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ORGANIZATIONAL TRAINING IN MANUFACTURING FIRMS AND ADVANCED MANUFACTURING TECHNOLOGIES*

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Abstract

The introduction of new microelectronic technologies in the manufacturing process forces companies to adapt human resource strategy to the changes in the workplace. While this subject has been widely researched from an operations management perspective, research from a human resource management viewpoint has been less frequent. The aim of this article is to gain insight into some of the factors that determine personnel training efforts in companies introducing advanced manufacturing technologies (AMTs.) The study provides empirical evidence from a sector with high rates of technological modernisation.

Keywords: ITraining, human resources, metal-mechanic sector, companies, Advanced Manufacturing Technologies, AMT.

INTRODUCTION

Implementation of advanced manufacturing technologies, or AMTs, has become a source of competitive advantage for companies. From an operational perspective there are many benefits from investing in cutting edge capital equipment.

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Greater flexibility, cost reduction, improved customer service and quality all contribute to making the introduction of AMTs profitable.

To fully exploit the potential of AMTs, companies should consider the need for a supporting infrastructure (Jonsson, 2000.) Shortcomings registered in these new technologies are frequently the result of insufficient attention to company organisation, infrastructure and maintenance. All three are necessary for advanced manufacturing technologies to work smoothly and show successful results.

The process of new technology introduction brings about changes in qualifications requirements for personnel, as task content and task organisation are adjusted to the new situation. Training is highlighted as the most appropriate tool to guarantee that the workforce will meet the new needs that manufacturing process innovation originates in a company.

From a human resource perspective, the present study focuses on the factors that cause companies implementing AMTs to provide training programmes for their employees. The study centres on the use of information technologies (IT) in the field of manufacture, especially in the fields of design and engineering, manufacture, mechanisation and assembly. Types of AMT follow the basic categories suggested by Adler (1988), Calabrese (1995), Jonsson (2000) and Meredith (1987): design technologies (CAD) and manufacturing technologies (CAD/CAM, CN/CNC, FMC/FMS, laser, other cutting technologies, robots, automatic warehousing systems, sensors.)

The scope of the study is restricted to formal training and off the job training, organised and carried out by the company. The theoretical background is based on human capital theory and resource and capabilities theory, which traditionally support training in organisations.

THEORY AND RESEARCH PROPOSITIONS

The purpose of this study is to answer the following questions: Does investment in AMTs have a significant impact on personnel training in companies? What factors prompt a company to organise personnel training and allocate specific training budgets? The key hypothesis of this study suggests that company training is mainly influenced by the introduction of AMTs in the manufacturing process.

New technologies affect job requirements (Mintzberg, 1984) and have an influence on workers' abilities, as they are required to acquire the skills necessary to perform their tasks. Therefore, when faced with a new technical alternative, options for task organisation and process training must be considered to justify the investment (Sorge and Streek, 1987.) Table 1 summarises literature that illustrates how successful implementation of AMTs in organisations requires a definite infrastructure and includes human resource mobilisation.

TABLE 1

Variables relating AMTs and infrastructure

Research	Necessary elements of infrastructure
Rockart et al. (1996)	Architecture to define necessary support. Organisational needs for integration and support.
Kathuria and Partovi (2000)	Human resource practice in managerial tasks (training.) Personnel management practice (delegation, supervision, participation.)
Martinez (1996)	Organisational support (training, involvement of other departments, support)
Lindberg (1995)	Recruitment, training, job design, organisational design
Guimaraes et al. (1999)	Operator training, man/machine interface quality
Horte and Hedlund (2000)	Synchrony – asynchrony in technical and organisational change. Human resource management, training, vertical and horizontal integration.
Jonsson (2000)	Organisational design, improvement programmes, empowerment (man-machine interface quality)
Noori (1997)	Strategy, organisation, personnel, government support and relationships
Ghani and Jayabalan (2000)	Structure, personnel (knowledge, attitudes, competencies)
Shepherd et al. (2000)	Personnel qualification, technology management
Mirvis et al (1992)	Training, participational change strategy, organisational elements
Swamidass (1998)	Personnel training
Upton and McAfee (1997)	Qualifications (training, experience)
Dean et al. (1992)	Improvement programmes, organic organisational structure, authorised personnel
McLachlin and Piper (1992)	
Saraph and Sebastian (1992)	
Maffei and Meredith (1994)	
Sun and Gersten (1995)	
Chen et al. (1995)	
Chen and Small (1996)	
Dawson (1996)	
Lei et al. (1996)	
Co et al. (1998)	
Wong and Ngih (1997)	
Subramanian, Nilakanta (1996)	Organisational factors (centralisation, formalisation, specialisation, size, lack of resources)
Lund, Gjerding (1996)	Technology-organisation harmonisation. Work management and organisation
Taplin (1995)	Complementary applications in non-production areas, work reorganisation

