An Integrated Talent Management System for Maintaining an Up-to-Date Technical Workforce

Harold G. Kaufman

Introduction

For an organization to successfully compete in today's global marketplace, the intellectual capital represented by the knowledge and skills of its technical workforce must remain up to date. It is ironic that the workers most responsible for technological change (engineers, IT specialists, and other technical professionals) have long been recognized as among the most vulnerable to its consequences – the rapid obsolescence of their knowledge and skills (Kaufman 1974a, 1975).

While obsolescence pertaining to people had been recognized as an organizational problem as far back as 1930 (Kaufman 1974a, 2006), concern over the issue became widespread following the rapid changes in technology that began during the post-World War II era. These changes included the rapid development of solid-state and computer technologies that accelerated the obsolescence of technical professionals. The so-called "half-life" of technical knowledge acquired through education rapidly diminished during this period (Kaufman 1974a, 2006; Zelikoff 1969). In addition, the advent of the Cold War and the long competition between the USA and the Soviet Union, especially the space race, spurred the rapid creation of new technical knowledge.

In the United States, the problem of obsolescence among technical professionals was addressed at many conferences as well as by a deluge of articles and research starting in the 1960s that continued unabated in subsequent decades (Kaufman 1974a, 2006). For many years this concern was concentrated largely in the United States and focused on engineers. But as technology spread globally, articles and research about obsolescence began to be generated in many countries throughout the world.

H.G. Kaufman (✉)
Organizational Behavior Program, Department of Technology Management, Polytechnic Institute of New York University, 6 MetroTech Center, Brooklyn, NY 11201, USA
e-mail: hkaufman@poly.edu

K.B. Akhilesh (ed.), *Emerging Dimensions of Technology Management*,
DOI 10.1007/978-81-322-0792-4_6, © Springer India 2013

In addition, the focus began to shift gradually from engineers to IT professionals as computer technologies became widespread. Today, obsolescence is even more of a threat to individual careers as well as to the survival of organizations on a global scale. This concern was expressed in an article from India about obsolescence with the subtitle: "A Wake-up Call to Avert a Crisis" (Chauhan and Chauhan 2008: 85).

Defining Obsolescence

Obsolescence has been defined as "the degree to which organizational professionals lack the up-to-date knowledge or skills necessary to maintain effective performance in either their current or future work roles" (Kaufman 1974a: 23). This definition of obsolescence includes several essential concepts, as follows:

A Lack of New Knowledge or Skills

Obsolescence occurs when the technical professional fails to keep up to date with new knowledge or skills. However, this is a matter of degree. Technical professionals need to stay current, although few are totally obsolete, and not many are completely up to date.

Ineffectiveness

Obsolescence becomes a problem when it leads to ineffectiveness. However, only ineffectiveness that results directly from a *lack* of current knowledge and skills should be attributed to obsolescence.

Job and Professional Roles

Technical professionals who lack the knowledge or skills necessary to perform effectively in their current work roles experience job obsolescence. When technical professionals do not keep up to date more broadly with new developments in their field or discipline, they become professionally obsolescent. Such obsolescence can impair their effectiveness in taking on new work roles.

Causes of Obsolescence: An Open Systems Model

There are multiple and complex contributing factors to the onset of obsolescence among technical professionals. An open systems model approach (Katz and Kahn 1978) has been applied to obsolescence that shows some of the interactions of the internal system components with the external environment (Kaufman 1978, 1979, 1989).

