Poduval (1971) studied the experiences of a chemical plant in introducing technological changes. They presented facts regarding the changes in technology and described the related organizational aspects. They found that the total number of employees required in the new set-up of changed technology was limited, that too who were highly skilled or trained in the new operation.

Based on a survey of office automation and its impact on clerical manpower in an oil company, Suri (1971) concluded that more than 50 percent of the total clerical employees were directly exposed to the effects of computerization, 27 percent were rendered surplus on account of
computers only, and about 19 percent of the clerical jobs were stated to have been eliminated during 1960-1968.

Ayres and Miller (1983) considered the impact of robots on manufacturing employment. Ayres & Miller concluded that robotics technologies could displace 1.5 million jobs in current manufacturing and as many as 4 million by 2005.

Denny and Fuss (1983) investigated the effects of automation on occupational groups within Bell Canada, using data on four separate occupations and a direct measure of the rate of technological change. Technological change in Bell Canada during 1952-72 increased the amount of capital and reduced the amount of labour per unit of output, with the labour saving effects felt most strongly in the least skilled occupations. The study found, however, that net employment growth within these occupations was positive because output growth more than offset the impact on employment of reductions in labour requirements per unit of output.

Studies by Hunt and Hunt (1983) also considered the impact of robots on manufacturing employment. They estimated that total employment displaced by 1990 would amount to only 68,000-1,34,000 jobs - well below levels of normal turnover within the manufacturing workforce.
Levy, Bowes and Jondrow (1984) assessed the effects on output growth and employment of labour, productivity growth resulting from technological change and increases in production plant scale during 1960-1980 in five manufacturing and mining industries (Steel, Aluminium, Automobiles, Coal mining and Iron mining). Within all these industries, technological change led to the substitution of capital for labour and to increases in labour productivity. In three of the five industries (coal mining, iron mining and aluminium production) the output-enhancing effect of technological change increased total employment; in the other two (steel and automobiles), demand growth was insufficient to offset the impact of reductions in the labour required per unit of output.

Howell (1985) used an input-output framework to forecast the employment effects of industrial robots. Howell considered the employment consequences of six different estimates of the number of installed robots in 1990 ranging from 72,000 to 2,85,000. Howell concluded that the net number of jobs displaced by robots by 1990 would range from 1,68,000 (assuming slow diffusion of robotics) to 718,000 (for the most rapid assumed diffusion rate).

Leonteif and Duchin (1985) in their study of impact of computer based automation on employment in the USA, found that one CNC (computer numerically controlled) machine can on an average, take the place of 4.5
conventional machines capable of doing similar type of work. This means that introduction of a CNC machine in place of conventional ones results in workstations equivalent to 3.5 workers per shift becoming redundant.

Roessner, Mason, Porter, Rossini, Schwartz, and Nelms (1985) conducted an analysis of office automation and projected that office automation could displace as much as 40 percent of 1980 clerical employment within the financial services and insurance industries by the year 2000. The conclusions drawn by Roessner team contrasts sharply with those of the National Research Council’s panel on technology and women’s employment. In its 1986 report the panel concluded that “massive job loss is unlikely to occur”.

Gil (1986) in his study on labour implications of technological change in rail and air transport found that new technologies have altered both the structure and volume of employment in both rail and air transport.

Hunt and Hunt (1986) surveyed the effects of technological change on clerical employment. The authors criticized several other studies on this topic for overlooking the often-slow pace of technological change and diffusion, the output-expanding impacts of reductions in the price of such clerical and secretarial activities as text editing, and the effect of expanding aggregate demand. They argued that these flaws lead to the studies to overstate the job-displacing impact of technological change. They
concluded that the current office technology offers significant improvements in productivity and that there is as yet no empirical evidence of an office productivity revolution that would displace significant numbers of clerical workers.

Osterman (1986) also studied the impact of information technologies on office and clerical employment in several industries and found that displacement was partly offset by an expansion in the demand for automated activities or functions. Although the adoption of computers initially reduced employment of clerks and managers in these industries during 1972-1978, displacement typically was followed in a few years by increases in clerical and managerial employment. According to Osterman, the increases in employment that followed the introduction of computers generally were insufficient to overcome the employment losses. Over a longer period, however, the net employment losses might well have been smaller or non-existent.

Young and Lawson (1986) used an input-output methodology to decompose the growth in employment during 1972-1984 into changes resulting from growth in final demand and those resulting from technological advance in 79 industries. The authors computed the changes in employment that would have resulted if the output of 1984 had been produced with 1972 technology. Young & Lawson found that technological
change during 1972-1984 reduced labour requirements per unit of output in 65 of 79 industries. Changes in final demand during this same period affected some or the entire decline in labour demand in 73 of the 79 industries. In 44 of the 79 industries, the labour saving effects of new technologies were more than offset by growth in final demand, that is, total employment expanded.

Biruda (1987) in her study on the effect of technological change on employment (textiles) found that the use of superior technology in spinning, generally turned out to be labour saving, while that in yarn mills was neutral.

Kortteinen, Lehto and Yl"stalo (1997) conducted a large scale Finnish Labour Force survey to study the implications of IT for working conditions in the early 1980's. They examined trends in employment at the workplace, levels of training given for the use of IT, what types of equipment were used, and the workers' evaluations of the changes in the quality of their jobs. The results support the "polarization hypothesis": rather than the use of IT resulting in general deskilling or upgrading of jobs, the outcome was a differentiation between the best and worst jobs, with a variety of "middle-range" jobs disappearing.
Raju (1989) studied the implications of new technology for workers engaged in printing industry. He found that there has been a change in the structure of employment in the industry due to technological change.