Key variables

The first key variable in our hypothesis is the implementation of Advanced Manufacturing Technologies or AMTs. AMTs are defined as manufacturing techniques that use microelectronic technology. The indicators for use of AMT have been established by reference to the measures suggested by Baldwin (1999), Baldwin et al. (1995a), Baldwin et al. (1995b), Bartel and Lichtenberg (1987), Bartel and Sicherman (1995), Bishop (1996), Daniel (1987), Johnson (1999), Lynch and Black (1997.)

The second key variable is training. The two main training approaches are on the job training and off the job training. In the context of this survey, "training" is specifically restricted to mean courses and activities organised either by the company, or by the company together with other companies, and made available for the company personnel. This is the definition adopted by Glover et al. (1999), Groot (1999), Groot et al. (2000), Kitching and Blackburn (2002), Lynch and Black (1997), Moy and McDonald (2000), Oosterbeek (1996) and Spilsbury (2001.) Thus, the study refers to formal training as described by Alcaide, González and Flórez (1996), i.e. structured training, on or off company premises, during working time or at other times.

Other variables

The main purpose of this study is to examine the relationship between AMTs and training. However, the model also introduces other variables that are likely to affect their dynamics. The study includes a heterogeneous group of factors which affect companies' training policies. We aim to gain some insight into the determinant factors of corporate training policies, with the assumption that implementation of AMTs will be shown to be the main issue regarding strategic decision to assign training efforts. An overview and definition of the variables included in the survey follows.

Work organisation

Work organisation has been highlighted as a possible determinant factor for training policies. Several studies suggest that AMTs should be implemented simultaneously with corresponding alterations in organisational structure. A link is shown between new organisational formulas and training, although thus far it has not been sufficiently proved. Nevertheless, certain new practices in company organisation, identified as new forms of work organisation (Bishop, 1996; Erickson and Jacoby, 1998; Frazis *et al.*, 1988; Kirstensen, 1998; Lynch and Black, 1997; Osterman, 1995) appear to be determinants of training. Sometimes both aspects are connected by new technologies.

Size of the organisation

The connection between size of the organisation and human resource management has been a topic for extensive research. Size is one of the variables proposed by Mintzberg (1984) as a determinant of company organisation parameters related to training.

Much of the research on the subject of training in companies emphasises the size of the organisation as a key factor which will produce different results. Several

reasons have been suggested to explain this association: risk aversion (Oosterbeek, 1996), scale economies in larger companies (Baldwin, 1995b), the difficulty of replacing personnel during the training period, the need to reduce supervision, the existence of specific human resource departments and posts, the availability of resources to acquire expensive training equipment (Planas and Plassard, 2000.) On the whole, a positive relationship between organisational training and the size of the organisation is proposed. It can thus be argued that the larger the company, the higher the likelihood of it investing in personnel training, and the more intense the training becomes.

Specificity

Human capital theory shows how the specificity of a company's human capital has a strong influence on a company's training activities and training policy. Greater specificity means a longer training period is required for efficient performance. The length of the training is an indicator of the value of the workforce for the company. The need for a long training period makes it harder to find specific human resources on the labour market, and affects human resource management, as personnel is considered unique and valuable (Lepak and Snell, 1999.)