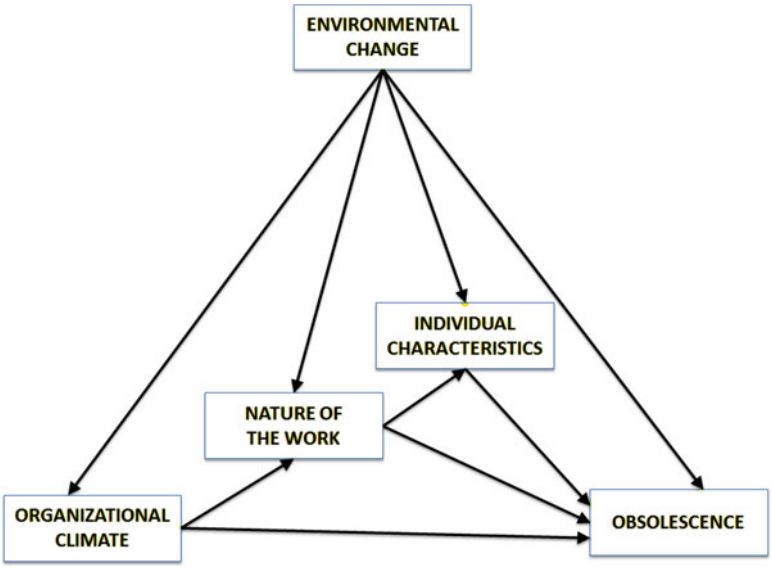

Fig. 1 A systems model of obsolescence

According to the model, four broad system components have been identified that are likely related to obsolescence as well as to each other (Fig. 1). These components and their interrelationships can be summarized as follows:

1. *Environmental change* is at the root of obsolescence and is all-pervasive, involving the rapidly changing technology, the information explosion, and the exponential rate of increase in technical knowledge. Other external forces such as organizational restructuring, global competition, and workforce changes tend to exacerbate the problem. Such environmental change has been the driving force toward creating a knowledge economy that produces and distributes ideas and information (Drucker 1969). Environmental change is depicted in the systems model as not only affecting the obsolescence of technical professionals directly but also individual, work, and organizational factors (Fig. 1).
2. *Individual characteristics* of technical professionals can affect their degree of obsolescence. These include individual differences that may either predispose technical professionals to keep abreast of new developments or contribute to their becoming out of date. These individual differences have been identified as demographic (e.g., age) or psychological in nature, involving cognitive, motivational, and personality characteristics (Kaufman 1974a).
3. *Nature of the work* carried out by technical professionals is a critical factor contributing to obsolescence, both directly and by its effects on individual characteristics (Fig. 1). Nature of the work involves job assignments and the degree of challenge and growth provided, including knowledge and skill utilization. Poor utilization negatively affects the growth and development of technical professionals, and it is most detrimental if it starts early in the career (Kaufman 1974a).

4. *Organizational climate* involves aspects of the work environment that are a consequence of management policies and practices, such as those related to professional career development or the organizational reward system vis-a-vis keeping up to date (Kaufman 1974a). According to the model, organizational climate not only has a direct effect on obsolescence but also impacts the nature of the work (Fig. 1).

The open systems model depicted in Fig. 1 addresses the complexity of obsolescence in a parsimonious fashion in order to identify its multifaceted causes and their interrelationships. There is evidence that the systems model presented here has validity (Kaufman 1978, 1979, 1989; Nwachukwu 1989; Trimmer et al. 1998). Nevertheless, such evidence should not preclude the validation of other models of obsolescence and updating that have been proposed (Dubin and Cohen 1970; Farr and Middlebrooks 1990; Fossum et al. 1996; Joseph et al. 2010; Kozlowski and Farr 1988; Rong and Grover 2009).

An Integrated Talent Management System

The four components of the open systems model that can lead to obsolescence may be addressed by organizations through the use of an integrated talent management system. Such a system would utilize appropriate interventions and practices intended to develop and maintain an up-to-date technical workforce as part of the overall organizational strategy. Talent management has become widely accepted in US industry and has a variety of definitions (Silzer and Dowell 2010). In a major research study by the Society for Human Resource Management, talent management was defined "as the implementation of integrated strategies or systems designed to improve processes for recruiting, developing and retaining people with the required skills and aptitude to meet current and future organizational needs" (Fegley 2006: v). Developing and implementing an integrated talent management system can be extremely useful to not only address the internal components of the model that can cause obsolescence – the individual characteristics, nature of the work, and organizational climate – but also the external environmental changes. Such a proposed integrated talent management system is presented in Fig. 2.