Brynjolfsson, Malone, Gurbaxani and Kambil (1993) tried to assess the hypothesis that the rapid growth of information technology (IT) is at least partially responsible for one important organizational change, the shift of economic activity to smaller firms. They examined this hypothesis using industry-level data on IT capital and four measures of firm size, including employees per firm. They found broad evidence that investment in IT is significantly associated with subsequent decreases in the average size of firms. They also found that the effects of IT on organizations are most pronounced after a lag of two to three years.

In their fieldwork in a telecommunications company, Brown, Nakata, Reich and Ulman (1997) witnessed a job that was transformed without recognition that new skills were being used in a dramatically different job. Telephone line assignors, who traced telephone lines by hand in a book of city telephone lines, were largely replaced by computers that automatically assigned lines except for the non-routine cases, which were done by a group of retrained workers.

Cheon (1999) in his study on changes in the employment, occupation and skill structure in the Korean manufacturing sector found that employment
growth has occurred primarily in those sectors that accomplished capital
deepening and technological development to secure global competitiveness
of exports or compete with foreign imports.

Goldar and Kumari (1999) attempted to analyze the effects of technological
imports on employment growth in 44 engineering companies for the years
1985-86 to 1994-95. Based on the analysis, they concluded that there was a
significant negative effect of technology imports on employment growth.
The effect of technology import was found favourable in the pre-reform
period (before 1991) but not in the post-reform period.

Patel and Gandhi (1999) analyzed the implications of two-way relationship
between trade and technology on employment in agro-based industries by
using ASI (Annual Survey of Industries) time-series data for the years
1974-75 to 1993-94. They found that growth rates indicated that the
significant rise in technology and trade does not lead to significant rise in
employment. They concluded that on the one side very small values of
marginal employment potentiality of technology and that of trade, and on
the other, very high negative growth rates have indicated that employment
is increasing at a diminishing rate.

Singh and Nandini (1999) conducted a study to discuss the impact of trade
and technology on employment in the Indian software industry by using
two models – open economy employment model and open economy
technology employment model. They took into account the macro perspective (industry level approach) and micro perspective (firm level approach). They concluded that in the case of open economy technology employment model, technological advancements (in terms of foreign technical collaborations and quality certifications) have, in general, a positive impact on salaries, employment and productivity.

Harabi (2000) used data from around 1600 firms in five different countries (Germany, Great Britain, Italy, Holland and Switzerland) to investigate the factors affecting direct employment changes due to eco-innovations (a subset of the overall technological change) at the firm level. He found the following results: firms investing in relatively important (from the firm’s perspective) labour cost saving product innovations that have not been subsidized by the state and pursuing a market driven business strategy that lead to increases of their sales in industries in which they have a market power also increases the likelihood of their achieving a positive long term direct employment affect. Firms that deviate- on average- from this ideal portrait do not have positive direct employment effects.

Drawing on a case study of the automobile repair industry, Levy, Beamish, Murnane and Autor (2000) argued that computers are most likely to substitute for jobs that rely on rule-based decision making while complementing non-procedural cognitive tasks.
Autor, Levy and Murnane (2002) in their study of a large bank described how a single technological innovation, the introduction of image processing of checks, led to distinctly different changes in the structure of jobs in two departments of a large bank overseen by one group of managers. In the downstairs deposit processing department, image processing led to the substitution of computers for high school educated labour in accomplishing core tasks and in greater specialization in the jobs that remained. In the upstairs exceptions processing department, image processing led to the integration of tasks, with an associated increase in the demand for particular skills. The case illustrates the interdependence of technological change and organizational change. It suggests that seeing the whole picture and associated conceptual and problem-solving skills are made more valuable by information technologies. Finally, it underscores that the short-term consequences of technological changes may depend importantly on regulatory forces.

Vijayabaskar and Parthasarathy (2003) in their study on Diffusion of Information and Communication Technologies in India have given results obtained from interviews conducted and information collected from four automobile firms and one call centre firm. They found that use of information and communication technologies in the automobile industry has led to reduced need for jobs in certain areas like documentation, inter-
departmental communication, data processing and similar clerical work apart from losses due to automation in the shop floor. They also found that while some jobs do require more skills with the use of information and communication technologies, some have witnessed reduced skill content hinting at a possible skill polarisation.

Mitsuru, Yoshio and Masahiro (2004) using a regression method derived from the neo-classical production model identified the impact of computerization on regular employment ratios, considering the substitution relationship between regular and non-regular employment. Their analysis suggests the possibility that in industries other than machinery manufacturing, the progress of computerization is a technological change that enables companies to reduce the number of regular positions. It also indicates that as a result of digitization of work and changes to internal information processing systems with the introduction of information and telecommunications technology, the advantages held by regular employees - i.e. that they are well-versed in the work and have built up human networks within the organization - may be diminished.

Chan and Rich (2006) introduced a two-step empirical approach for examining both the nature and sources of non-neutral technical change across multiple occupations. First, conventional labour-demand parameter estimates and unbiased tests for neutrality were obtained in the context of a
flexible cost system. The resulting input-specific indices of technical change, unconstrained with respect to time path, facilitated subsequent evaluation of proposed sources. In their application to employment decisions of airline firms, they found labour-saving technical change that was non-neutral across occupations. The authors also documented occupation-specific responses to aircraft technology adoption, route system developments and an unprecedented range of technical change elements.