Literature provides examples of research analysing the connection between inadequacy of the labour force available on the market and training provided by Canadian and Australian organisations (Blandy, 1998; Baldwin et al., 1995.) These studies conclude that a large part of the training provided is linked to specific company training needs.

Cost of the investment

Human capital theory proposes that the possibility of personnel leaving the company discourages company training policies. A worker's departure from a company means the direct cost of training is not recovered. Other costs are the loss of productivity until the company finds a substitute and he/she reaches full productivity. Recruitment and selection costs must also be accounted for. As a result, the rate of labour turnover has an effect on training efforts within companies.

Numerical flexibility

When the distinction is made between permanent and non-permanent personnel (temporary, part time and contract workers), permanent workers have generally been found to enjoy priority access to company training (Sauter, 1988.) Permanent workers are more liable to give the company a return on its investment, and often need training the most. Research has shown that continuous training

tends to be restricted to permanent personnel, who will provide the most return on the investment (Planas and Plassard, 2000; Oosterbeek, 1996.) Training is given to personnel that is expected to provide the company with the highest returns for the longest period, so permanent personnel is more liable to receive company training. The length and the nature of working contracts have an influence on a company's decision on how often and how much it invests in training.

Personnel qualifications

Organisations aim to obtain the highest profitability from their training efforts. The decision on which workers to train depends on the existing characteristics of the workers themselves, that is, the stock of human capital. The literature emphasises personnel qualifications and degree of education as a determinant of training.

Research suggests that formal education provides the basis for best advantage of specific training, and that successful personnel training depends on the degree of previous education. It follows that companies that choose to provide training for their workforce will seek to protect their investment by selecting those with higher qualifications, who showed ability to learn in formal education programmes. Therefore, highly qualified workers are more likely to receive training.

Companies with a highly qualified workforce are also companies with the highest rates of training investments. Thus, individual outlays in human capital are the cause behind corporate investments, and investment in human capital tends to constitute a vicious circle.

Similarly, research conducted by Bartel and Sicherman (1995) and Lynch and Black (1997) found that workers with the highest qualifications are the most likely recipients of continuous training when companies carry out personnel training. Groot's (1997) review of international literature on the topic found that highly qualified workers tend to receive more training than others. These studies suggest that companies with a high investment in human capital and a highly qualified labour force invest more highly in training.

Availability of governmental financial backing

In the current economic context in Spain, continuous training in the workplace is part of governmental employment policies, which include substantial public funding to help cover the costs of company training. External funding for company training activities is a crucial factor in a company's decision to invest in training (Sole and Castañete, 1994.) Some organisations lack specific training budgets and develop all activities of this kind on public funding. These companies generally lack real involvement in personnel training, and only train personnel when no cost is involved for the company.

The human capital model proposes that organisations carry out training programmes if they obtain a return on their investment. Consequently, training is mostly specific and tailored to the company's specific requirements. The prospect of covering training expenses via public funding can influence an organisation's decision regarding personnel training.

RESEARCH METHOD

This study focuses on the metal-mechanic sector, which plays a leading role in the economy of Spain and in the north-western Spanish region of Galicia. The number of companies and employees mean the sector has a strong weight in the intermediate goods and services market. The sector displays notoriously high rates of technological innovation and implementation of AMTs in production processes. Data available before our study indicated that organisations operating in the metal-mechanic sector often carry out training activities linked to process innovation. Companies in this sector are frequent recipients of government supported training. The sector is one of the greatest beneficiaries of institutionalised continuous training, with a large volume of courses and personnel which received training, through the medium of the Fundación para la Formación Continua. Thus, companies in this sector are ideal candidates for a survey on the dynamics of training and AMTS.

Concerning population, sample and sample size, a group of companies was chosen to contrast our hypotheses with minimum distortion. We focus on companies from the metal-mechanic sector (SIC codes 34 and 35) with AMT implementation. Data were collated from forty-five companies, sufficient to apply the statistical techniques to suitably evaluate our hypotheses.