Environmental-Organizational Interface: Monitoring Obsolescence

Environmental Scanning

Environmental change is all encompassing and impacts the other factors affecting obsolescence. Organizations can monitor such change through environmental scanning, which involves the acquisition and use of information related to technology,

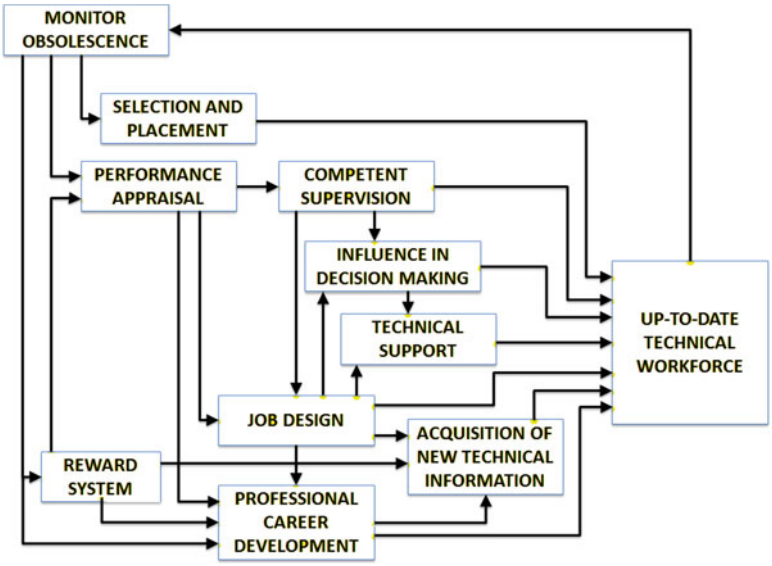

Fig. 2 An integrated talent management system for maintaining an up-to-date technical workforce

competitors, customers, suppliers, and other market-related aspects of the organization's external environment (Choo 2001). Environmental scanning is the principal method of strategic organizational learning involving the import of explicit knowledge, which is knowledge readily accessible for easy communication and utilized by the organization to develop new products, processes, and innovations (Nonaka and Takeuchi 1995). When environmental scanning is combined with forecasting technological and other changes likely to affect obsolescence, the organization can use the information in its strategic planning to identify competency gaps for maintaining an up-to-date technical workforce. However, only about half of the organizations with talent management initiatives attempt to identify gaps in competency levels for current or prospective employees (Fegley 2006). Moreover, identifying competency gaps is also one of the practices most in need of improvement. Monitoring the environment is critical as the first step in achieving a technically competent workforce utilizing the integrated talent management system illustrated in Fig. 2.

Knowledge Loss to the Environment

Technical knowledge gaps in organizations can not only occur because of external environmental change but also as a result of knowledge loss from inside the organization to outside its boundaries, which also requires monitoring. Organizations experience a loss of knowledge when technical professionals leave the organization as a result of retirement as well as voluntary and involuntary termination. When such

individuals leave, the organization loses its tacit knowledge, which constitutes the largest part of what one knows and is acquired largely through experience and interactions with others (Polanyi 1966, 1976). The retention of tacit knowledge and its importance to organizations has become the focus of recent research (Levy 2011; McQuade et al. 2007; Martins and Meyer 2012). Monitoring tacit knowledge possessed by technical professionals leaving their firm in order to transfer it to those remaining helps preserve the intellectual capital of the organization.