**Studies on The Skill-Bias Effect of Technological Change**

Baran (1985) in her study of the technological transformation of the insurance industry found that, as regards office automation, the introduction of high technology eliminates the lowest-skilled jobs, upgrades some semi-skilled clerical and secretarial jobs connected with the operation of the equipment, and also tends to eliminate many lower and middle management jobs – precisely those that hitherto provided upward mobility in the industry for women.

Flynn (1985) analyzed almost 200 case studies of the employment effects of process innovation during 1940-1982. He surveyed process automation and considered the impacts of technological change on skill requirements. He found that process innovation in skill-intensive manufacturing processes often eliminated high-skill jobs and generated low-skill jobs. The opposite was true, however, for the adoption of data word processing technologies in
offices, which eliminated low-skill jobs and created high-skill jobs. Flynn
found that in addition to transforming the contents of many jobs, automation created new jobs at both ends of the skill spectrum. Flynn
concluded that the net effect of process innovation on employment was indeterminate and depended heavily on conditions within individual firms or industries.

Baran (1986) in her study of the technological transformation of white collar work in the insurance industry noted that the effects of product innovation and redesign (e.g., Substituting microelectronics for electromechanical components in office equipment) on skills are considerable. Baran reported that automation fragmented and standardized clerical work, requiring lower-level and narrower skills.

National Research Council's committee on the effective implementation of advanced manufacturing technologies (1986) found that the introduction of automated manufacturing technologies reduces the number of job classifications while broadening the scope of activities within each classification. The new groupings typically involved a broader range of skills, reflecting greater number of machines, an expansion of the range of operations for which a worker was responsible, or the rotation of workers through different jobs.
In their studies of the British Engineering industry, Senker and Beesley (1986) showed that technological changes alter the occupational structure in favour of the highly skilled strata.

A set of case studies in Asian countries (ILO, 1988) of automation in the banking, engineering, electrical appliance, and printing industry concluded that it is difficult to identify deskilling or reskilling with automation. The report pointed out that, it seems that the new jobs being created do not require higher skills, only different skills.

Henderson (1989), in his study of the British Engineering industry, showed that technological changes alter the occupational structure in favour of the highly skilled strata.

Berndt, Morrison and Rosenblum (1992) in their industry-level study also showed a strong connection between investment in high technology equipment and the demand for skilled, educated workers.

Bound and Johnson (1992) examined wage rates and education levels across a number of industries using the 1973-1974, 1979 and 1988 U.S. Current Population Survey. They demonstrate that the strongest factor in the increase of the relative wages of higher skilled workers and the relative decrease in wages of less skilled workers was technological change that favoured more educated labour over less educated labour.
In their study on skill-bias effect of technological change, Berman, Bound, and Griliches (1994), in their study at the sectoral level found a positive and significant relationship between R & D and skilled labour in the US. Berman et al. (1994) used data from the Annual Survey of Manufactures to examine directly the evidence for skill-biased technical change in the U.S. labour market. They found that the proportion of non-production workers in U.S. manufacturing plants increased from 27 per cent in 1959 to 35 per cent in 1989, and that the rate of increase rose after 1973. The same pattern is also evident in total payrolls, which Berman et al. argue to be a better indicator of demand shifts. Non-production workers are defined as ‘those engaged in supervision (above the working foreman level), installation and servicing of own product, sales, delivery, professional, technical, administrative etc.’ Using labour market data, the authors argue that there is a close correspondence between educational attainment, white collar status, and being a non-production worker. Because the shift towards non-production workers occurred within the 450 different categories of manufacturing industry, and was not the result of shifts in employment across industries, the authors conclude that the shift was caused by skill-biased technical change, rather increased foreign competition or the increase in defence spending. These latter influences would have tended to change the composition of demand across industries, which do not seem to have happened.
Penn (1995) conducted an interesting examination of the impact of technological change on employment patterns in British retailing during the late 1980s. The study revealed that technological change had not produced much in the way of deskilling. In fact, in the majority of cases, the outlets surveyed reported no perceived effects on skill levels as a result of the introduction of new technology. Indeed, some organizations identified an enskilling process at work, although this enskilling process was confined to management grades. In effect, the introduction of technology enhanced the skills of already highly qualified and trained managers but it did not enhance the skills of poorly qualified and minimally trained sales staff. This led Penn to suggest that something of a process of polarization was at work in retailing. Consequently, he concluded that technology had not produced much in the way of deskilling but had enskilled a certain section of the workforce and this had added to the bifurcation of employment opportunities within retailing.

Dunne, Haltiwanger and Troske (1996), in their study on skill-bias effect of technological change at the firm level have also found a positive and significant relationship between R & D and skilled labour in the US.

In their case study of accountants at a large urban bank, Levy and Murnane (1996) found that computerization eliminated the routine parts of the job (e.g., data entry and transfer, computation) and left the more difficult
exceptions (e.g., data rework, valuation, and analysis). They concluded that although computerization increased the demand for skilled labour in the redesigned job, the bank chose to provide in-house training rather than increase the wages and skill requirements for new hires. Computerization also required upgrading the skills of the first-line managers and allowed the development of increasingly complex products.

In his study on the skill-bias effect of technological change for the UK, Machin (1996) – using both sectoral-level and firm-level data in the 1990’s – demonstrated a positive relation between R & D intensity, number of innovations produced and used, and skilled labour.

Plant-level studies of U.S. manufacturing by Bernard and Jensen (1997) found strong positive relationships between within-plant skill upgrading and both R&D intensity and computer investments.