The study used a survey created in 2002 which provided information on the metal-mechanic sector in the region of Galicia (Spain.)

RESULTS

We investigated which of the suggested variables has the most influence when defining corporate training policies. Binary logistic regression was used to ascertain which companies belonged to the group. The correct logistic regression was determined using step-by-step construction and the forward conditional method. The dichotomic dependent variable is the existence of training activities in the company.

A list of the variables used to test the hypotheses follows. The six first were used as independent variables.

- ✓ Investment in AMT (Euros invested over the past five years, INVTFA.)
- ✓ Quantity of new task organisation forms (WORK ORGANIZATION.)
- ✓ Size of the organisation (number of employees, SIZE.)
- ✓ Specificity of working qualifications (necessary training period, ESPECIFICITY.)
- ✓ Numerical flexibility (percentage of non-permanent workers, NUMFLEX.)
- ✓ Stock of human capital (personnel qualifications, PERSQUAL.)
- ✓ Financial support for training (number of financial supporters, FINANTRAIN.)

The technique is applied to the dependent variable and the result is the following optimal model information.

TABLE 2

Equation variables

	B	E. T.	Wald	Gl	Sig.	Exp (B)
NUMFLEX (Numerical flexibility)	-1,826	,919	3,952	1	,047	,161
Constant	,260	,096	7,368	1	,007	1,297

Coefficients and their levels of significance show that stability in employment, measured by the percentage of workers with non-permanent jobs, is the only variable which affects training activities in companies. Value of Exp (B) is lower than 1 and shows that probability of training declines as the number of non-permanent workers grows.

TABLE 3

Variables not included in the equation

			Points	Gl	Sig.
Step	Variables	SIZE	5,014	1	,325
		WORK ORGANIZATION	,417	1	,518
		SPECIFICITY	,054	1	,816
		INVAMT	1,914	1	,167
		PERSQUAL	,480	1	,488

Results when the remaining independent variables are included in the model are tested by contrasting the null hypothesis that the variable has no effect. Level of significance is higher than 0,05 for all the variables and confirms that these do not contribute to determine the dependent variable.

The accuracy of the classification was evaluated with a confusion matrix. The global percentage showing the predictive capacity of the model has a high value (over 80%.)

TABLE 4

Classification

Observed		Predicted		
		Training		Accuracy
		Negative	Positive	
Training	Negative	18	0	100
	Positive	12	60	83,3
				86,7

Cut value 0,50

Only organisations with training programmes were considered to determine the factors which affect the existence of a specific training budget. Student's t-Test was used. The study assessed which of the variables show differentiated behaviour in companies, according to whether they had specific budget items for training. Some of the variables showed non-normal behaviour, so the Mann-Whitney U test, which does not require normal behaviour, was run.

TABLE 5

Statistical proof for the variables included in the model

VARIABLES	PROOF OF CONTRAST	CONTRAST STATISTIC	LEVEL OF SIGNIFICANCE	SIGNIFICANT DIFFERENCE
INVTFA	T	1,130	,259	NO
WORK ORGANIZATION	M-W	105,5	,109	NO
ESPECIFITY	M-W	88,5	,030	YES
SIZE	T	2,872	,032	YES
NUMFLEX	M-W	121,5	,276	NO
FINANTRAIN	M-W	48,5	,000	YES
PERSQUAL	M-W	34	,000	YES

TABLE 6

Ranges

	Budget	N	Average range
INVTFA	NO	26	102,53
	YES	48	193,91
WORK ORGANIZATION	NO	26	21,10
	YES	48	15,12
ESPECIFICITY	NO	26	24,19
	YES	48	16,19
SIZE	NO	26	124,04
	YES	48	56,53
NUMFLEX	NO	26	17,56
	YES	48	21,65
FINANTRAIN	NO	26	10,73
	YES	48	23,48
PERSQUAL	NO	26	24,08
	YES	48	9,62

The results above reveal how new technologies alone are not sufficient to explain a company's decision to allocate specific training budgets. Significant differences in averages show that the larger companies are more likely to have specific training budgets than smaller organisations.