Metrics for Monitoring

Various metrics for monitoring obsolescence in the organization have been identified, including the use of relevant personnel record data such as education and training activities, professional contributions, and skills inventories (Kaufman 1974a, 1990). While tests of knowledge may be the most direct way of monitoring obsolescence (Mali 1975), they are difficult to implement. On the organizational level, periodic attitude surveys may provide a much easier way to monitor obsolescence. For individuals, self-assessment instruments have been used to evaluate the degree of obsolescence among technical professionals in organizations (Kaufman 1978, 1979, 1989). Whatever approach is used, the goal should be to monitor obsolescence with a valid metric.

Individual Characteristics

There are standard talent management techniques that organizations can use that focus on individual characteristics for the purpose of maintaining an up-to-date technical workforce. These include selection and placement as well as performance appraisal. Results of various monitoring processes should have a direct input to these techniques (Fig. 2).

Selection and Placement

Recruiting and onboarding are fundamental functions in talent management (Silzer and Dowell 2010). As part of these functions, organizations can address individual differences among job applicants by applying effective techniques of selection and placement to maintain an up-to-date technical workforce (Kaufman 1974a, 1990). The goal is to achieve a good fit between the knowledge and skills, as well as motivation, of technical professionals and their current and future job requirements, based on the results of environmental monitoring. Organizational fit must also be considered in selection and placement, since a mismatch can detrimentally affect the maintenance of technical competency (Wingreen and Blanton 2007).

Given that the first job experience can be crucial to the career development of technical professionals (Kaufman 1974a, b), obsolescence can be controlled from the very start by achieving a good fit between new hires with their job requirements and organization.

Performance Appraisal

Various techniques of periodic performance appraisal are integral to practically all talent management systems (Fegley 2006). It should be noted that such evaluations are an important component of current performance management systems that also include feedback and coaching (Aguinis 2009). The latter are typically part of talent management systems, including the one being proposed. Performance appraisals should not only focus on current gaps in knowledge but also on future potential and career development needs to prevent obsolescence, again based on the results of environmental monitoring. Appraisal techniques utilizing goal setting and feedback, such as management by objectives (MBO), have long been advocated as an approach to prevent technical obsolescence (Horgan and Floyd 1971). Moreover, appraisals of future potential also can be made by utilizing assessment center techniques for the purpose of professional career development (Kaufman 1974a).

Nature of the Work

A central system component directly related to obsolescence is the nature of the work (Fig. 1). The evidence indicates that work assignments are the major factor contributing to the onset of obsolescence among technical professionals (Kaufman 1974a, b, 1978, 1979, 1989; Kozlowski and Farr 1988; Newton et al. 2002). Moreover, individual characteristics can be affected by the nature of the work (Brousseau and Prince 1981). The results of performance appraisals can be applied directly to improving job design as well as enhancing the competence of supervisors, which can affect their decision making and how they design jobs (Fig. 2).

Job Design

While job design is sometimes included in talent management systems (Silzer and Dowell 2010), it can play an important role in maintaining an up-to-date technical workforce. One of the most important needs of technical professionals is challenging work that utilizes their knowledge and skills, but many are not well utilized (Kaufman 1986, 2006). Poor utilization detrimentally affects professional career development, which can start early in the career. Redesigning the work of technical professionals entails, in part, using job assignments to motivate learning new knowledge and skills (Kaufman 1974a, b, 1978, 1979, 1986). Obsolescence is likely to occur among technical professionals when their work becomes so specialized that the broader base of knowledge and skills is not used and forgotten. Therefore, job design should emphasize a diversity of challenging work assignments that require on-the-job problem solving that involves learning new knowledge and skills. Such an approach results in what has been referred to as *smart jobs,* "that can stimulate learning, growth, and employability" (Hall and Las Heras 2010: 448). Since technical professionals

typically are assigned to projects involving teamwork, job design must also take into account the social as well as individual factors affecting group performance (Oldman and Hackman 2010).