In her study on the skill-bias effect of technological change in Canada, Betts (1997), who examined manufacturing, showed a connection between several different measures of technology and the growing demand for skilled workers.

Plant-level studies of U.S. manufacturing by Doms, Dunne, and Troske (1997) found strong positive relationships between within-plant skill upgrading and both R&D intensity and computer investments. But they found little relationship between a plant-level indicator of the number of
new factory automation technologies being used and within-plant skill upgrading. In contrast, case studies by the Bureau of Labour Statistics indicated large production labour saving production innovations were adopted in the 1970s and 1980s in the electrical machinery, machinery, and printing and publishing sectors -- three industries that are among the leaders in the rate of skill upgrading in most developed countries (Berman, Bound, and Machin 1998; Mark 1987).

Hitt and Brynjolfsson (1997) surveyed about four hundreds firms and found not only that greater levels of information and communication technologies were associated with increased delegation of authority to individuals and teams, but also that the combination of technological and organizational change involved a skill bias both in the firms' actual workforces and in their recruitment strategies.

Siegal, Waldman and Youngdahl (1997) used a firm level survey to examine the compositional and empowerment changes that occur due to technological change. They concluded that introduction of advanced manufacturing technologies is associated with downsizing of the firm and a shift in labour composition in favour of workers with higher levels of education.

Autor, Katz, and Krueger (1998), in their study on computerization, using three-digit Census industries, found that the rate of within-industry relative
demand growth for college workers increased from the 1960s to the 1970s and remained at a higher level in the 1980s through 1996. The large jump in within-industry skill upgrading occurred first in service industries in the 1970s and later in manufacturing industries in the 1980s. This timing pattern appears consistent with an earlier impact of computerization through organizational applications of computers on many service industries in the 1960s and 1970s and the somewhat later large-scale impact of microprocessor technologies on manufacturing production processes. These findings motivate a more detailed and direct look at the evidence on the impact on labour demand of skill-biased technological change and the spread of computers.

Baumol and Wolff (1998) conducted a study on the effects of technological variables on unemployment duration and the results showed that unemployment duration increases when the rate of technological change rises. The mean duration of unemployment remained unchanged over 1950’s, 1960’s and 1970’s at about 11.5 weeks, it jumped to 14.6 weeks in the 1980’s and 15.6 weeks in the first half of the 1990’s. The result also showed that technological change affects older workers more adversely than younger workers in terms of duration of unemployment.

Machin and Reenen (1998), in their study on the skill-bias effect of technological change (at the manufacturing sector level for seven developed
countries over the period 1973-89) showed that the relative demand for skilled workers was positively linked to R & D expenditure.

Siegel (1998) studied the impact of technological change on employment and found evidence of upskilling in those Long Island manufacturing plants that had introduced new technologies.

Adams (1999) in his study of US chemical firms also showed the skill-bias nature of R & D expenditure and innovative investments.

Brown and Campbell (1999) in their study on technological change in semiconductor companies found that the use of new automation and IT systems appears to go with a worsening of career ladders for higher skilled workers at semiconductor plants, and this is the opposite of the result expected with SBTC (Skill Biased Technical Change). They concluded that this indicates that the impact of technological change on skill demand, including education and the speed of knowledge depreciation, is a complex relationship that must be explored in more detail.

In Germany, Falk (1999), in his study on the skill-bias effect of technological innovations at the firm level showed that the joint implementation of new products and processes had the greatest effect on the employment structure, exerting the strongest positive impact on the demand for highly skilled workers.
In their study on the skill-bias effect of technological change in Canada, Gera, Gu and Lin (1999), who focused on both the manufacturing and service sectors (1981-94), showed a connection between several different measures of technology and the growing demand for skilled workers.

In their study of the skill-bias effect of technological change for the UK, Haskel and Heden (1999) – at the firm-level – demonstrated a positive relation between R & D intensity, number of innovations produced and used, and skilled labor. Using panel data, Haskel and Heden found that as establishments computerized, their demand for more highly skilled workers increased and for manual workers decreased.

Murnane, Levy and Autor (1999) in their study of a bank on technological change and skill demands showed how the lower-skilled jobs in check processing were redesigned with the introduction of image processing technology. They found that the outcomes for these jobs were more complex, in those instances of both increases and decreases in skill and pay occurred. The transformation required a structured training program and worker buy-in to be successful.

Siegal (1999) conducted a survey to find out the organization wide impact of workplace changes that result from the implementation of new technologies. He concluded that technological change is associated with
downsizing and a shift in labour composition in favour of workers with higher levels of education.

In France, Mairesse, Greenan and Topiol-Bensaïd (2001) obtained results similar to those of Machin (1996) for firm level data where the technological variables were ICT (Information and Communication Technologies) capital and ICT workers. However, only the negative relation between ICT and less-qualified labour was robust in the time-series estimations. This confirmed the results of Goux and Maurin (2000), who showed that an increased spread of new technology accounted for only 15 per cent of the change in labour demand between 1970 and 1993.

Paul and Siegel (2001) assessed the impacts of trade, technology, and outsourcing on shifts in labour demand using a dynamic cost function framework and comprehensive measures of workforce composition and investment in technology. Their findings indicate that technological change has had the largest impact on changes in labour composition. However, the indirect impact of trade on shifts in employment augments its direct impact because trade stimulates computerization, which further exacerbates skill-biased technological change.

Bauer and Bender (2002) studied the effect of organizational and technological changes on gross job and worker flows. They found that organizational change is skill-biased because it reduces predominantly net
employment growth rates of unskilled and medium skilled workers, whereas the employment patterns of skilled workers are not affected significantly. They, however, found that new IT does not have significant affects on gross job and worker flows as soon as established fixed-effects are controlled for.