The percentage of temporary workers showed no significant differences in companies with and without training budgets, and does not seem to be a determinant factor in a company's decision to budget for training. Human capital stock shows a different behaviour, as the personnel qualifications variable shows strong differences in the two samples. Companies with a highly qualified labour force have a higher average range if the company has a training budget.

Specificity of qualifications also shows different behaviour in the two groups of companies. The average is significantly different in the two groups. Average range is higher for organisations with no training budget and lower for companies which have training budgets.

Regarding financial support for training, companies with a specific training budget are shown to draw on a larger number of financial supporters. Organisations with no training budget have a smaller amount of financial supporters on average.

The statistical contrasts show that the factors which determine the existence of a specific training budget in a company are company size, human capital stock, specificity of qualifications and financial support for training.

CONCLUSIONS

The survey reveals that most organisations do develop training related to the process of AMT implementation. However, the managerial decision to develop training is determined by a factor which is extraneous to the investment in new production technologies, that is to say, recruitment policies. As argued by human capital theory, recruitment of non-permanent workers disincentivates training policies.

As for the existence of a specific training budget, implementation of AMTs does not appear to determine a company's decision to allocate specific budget items to personnel training programmes.

We can therefore conclude that training policies are strongly influenced by factors outside the inner context of the organisation. Availability of public funding for training, the size of the company, numerical flexibility, human capital stock and specificity of required qualifications appear to carry more weight in managerial decisions to invest in human resources than the need to suit qualifications to new technologies or provision of training as part of the supporting infrastructure for newly introduced AMTs.

This article centres on formal training, and does not include all the possible variables which influence corporate training policies. Future lines of research could

include the analysis of strategies for complementing human capital and new technologies in companies. One proposal is to explore the effects on profitability of aligning human resource practice with company use of technology. Similar research could be conducted on informal corporate training, working with new variables to determine how they affect company training policies.

Bibliografia

Adler, P. (1988): "Managing flexible automation", *California Management Review*, vol. 30 nº 3, pp.34-56.

Alcaide, M.; González M.; Flórez, I. (1996): *Mercado de trabajo, reclutamiento y formación en España*, Ed. Pirámide, Madrid.

Baldwin, J. (1999): *Innovation, training, and success*, Supporting Document nº 13. Advisory Council on Science and Technology, Canada.

Baldwin, J.; Johnson, J. (1995b): *Human capital development and innovation: The case of training is small and medium size-firms*. Analytical studies branch research paper series, nº 74, Ottawa.

Baldwin, J.; Gray, T.; Johnson, J. (1995a): *Technology use, training and plant specific knowledge in manufacturing establishments*, Analytical studies branch research paper series, nº 86, Ottawa.

Bartel, A.; Lichtenberg, F. (1987): "The comparative advantage of educated workers in Implementing New Technologies", *Review of Economics and Statistics*, nº 69, pp. 1-11.

Bartel, A.; Sicherman N. (1995): *Technological change and the skill acquisition of young workers*, NBER, Working Paper nº 50, Cambridge.

Bishop, J. (1996): *What we know about employer-provider training: A review of literature*, Centre for Advanced Human Resources Studies, Working Paper Series 96-09, Cornell University.

Blandy, R. (1998): *Enterprise return on a training investment in the Australian context*, National Centre for Vocational Education research, Nº 8010.

Calabrese, G. (1995): "The employment effects of flexible automation in small and medium firms: evidence from the Italian case", *Integrated manufacturing Systems*, vol. 6, nº 2, pp. 35-41.

Co, H.C.; Patuwo, B.E.; Hu, M.Y. (1998): "The human factors in advanced manufacturing technology adaptation: an empirical analysis" *International Journal of Operations & Product Management*, vol. 18, nº 1, pp. 87-106.

Chen, I.; Gupta A.; Chung C.H. (1995): "Employee commitment to implementation of flexible manufacturing systems" *International Journal of Operations& Management*, vol. 16, nº 7, pp. 4-13.