Competent Supervision

The identification and development of high-potential employees is usually a component of talent management (Silzer and Dowell 2010). The performance appraisal process can use various techniques, including peer assessments, to select supervisors of technical professionals based on competence in their field or specialty. The support of the immediate supervisor plays a significant role in the updating of technical professionals throughout their career (Pazy 1996). Moreover, the supervisor is critical in determining job assignments as well as providing oversight, thereby shaping the knowledge and skill utilization of those in their work group (Kaufman 1974a, 1995). Utilization of knowledge and skills can be a problem for technical professionals whose supervisors are themselves obsolescent and cannot properly evaluate technical performance (Farr et al. 1983). It is the technical competence of supervisors that provides the basis of their influence as leaders of their work group (Kaufman 1974a). Therefore, the development of technical professionals through techniques such as participative goal setting, performance feedback, or career coaching can depend on how well their supervisor possesses the up-to-date knowledge and skills relevant to their work.

Technical Support

Job design should address the need for technical support to achieve the proper utilization of technical professionals. This support includes technical and clerical assistance as well as up-to-date computer hardware and software plus any equipment required to achieve high levels of performance (Kaufman 1986). While the technology provided may be adequate, the support personnel often are not. It is the lack of technical and clerical assistance that has been a major factor in the proper utilization of technical professionals, which ultimately affects their obsolescence. Therefore, the job design process should lead directly to the provision of effective technical support (Fig. 2).

Organizational Climate

The final component of the systems model of obsolescence to be addressed is organizational climate (Fig. 1). Definitions of organizational climate typically emphasize an organization's observable practices and procedures as perceived by its members (Denison 1996). There is consistent evidence that organizational climate

can have a major impact on obsolescence as well as determining the nature of the work (Kaufman 1978, 1979; Joseph and Kuan Koh 2011; Nwachukwu 1989; Steiner and Farr 1986; Trimmer et al. 1998). Moreover, the most important climate factor differentiating organizations was one that supports updating and professional development (Kozlowski and Hults 1987). While there are many organizational practices and procedures that may contribute to reducing obsolescence (Kaufman 1974a, 1990), a select few will suffice that are appropriate for the integrated talent management system proposed (Fig. 2).

Influence in Decision Making

Organizations utilizing talent management practices are significantly more likely to empower employees to make decisions that impact their work (Fegley 2006). Increasing the influence of technical professionals in the decision-making process may be accomplished through effective supervision and job design to enhance responsibility and control over their work, as depicted in the integrated talent management model (Fig. 2). Technical professionals desire to have such influence over decisions pertaining to their work, but those needs may not be met (Kaufman 1986). Providing greater responsibility and control to technical professionals serves to create a climate that encourages autonomy in the pursuit and development of new ideas, which results in a more up-to-date workforce. This can be accomplished through the restructuring of groups and individual roles. For example, autonomous team structures are delegated a high degree of responsibility and control which can result in rapid and efficient new product or process development (Clark and Wheelwright 1992). Such team structures have been referred to as "hot groups" and what helps keep them hot is their autonomy and independence from organizational bureaucracy (Leavitt and Lipman-Blumen 1995). A different approach that focuses on individual autonomy is that of intrapreneurship, which encourages individual initiative to pursue and champion new ideas (Pinchot 1987). Regardless of which techniques are used to increase technical professionals' influence in the decision-making process, such practices should serve to directly stimulate the development of a technical workforce that is up to date (Fig. 2).

Reward System

Most talent management programs include reward systems other than compensation (Fegley 2006; Silzer and Dowell 2010). As shown in Fig. 2, the results of monitoring obsolescence serve as direct inputs to the reward system. Environmental scanning of technological, human resource, and other changes likely to affect obsolescence provides information that can be used by the organization to better design reward systems for maintaining an up-to-date technical workforce. In fact, the reward system is most valued when it provides challenging work assignments (Steiner and Farr 1986). Although financial rewards are important to technical professionals, the

nonmonetary or intangible rewards are often more critical in motivating and reinforcing updating and career development activities (Kaufman 1974a). For example, the best reward for successful intrapreneurs is more freedom, together with a budget, to pursue the development of new products or processes (Pinchot 1987). Nevertheless, it is questionable whether many technical professionals feel they are rewarded adequately (Kaufman 1986). Here is where the performance appraisal system needs to be designed to function more effectively together with the reward system in motivating professional career development as well as the acquisition of new technical information (Fig. 2).