Bresnahan, Brynjolfsson and Hitt (2002) investigated the hypothesis that the combination of three related innovations, 1) information technology (IT), 2) complementary workplace reorganization, and 3) new products and services, constitute a significant skill-biased technical change affecting labour demand in the United States. Using detailed firm-level data; they found evidence of complementarities among all three of these innovations in factor demand and productivity regressions. In addition, they found that firms that adopt one or more of these innovations tend to use more skilled labour. They said that the effects of IT on labour demand are greater when IT is combined with the particular organizational investments, highlighting the importance of IT-enabled organizational change.

Kölling and Schank (2002) in their study on Skill-biased technological change, international trade and the wage structure investigated their hypothesis for West Germany, 1994-1997, using the LIAB, a unique German linked employer-employee panel data set, which combines information from the German employment statistics and the IAB
establishment panel. Employing a generalised Leontief cost function and controlling for unobserved plant heterogeneity, the demand for three different skill types of labor was estimated. The results showed that the major part of the skill structure is determined by wages, while they found only minor impacts of a skill-biased technological change, of international trade and of short-run effects due to the business cycle.

Autor, Levy and Murnane (2003) studied how computer technology alters job skill demands. They contended that computer capital (1) substitutes for a limited and well-defined set of human activities, those involving routine (repetitive) cognitive and manual tasks; and (2) complements activities involving non-routine problem solving and interactive tasks. Provided these tasks are imperfect substitutes, their model implies measurable changes in the task content of employment, which they explored using representative data on job task requirements over 1960 -- 1998. They concluded that computerization is associated with declining relative industry demand for routine manual and cognitive tasks and increased relative demand for non-routine cognitive tasks. Shifts were evident within detailed industries, within detailed occupations, and within education groups within industries. Translating observed task shifts into educational demands, the sum of within-industry and within-occupation task changes explained thirty to forty per cent of the observed relative demand shift favouring college
versus non-college labor during 1970 to 1998, with the largest impact felt after 1980. Changes in task content within nominally identical occupations explained more than half of the overall demand shift induced by computerization.

Bjørnstad and Skjerpen (2003) in their study on Technology, Trade and Inequality used a large macroeconomic model for Norway (MODAG) to quantify the importance that technological developments and competition from low-cost countries have had for the economy and for low- and high-educated labour. The results showed that above all technological developments, but also increased trade with low-cost countries, have reduced demand for low-educated labour relative to well-educated labour. Wage formation factors have however meant that technological developments have also benefited those with low education who still hold a job.

Falk and Koebel (2003) studied the impact of office machinery and computer capital on the demand for heterogeneous labour. Their empirical analysis indicated that the accumulation of office machinery and computer capital stock - in 35 German industries over the period 1978-94 - was a relevant factor contributing to the shift in labour demand towards highly skilled workers (university graduates).
Goos and Manning (2003) in their study on the Rising Polarization of Work in Britain argued that skill-biased technical change had some deficiencies as a hypothesis about the impact of technology on the labor market and that a more nuanced view recently proposed by Autor, Levy and Murnane (2003) is a more accurate description. The difference between the two hypotheses is in the prediction about what is happening to employment in low-wage jobs. Their paper presents evidence that employment in the UK is polarizing into lovely and lousy jobs and that a plausible explanation for this is the Autor, Levy and Murnane hypothesis.

Pierrard and Sneessens (2003) conducted their study that was both methodological and empirical on Low-Skilled Unemployment, Biased Technological Shocks and Job Competition. They constructed a dynamic general equilibrium model with two types of jobs and two types of workers and with search unemployment. The model was calibrated and simulated to examine the interactions between the “skill bias” and “crowding out” mechanisms. When such interactions were accounted for, the model reproduced quite well the observed unemployment changes.

Piva, Santarelli, and Vivarelli (2003) estimated a SUR model for a sample of 400 Italian manufacturing firms, showing that the upskilling is more a function of the reorganizational strategy than a consequence of technological change alone. Moreover, some evidence of super additive
effects emerges, consistently with the theoretical hypothesis of a co-evolution of technology and organization.

Sanchez-Paramo and Schady (2003) in their study on Technology, trade and the rising demand for skilled workers in five Latin American countries—Argentina, Brazil, Chile, Colombia, and Mexico used repeated cross-sections of household surveys, and decomposed the evolution of relative wages into factors associated with changes in relative supply and relative demand. The authors had three main conclusions: 1) Increases in the relative wages of the most skilled (university-educated) workers took place concurrently with increases in their relative abundance in all of the countries except Brazil. This is strong evidence of increases in the demand for skilled workers. 2) Increases in the wage bill of skilled workers occurred largely within sectors, and in the same sectors in different countries, which is consistent with skill-biased technological change. 3) Trade appears to be an important transmission mechanism. Increases in the demand for the most skilled workers took place at a time when countries in Latin America considerably increased the penetration of imports, including imports of capital goods. The authors show that changes in the volume and research and development intensity of imports are significantly related to changes in the demand for more skilled workers in Latin America. Their
research complements earlier work on the effects of technology transmitted through trade on productivity and on the demand for skilled labor.

Kudyba (2004) conducted his study to identify the effect on companies' output of investment in IT (Information Technology) skills using data for 1995-97 regarding numbers of workers and IT-skilled workers employed by the top 500 corporations making intensive use of IT in the United States, as well as company disclosure reports. He concluded that changes in firms' IT capabilities indeed increased demand for IT-skilled labour and improved productivity.