Chen, I. J.; Small M.H. (1996): "Planning for advanced manufacturing technology: a research framework" *International Journal of Operations & Production*, vol. 16, nº 5 pp. 4-24.

Daniel, W. (1987): *Workplace industrial relations and technical change*, Blackmore Press.

Dawson, P. (1996): "Advanced technology design, people and organization: Experience of Australian industrial collaboration" *Integrated Manufacturing, System*, vol. 7, nº5, pp.5-11.

Dean, J.W.; Joon, S.J.; Susman, G.I. (1992): "Advanced manufacturing technology and organization structure: empowerment or subordination?" *Organization Science*, vol. 2, nº 2, pp. 203-29.

Erickson, C.; Jacoby, M. (1998): *Training and Work-Organization Practices of California´s Private Employers*, From the California Policy Seminar Brief Series, U.S.A.

Frazis, H.; Gittleman, M.; Joyce, M. (1998): *Determinants of training: An analysis using both employer and employee characteristics*, Working Paper, of Bureau of Labour Statistics

Ghani, A.; Jayabalan, V. (2000): "Advanced manufacturing and planned organizational change" *The Journal of High Technology Management Research*, vol. 11, nº 1, pp.1-18.

Glover, R.; Long, D.; Haas, C.; Alemany, C. (1999) *Return-on-investment (ROI) Analysis of education and training in the construction industry*, Document of Workforce Thrust Team, Austin, Texas.

Groot, W (1997): *Training and labor market flexibility*: A survey, Paper of Monash University-ACER for the Economics of Education and Training, Julio.

Groot, W. (1999): "Productivity effects of enterprise-related training", *Applied Economics Letters*, nº 6, pp. 369-371.

Groot, W.; Maassen, H. (2000): "Education, training and employability", *Applied Economics*, nº 32, pp. 573-581.

Guimaraes, T. et al (1999): "Empirically testing the impact of manufacturing system complexity on performance", *International Journal of operations & Production Management*, vol. 19, nº 12, pp. 1254-1269.

Horte, S; Hedlund, S. (2000): *Changes in development approaches of technology and work organization and the impact of performance*, Working paper of Lulea Tekniska Universitet, AR 2000:39.

Johnson, S. (1999): *Skills Issues for small and Medium sized Enterprises*, Skills Task Force, Research Paper 13, Centre for Enterprise and Economic Development Research, London.

Jonsson, P. (2000): "An empirical taxonomy of advanced manufacturing technology", *International Journal of Operations and Production Managemen*t, vol. 20, nº 12, pp. 1146-1474.

Kathuria, R.; Partovi, F. (2000): "Aligning work force management practices with competitive priorities and process technology: A conceptual examination", *The Journal of High Technology Management Research*, vol. 11, nº 2, pp. 215-234.

Kirstensen, P. (1998): "Paradojas y escollos para las estrategias de formación continua", en Kitching, J. y Blackburn, R. (2002): *The nature of training and motivation to train in small firms*, Research Report 330. Small Business Research Center Kingston University.

Lei, D.; Hitt, H.; Goldhar, J. (1996): Advanced manufacturing technology: organizational design and strategic flexibility", *Organizational Studies*, vol. 17, nº 3, pp. 501-523

Lepak, D.; Snell, S.A. (1999): "The human resource architecture: toward a theory of human capital allocation and development" *Academy of Management Review*, nº 24, pp.31-48.

Lindberg, P. (1995): "Managing and Organizing for Advanced Manufacturing Technology" en Kumar, A., *Workers and Automation*, Sage Publications pp. 70-97

Lund, R.; Gjerding, A. (1996): *The flexible company Innovation, work organisation and human resource management* DRUID WORKING PAPER Nº 96-17.

Luque T. (2000): *Técnicas de análisis de datos en investigación de mercados*, Pirámide.

Lynch, L. y Black, S. (1997): *Beyond the incidence of training: Evidence from a national employer's survey*, NBER Working Paper nº 362, Cambridge.