Professional Career Development

Career planning and development activities are usually included among talent management practices (Silzer and Dowell 2010). Organizations utilizing talent management initiatives were found to be significantly more likely to have policies that encourage career growth and developmental activities (Fegley 2006). However, such policies were among those most in need of improvement in organizations that had a talent management system in place. Such improvement can be accomplished by first addressing the monitoring, performance appraisal, reward system, and job design components of the integrated talent management system, all of which can affect professional career development (Fig. 2).

Firms in the USA have long focused on continuing education as the way to deal with the obsolescence problem (Dubin 1990; Kaufman 1974a, 1975, 1982a; National Research Council 1985; Rosen and Jerdee 1985). This may be attributed to the half-life of a technology-based education, which has been rapidly diminishing as a result of changing requirements for technical knowledge and skills. Fields impacted by changes in information technology typically have the shortest half-life and have the greatest need for updating.

Most formal continuing education for technical professionals in US industry has been in-house and noncredit (National Research Council 1985). Such courses can be offered via e-learning, which appears attractive to technical professionals who are early adopters of this mode (Gallaher and Wentling 2004; Waight and Stewart 2009). Despite the fact that continuing education is considered important by technical professionals for their career development, they do not feel that their employers encourage them to participate (Kaufman 1982a, b; National Research Council 1985; Engineering Manpower Commission 1986). One approach to address this dilemma is to use the work itself to motivate formal as well as informal professional development. Here is where the talent management components can be applied to stimulate career growth through job design, performance appraisal, and reward system. There is evidence that an organizational climate that encourages updating and fosters professional growth also provides challenging work assignments (Kozlowski and Farr 1988). Such a professional, growth-oriented climate can be created by supervisors assigning challenging jobs that require technical professionals to learn new knowledge and skills through continuing education or other career development activities. In organizations where the technology has totally changed,

retraining and redeployment are viable options as an alternative to termination (Kaufman 1982b, 1995, 1994).

Acquisition of New Technical Information

Professional career development activities, together with the reward system and the design of the job, can have a direct influence on the acquisition of new technical information (Fig. 2). This is a unique component of the integrated talent management system for maintaining an up-to-date technical workforce. Without adequate access to new technical information, obsolescence of knowledge and skills is inevitable. Interactions with colleagues are a major source of information required by technical professionals (Allen 1977; Kaufman 1974a, 1984). Therefore, open communication, internal as well as external to the organization, is necessary for staying up to date. However, technical professionals have been frustrated in gaining access to new technical information (Kaufman 1986; Engineering Manpower Commission 1986). The nature of interorganizational competition puts constraints on the open sharing of information among technical professionals outside their own firm (Allen 1997). There can also be a reluctance to share information internally (Klein 1998). Nevertheless, more open communication, both internally and externally, is necessary to acquire new technical information to assure an up-to-date climate. There are a number of practices that can improve the information acquisition process. The role of technological gatekeepers is critical in acquiring information externally and disseminating it internally (Allen 1977). The effectiveness of such gatekeepers can be enhanced through information dissemination systems. Even the reluctance to share information internally can be addressed. For example, organizations see wikis as an up-and-coming technology for supporting collaborative work (Arazy et al. 2009). However, the introduction of any electronic system for information sharing may require a culture change involving the reward system (Klein 1998). The information acquisition process is linked via the reward system to the monitoring of obsolescence, which is the initial component in the proposed integrated talent management system (Fig. 2). In essence, this integrated system begins and ends with related processes of environmental scanning for new knowledge and information acquisition to maintain an up-to-date technical workforce, with a feedback loop to monitoring obsolescence.