Baltagi and Rich (2005) in their study on Skill-Biased Technical Change in U.S. Manufacturing applied recent advances in productivity and efficiency measurement to the evaluation of skill biased technical change. Using the general index approach they were able to establish an explicit and unconstrained time path for non-neutral technical change between production and non-production labour in U.S. manufacturing industries over the 1959-1996 period. Their findings confirm the prevailing interpretation in the labour economics literature that substantial reductions in the relative share of production labour are attributable to a sustained period of non-neutral technical change. However, they found that skill-biased technical change effects are most evident prior to 1983. This predates the diffusion of personal computer technologies in the workplace.
and the dramatic wage structure changes associated with the 1980’s. In contrast to prevailing alternatives, the general index approach also permits us to explain observed shifts in relative labour demand as a combination of price-induced substitution, nonhomothetic output effects and skill-biased technical change responses to a range of proposed elements.

Berman, Somanathan and Tan (2005) investigated the hypothesis that skill-biased technological change did in fact arrive in India in the 1990s using panel data disaggregated by industry and state from the Annual Survey of Industry. These data confirmed that while the 1980s were a period of falling skills demand, the 1990s showed generally rising demand for skills, with variation across states. They found that increased output and capital-skill complementarity appear to be the best explanations of skill upgrading in the 1990s. Skill upgrading did not occur in the same set of industries in India as it did in other countries, suggesting that increased demand for skills in Indian manufacturing is not due to the international diffusion of recent vintages of skill-biased technologies.

Giuri, Torrisi and Zinovyeva (2005) explored the complementarities between skills, organizational change and investments in information and communication technology (ICT). Their work contributes to the literature on the effects of ICT by testing the hypothesis of complementarity in a panel of 540 Italian manufacturing firms during the period 1995-2000.
Their analysis provides strong support to the hypothesis of complementarity between skills and ICT (which is at the core of the skill-biased technical change theory). They also found some evidence in favor of the skill-biased organizational change hypothesis. The results obtained by drawing on different statistical methods suggest that interactions among ICT, skills and organizational change are complex and non-linear and difficult to explain.

Huttunen (2005) investigated the impact of exports and R&D activity on the skill structure of labour demand, using panel data on Finnish establishments for 1988-2001. The author defined worker’s skill level by both education and age. The results indicate that despite the general shift in employment towards highly educated and older workers, the selected technology and trade indicators, R&D intensity, and export share, did not have significant effect on the changes in the skill demand within manufacturing sector plants in Finland during the period.

Moutos (2006) in his study on Technological Change, Inequality and Work Sharing constructed a model in which hours of work and technological change affect both the (relative) demand and supply of unskilled workers. The labour supply of unskilled workers (numbers of persons) was derived from a model of household labour supply in which households differ regarding the disutility suffered when both household members work.
Combining together the (relative) supply and demand parts of the model he was able to study the effects of technological change on wage and income inequality and to provide an explanation of recent trends more consistent with the stylized facts.

**Role of Technology in Downsizing**

Pinsonneault and Kraemer (1997) addressed the state of inconsistent findings across multiple studies by examining the impact of information technology on the number of middle managers using two additional variables: the degree of centralization of organizational decision authority and the degree of centralization of computing decision authority. They surveyed one hundred and fifty-five city governments. They found that information technology was both positively and negatively associated with the size of the middle management workforce. The impact of information technology was fundamentally determined by who controlled computing decisions and what interests were being served, and by the roles of middle managers. Information technology was associated with a decrease in the size of the middle management workforce in organizations with centralized decision authority and with an increase in the number of middle managers in organizations where decision authority was decentralized.

Simón, Sánchez and Olazaran (1999) analyzed the process of technical and organizational innovation through which a leading firm in the Spanish legal
information sector adapted to the changes in its environment in the late 1980s and early 1990s. They found that there had not been downsizing in the narrow sense of the term. A deep reorganization process had been carried out, but total number of workforce had not been reduced and there had not been any dismissals. The number of production activities workers had been reduced but this had been compensated by increasing levels of analysis and information-processing department’s personnel (the “intellectual core” of the firm).

Pinsonneault and Kraemer (2002) conducted a study to explore the role information technology (IT) plays in organizational downsizing by studying two medium-sized American cities over a period of 10 years (1985-1995). Four main findings emerged from the case studies. First, IT was found to facilitate organizational downsizing, but not to cause it. New City invested heavily in state-of-the-art IT over the years and more successfully downsized the organization than Old City, which lagged behind in IT investment and made no serious attempts to use IT as a tool to support strategic actions. Second, adverse environmental conditions triggered downsizing in both cities and determined the change strategies that managers used. When environmental pressures were mild (1985-1990), managers favoured a convergent change strategy that resulted in limited downsizing efforts and small personnel reductions. In contrast, when
environmental pressures were strong (1990-1995), managers of both cities engaged in strategic reorientation and in downsizing efforts that led to larger personnel reductions. Third, the role IT played in organizational downsizing varied according to the change strategy. IT was used to facilitate work redesign in a convergent change strategy and to facilitate more significant structural and work redesign in strategic reorientation. Fourth, more integrated and better use of IT allowed managers of New City to downsize more rationally and efficiently. It facilitated the transfer of personnel within departments, from middle management to the operations level, and across departments, from internally oriented to customer-oriented personnel. In doing so, managers of New City minimized operating costs while maintaining the same level of services. In contrast, IT in Old City did not facilitate such an agenda and managers downsized more superficially across the board, in all departments.