Maffei, M.J.; Meredith, J. (1994): "The organizational side of flexible manufacturing technology: guidelines for managers" *International Journal of Operations and Production Management*, 14(8), 17-27.

Martinez A. (1996): "Adopting Advanced Manufacturing Technologies: experience from Spain", *Journal of Manufacturing System*, vol. 15, nº 2, pp.133-410.

McLachlin, R.; Piper C. (1992): "Employee involvement in just in time manufacturing" in Satir, A. (ed) *Operational Planning and Control Issues*, Elsevier, Amsterdam, pp. 33-42.

Meredith, J.R. (1987): "Installation of flexible manufacturing system teaches management lessons in integration labour cost, benefits" *Industrial Engineering*, nº 20, pp. 18-27.

Mintzberg, H. (1984): *La estructuración de las organizaciones*, Ariel, Barcelona.

Mirvis, Ph.H.; Sales, A.; Hackett, E. (1991): "The implementation and adoption of new technology in organizations: The impact on work, people and culture", *Human Resource Management*, Sprig, vol. 30, nº 1, pp. 113-119.

Moy, J.; McDonald, R. (2000): *Analyzing enterprise returns on training*, National Center for Vocational Educational Research.

Noori, H. (1997): "Implementing advanced manufacturing technology: The perspective of a newly industrialized country (Malaysia)". *The Journal of High Technology Management Research*, vol. 8, nº 1, pp. 1-20.

Oosterbeek, H. (1996): "A decomposition of training probabilities", *Applied Economics*, nº 28, pp. 799-805.

Osterman, P. (1995): "Skill, training, and work organization in American establishments", *Industrial Relations*, vol, 34, nº 2, pp. 125-146.

Planas, J.; Plassard, J.M (2000): "La inversión en formación inicial como condición previa para las inversiones en formación a lo largo de la vida" en *Efficacité versus equité en économie sociales*, Ediciones L'Harmattan

Rockart, J.; Earl, M.; Ross, J. (1996): "Eight Imperatives for New IT Organization", *Sloan Management Review*, Fall 1006, pp.43-55.

Saraph, J.V.; Sebastian P. (1992) "Human resources strategies for effective introduction of advanced manufacturing technologies (AMT)" *Production and Inventory Management Journal*, vol. 33, nº1, pp. 64-70.

Shepherd, D. et al. (2000): "Advanced manufacturing technology: Does more radicalness mean more perceived benefits?", *The Journal of High technology Management Research*, vol. 11, nº 1, pp. 9-33.

Solé, F.; Cabañete, A. (1994): "La tecnología y la formación. De lo residual a lo substancial", *Dirección y Organización*, nº 12, Octubre-Diciembre, pp. 34-44.

Sorge, A.; Streek, W. (1987): "Industrial relations and technical change: The case for an extendent perspective" pp. 19-47 en *New Technology and Industrial Relations* Spilsbury, D. (2001): *Learning and training at work 2001*, Research Report Nº 334. Department for Education and Skills.

Subramanian, A.; Nilakanta, S. (1996): "Organizational Innovativeness: Exploring the relationship between Organizational Determinants of Innovation. Types of Innovations, and Measures of Organizational Performance", *Omega,* vol. 24, nº 6, pp. 631-647.

Sun, H.; Gertsen, F. (1995): "Organizational change related to advanced manufacturing technology in the production area", *International Journal of Production Economics*, vol. 41, pp. 369-75.

Swamidass, P. (1998): *Technology on the factory floor III*, The Manufacturing Institute.

Taplin, I. (1995): "Flexible production, rigid jobs: Lessons from the clothing industry" *Work and occupations*, vol. 22, nº 4, November, pp. 412-438.

Upton, D.; McAfee, A. (1997): *A path-based approach to information technology in manufacturing*, working paper.

Wong, P.K.; Ngin, P.N. (1997): "Automation and organizational performance: The case of electronics manufacturing firms in Singapore" *International Journal of Production Economics*, vol. 52, pp. 257-68.