Conclusion

The widespread problem of knowledge and skill obsolescence among technical professionals has traditionally been addressed on a piecemeal basis. What is being proposed here is an integrated talent management system that would utilize appropriate interventions and practices to develop and maintain an up-to-date technical workforce. In order for such a system to be effective, it must be an integral part of the overall organizational strategy and have commitment from top management.

References

Aguinis H (2009) Performance management, 2nd edn. Prentice Hall, Upper Saddle River
Allen TJ (1977) Managing the flow of technology. MIT Press, Cambridge, MA
Allen TJ (1997) Managing technical communications and technology transfer: distinguishing science from technology. In: Katz R (ed) The human side of managing technological innovation. Oxford University Press, New York, pp 307–319
Arazy O, Gellatly I, Jang S, Patterson R (2009) Wiki deployment in corporate settings. IEEE Technol Soc 28(2):57–64
Brousseau KR, Prince JB (1981) Job-person dynamics: an extension of longitudinal research. J Appl Psychol 66:59–62
Chauhan SP, Chauhan D (2008) Human obsolescence: a wake-up call to avert a crisis. Glob Bus Rev 9(1):85–100
Choo CW (2001) Environmental scanning as information seeking and organizational learning. Inform Res 7(1):1–21. http://InformationR.net/ir/7-1/paper112.html
Clark KB, Wheelwright SC (1992) Organizing and leading "Heavyweight" development teams. Calif Manage Rev 34(3):9–27
Denison DR (1996) What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. Acad Manage Rev 21(3):619–654
Drucker PF (1969) The age of discontinunity. Harper & Row, New York
Dubin SS (1990) Maintaining competence through updating. In: Willis SL, Dubin SS (eds) Maintaining professional competence. Jossey-Bass, San Francisco, pp 9–43
Dubin SS, Cohen DM (1970) Motivation to update from a systems approach. Eng Edu 60(5):366–368
Engineering Manpower Commission (1986) Toward the more effective utilization of American engineers. American Association of Engineering Societies, Washington, DC
Farr JL, Middlebrooks CL (1990) Enhancing motivation to participate in professional development. In: Willis SL, Dubin SS (eds) Maintaining professional competence. Jossey-Bass, San Francisco, pp 195–213
Farr JL, Dubin SS, Enscore EE, Kozlowski SWJ, Cleveland JN (1983) Relationships among individual motivation, work environment, and updating in engineers. Psychol Doc 13(16) (Ms. No. 2563)
Fegley S (2006) Talent management: survey report. SHRM Research Department, Alexandria
Fossum JA, Arvey RD, Paradise CA, Robbins NE (1996) Modeling the skills obsolescence process: a psychological/economic integration. Acad Manage Rev 11(2):362–374
Gallaher J, Wentling TL (2004) The adoption of e-learning across professional groups. Perform Improv Quart 17(3):66–85
Hall DT, Las Heras M (2010) Reintegrating job design and career theory: creating not just good jobs but smart jobs. J Organ Behav 31:448–462
Horgan NJ, Floyd RP (1971) An MBO approach to prevent technical obsolescence. Pers J 50(9): 686–692
Joseph D, Kuan Koh CS (2011) Organization support as a moderator in coping with the threat of professional obsolescence. In: AMCIS 2011 proceedings – all submissions. Paper 120
Joseph D, Kuan Koh CS, Hao Foo AC (2010) Sustainable IT-specific human capital: coping with the threat of professional obsolescence. In: ICIS 2010 proceedings. Paper 46
Katz D, Kahn R (1978) The social psychology of organizations. NY: Wiley
Kaufman HG (1974a) Obsolescence and professional career development. AMACOM, New York
Kaufman HG (1974b) Relationship of early work challenge to job performance, professional contributions and competency of engineers. J Appl Psychol 59(4):377–389
Kaufman HG (ed) (1975) Career management: a guide to combating obsolescence. IEEE Press/ Wiley-Interscience, New York
Kaufman HG (1978) Technical obsolescence: an empirical analysis of its causes and how engineers cope with it. In: Proceedings 86th annual conference of the American Society for Engineering Education. ASEE, Washington, DC, pp 194–206