Dewettinck and Buyens (2004) executed 19 case studies in Belgian organizations that were confronted with downsizing. They found that technological evolutions influence the magnitude of downsizing. They observed that labour-intensity of production processes can decline very heavily by technological innovations. A second observation that they made is that technological innovation can influence the market, and can lead to a changed demand. Depending on the speed whereby technological
innovations influence market demands, the degree of innovation and the
difficulty to upgrade competencies, organizations can take the option to
right size human resources.

**Psychological Aspects of Change**

Coch and French (1948) conducted research at the Harwood Manufacturing
Company, to find out as to why people resist change so strongly and what
could be done to overcome the resistance. Through a variety of
experiments, Coch and French basically concluded that groups that were
allowed to participate in the design and development of the changes had
much lower resistance than those that did not. Moreover, they concluded
that participation through representation results in slower recovery than
does total participation.

Ashford, Lee and Bobko (1989) developed a Job Insecurity Scale for their
study on job insecurity. The authors reported that job insecurity is
associated with declines in commitment, trust in organization, and job
satisfaction. They also reported positive relationships between job
insecurity and both organizational change and role ambiguity, and that a
significant negative relationship exists between job insecurity and power to
control outcome.

Pedersen (1991) studied the effects of layoffs on work performance of
engineers. He reported that a merit based work-force reduction policy
combined with timely communications about the layoff process may tend to improve the work performance of the survivors, enabling the organization to get back on track.

On the basis of three large-scale surveys undertaken in 1980, 1984 and 1990, of around 2000 British workplaces, Daniel and Millward (1993) observed wide spread support for technical changes, including advanced technical changes, among both manual and non-manual workers. The support from their trade union representatives was even stronger. However, the same study pointed out that the reactions provoked by organizational changes were much more mixed. Organizational change was more often resisted than supported by manual workers. The reactions of office workers in this respect were fairly evenly balanced between favourable and unfavourable, but these employees, too, were much less supportive about organizational change than technical change.

Korunka, Weiss, and Karetta (1993) examined the influence of the implementation process of new technologies on the level of strain and satisfaction and the stress aspects of job contents, organization and the physical conditions of the environment. They found that the level of strain increases during the implementation process. The amount of this increase was found to correlate with the company’s style of implementation as well as the type of the individual work activity. The highest level was found
among those employees little included in the implementation process and those whose work was described as monotonous.

McCarthy (1993) used Ashford et al.'s Job Insecurity Scale as a measurement tool for his study of job insecurity in a merger environment. He reported that the measure of job insecurity did show a significant difference between the three locations as hypothesized. In addition, his results indicated that both powerlessness and organizational trust were significantly related to job insecurity, further validating Ashford et al.'s study. It suggests a relationship between the degree of organizational change and the measure of job insecurity. It also substantiates several of Ashford et al.'s results with a high return rate that supports the inferential validity of the Job Insecurity Scale. Koesterer (1994) further validated Ashford et al.'s Job Insecurity Scale. In her study, three variables emerged as significant predictors of job insecurity: management level, job changes, and relocation.

Research by Pickard (1993) on redundancy showed that employees offered outplacement are very positive about the support.

In 1994, Johns studied the effects of downsizing on middle managers. He found that those perceiving a significant role change or ambiguity reported a decline in work performance.
Kotter (1995) observed over 100 companies in a decade and reported that when organizations attempt a major change, the employee often understands the new vision and wants to make it happen, but there are obstacles that prevent execution.

Roy (1995) from her study of the banking industry concluded that the worker may become an eager supporter of technological change.

Spreitzer and Quinn (1996) report a model of managerial change based upon a large-scale change effort at the Ford Motor Company. Over a four-year period, 3,000 middle managers voluntarily participated in a management development program that was designed to be transformational. Spreitzer and Quinn hypothesized a model that was then tested with 191 managers who participated in follow-up sessions. This model suggests that a manager's willingness or resistance to engage in a transformational change initiative depends on individual and organizational characteristics. Spreitzer and Quinn hypothesized that the following individual factors would be significant in whether or not a middle manager would initiate a transformational change effort (as opposed to transactional change, personal style change, or no change): 1.) high self esteem, 2.) positive affect, 3.) "high potential." Their research confirmed the first two factors, but paradoxically found a statistically significant negative finding with "high potential." The middle managers making transformational
changes targeted at the organizational level had both the lowest promotion rate prior to attending the training and as measured 2 ½ years later. Spreitzer and Quinn learned from plateaued managers that they felt they could now do "the right thing" (transformational change) since they didn't feel restrained by the political race for promotion which would encourage them to do the "political thing" or the "easy thing." Spreitzer and Quinn also hypothesized that some factors of organizational context would be significant: 1.) social support of coworkers, 2.) social support of supervisor, 3.) perceived structural barriers, 4.) perceived imbedded conflict barriers. Again, their study confirmed the first two factors as statistically significant. Spreitzer and Quinn found that all of the managers reported some structural and cultural barriers and the presence of the significant factors above is what made the difference in whether or not a middle manager was willing to attempt transformational change. Spreitzer and Quinn claim their findings affirm Smith (1982) whose laboratory work revealed that whoever is in power would seek to maintain the status quo rather than seek change. These authors believe that if leaders call for more empowered behavior, but do so in ways that are seen by followers as disempowering, then resistance will result. Kher (1997) in his study of coping with technological change noted that although the workers and unions have been resisting changes in the shop
floor directly and technological changes indirectly, companies in the private sector have dealt with the workers successfully by incorporating counter-demands in their wage settlements.

A longitudinal study conducted by Waldersee and Griffiths (1997) of 500 large Australian organizations during 1993 and 1996 revealed that employee resistance was the most frequently cited implementation problem encountered by management when introducing change. Over half the organizations surveyed experienced employee resistance.

Wright, Kacmar, McMahan, and Jansen (1997) conducted a longitudinal study to examine the impact of an information technology system on the job and employee attitudes in a parts distribution centre for a Fortune 500 company. Data were collected prior to, during, and following the implementation of an automated information technology system. Results of both the within subjects (N=24) and between subjects (N=58) analyses indicated that the automated technology reduced motivational and increased mechanistic aspects of the job as well as reduced employee attitudes.

Research by De Vos, Denolf, Denys, Buyens, Vandenbossche and Martens (1998) on outplacement showed that employees offered outplacement are very positive about the support. Further, outplacement enhances the chance to reemployment significantly.
Research by De Vos and Buyens, (1999) on the use and effectivity of group outplacement in case of downsizing also showed that employees offered outplacement are very positive about the support.

Wagner (1999) conducted his study at an electric utility designed to test for the presence of a relationship between job insecurity and resistance to an organizational culture shift at an organization where cultural-shift activities were being performed concurrently with downsizing efforts. The study provided evidence that the possession of either a high degree of job insecurity or a high degree of entitlement mentality will tend to present an obstacle to an organizational culture shift in that organization’s members. While the contribution of job insecurity and entitlement mentality, when used as a predictor for resistance to an organizational shift, account for only a fraction of the variance, the results clearly indicate that the three variables, as defined for the study, are related.

Bovey and Hede (2001) conducted surveys to investigate the role of both adaptive and maladaptive defence mechanisms in individual resistance in nine organisations undergoing major change and obtained responses from 615 employees. The results indicate that five maladaptive defence mechanisms are positively correlated with behavioural intention to resist change, namely, projection, acting out, isolation of affect, dissociation and denial. The adaptive defence mechanism of humour was found to be
negatively correlated with resistance intention. The authors identified two intervention strategies that can be used by management to address the effects of defence mechanisms on resistance during periods of change in organisations.

Dent and Powley (2001) tried to explore the belief that people resist change in organizational life. An exploratory study was conducted using interviews to reveal the fullness of how people experience change at work. Six primary dimensions surfaced from 945 change incidents analyzed. Reactions to change varied considerably by dimension. Overall, interviewees made 1.9 positive statements about change for every negative statement. The authors concluded that the belief in resistance to change may be not only inaccurate, but one which impedes the success of change efforts.

Armstrong-Stassen, Wagar, and Cattaneo (2004) used a longitudinal panel study to investigate the interactive effect of work-group membership stability and time on survivors' reactions to organizational downsizing. The participants were 159 non-management employees of a federal government department. They found that survivors in moderate-change work groups did not react more negatively to the downsizing. In fact, they reported a significant increase in job satisfaction, job security, job performance, and employee morale. Survivors who changed to different work groups expressed the least positive attitudes in the initial phase of the downsizing,
but the most positive attitudes at the completion of the downsizing. Workgroup membership (in) stability was more likely to affect survivors' reactions to various aspects of their job over time than factors related to the work group itself.

Stam, Stanton, and Guzman (2004) conducted their study employing concepts from Kling's social aspects of computing and Schein's career anchor theory, and used qualitative methods including an adaptation of Sacks's membership category analysis method from the field of ethnomethodology that led to insights about the underlying causes of IT resistance among social service workers. The approach revealed, in this situation, that workers' resistance was based particularly on a local history of organizational dysfunction in addition to elements such as performance and effort expectancy, attitudes, and anxiety that is typically discussed in the information technology acceptance literature.

Dong and Xu (2005) using a new data set of state-owned and private Chinese firms to evaluate the effects of labour downsizing on firms allocation efficiency, financial performance, and employee wages found evidence that downsizing has strong psychological costs, leading to severe negative effects of downsizing in state owned enterprises and private firms alike.
Robinson and Griffiths (2005) studied transformational change in a government department to explore why change can be stressful and how individuals employ coping responses to deal with it. Five sources of change stress were found: increased workload, uncertainty/ambiguity, interpersonal conflict, perceived unfairness, and perceived loss. Fifteen coping responses accounted for the data. These were categorized into four coping types: task-centered coping, emotion-focused coping, cognitive coping, and social support coping. Four of the five stressors were related to the use of certain coping types.

Serour and Henderson-Sellers (2005) report the findings of two empirical studies, using Action Research (AR), that were conducted over a period of two years at a mid-size publishing organization in Sydney to investigate the effect of various human behavioural patterns during the organizational transition to Object Technology (OT). They carried out this investigation to validate their theory that the appropriate planning and managing of the human factors during an organizational change may eliminate/mitigate people’s natural resistance to change and increase the chance of success. They focussed on the resistance factor. They observed that human factors such as resistance to change contributed to the first project’s relative failure whereas acceptance of change (managing resistance) contributed to the second project’s success.
Harley, Wright, Hall, and Dery (2006) explored how different types of managers respond to large-scale organizational change and what factors underpin differences in management attitudes and reactions. Through qualitative analysis of the introduction of enterprise resource planning (ERP) systems in two case study organizations, the authors argue that variations in managerial responses to organizational change relate to both the structural position of individual managers and their level of involvement in the implementation of change. Managers are also shown to exhibit agency in interpreting, influencing, and negotiating the impact of organizational change.