Kaufman HG (1979) Technical obsolescence: work and organizations are the key. Eng Edu 68:826–830
Kaufman HG (1982a) Continuing professional development at mid-career. In: Proceedings 1982 college industry education conference of the American Society for Engineering Education, ASEE, Washington, DC, pp 88–97
Kaufman HG (1982b) Professionals in search of work: coping with the stress of job loss and underemployment. Wiley-Interscience, New York
Kaufman HG (1984) Information acquisition in engineering problem solving: a systems model approach. In: Proceedings international congress on technology & technology exchange. International Technology Institute, Pittsburgh, pp 423–424
Kaufman HG (1986) A review of previous studies relating to engineering utilization. In: Engineering manpower commission, toward the more effective utilization of American engineers. American Association of Engineering Societies, Washington, DC, pp 89–97
Kaufman HG (1989) Obsolescence of technical professionals: a measure and a model. Int J Appl Psychol 38:73–85
Kaufman HG (1990) Management techniques for maintaining a competent professional work force. In: Willis SL, Dubin SS (eds) Maintaining professional competence. Jossey-Bass, San Francisco, pp 249–261
Kaufman HG (1994) Obsolescence and retraining of technical professionals: a research perspective. J Contin High Edu 42(2):2–11
Kaufman HG (1995) *Employees, Careers, and Job Creation: Developing Growth-Oriented Strategies and Programs*, edited by M. London. San Francisco: Jossey-Bass. pp 105–120
Kaufman HG (2006) Obsolescence of knowledge and skills. In: Greenhaus JH, Callanan GA (eds) Encyclopedia of career development. Sage, London, pp 539–545
Klein DA (ed) (1998) The strategic management of intellectual capital. Butterworth-Heinemann, Woburn
Kozlowski SWJ, Farr JL (1988) An integrative model of updating and performance. Hum Perform 1(1):5–29
Kozlowski SWJ, Hults BM (1987) An exploration of climates for technical updating and performance. Pers Psychol 40:539–563
Leavitt HJ, Lipman-Blumen J (1995) Hot groups. Harv Bus Rev 73:109–116
Levy M (2011) Knowledge retention: minimizing organizational business loss. J Knowl Manag 15(4):582–600
Mali P (1975) Measurement of obsolescence in engineering practitioners. In: Kaufman HG (ed) Career management: guide to combating obsolescence. IEEE Press/Wiley-Interscience, New York, pp 25–35
Martins EC, Meyer HWJ (2012) Organizational and behavioral factors that influence knowledge retention. J Knowl Manag 16(1):77–96
McQuade E, Sjoer E, Fabian P, Nascimento JC, Schroeder S (2007) Will you miss me when I'm gone? A study of the potential loss of company knowledge and expertise as employees retire. J Eur Ind Train 31(9):758–768
National Research Council (1985) Engineering education and practice in the United States: continuing education of engineers. National Academy Press, Washington, DC
Newton S, Schambach T, Blanton JE (2002) Nature of work effects on motivation of information technology professionals. In: AMCIS 2002 proceedings. Paper 293
Nonaka I, Takeuchi H (1995) The knowledge creating company: how Japanese companies create the dynamics of innovation. Oxford University Press, New York
Nwachukwu JC (1989) Job obsolescence and its contributing factors among production managers. Eng Manag Int 5:299–308
Oldman GR, Hackman JR (2010) Not what it was and not what it will be: the future of job design research. J Organ Behav 31:463–479
Pazy A (1996) Concept and career-stage differentiation in obsolescence research. J Organ Behav 17(1):59–78
Pinchot G III (1987) Innovation through intrapreneuring. Res Technol Manag 30(2):14–19

Polanyi M (1966) The tacit dimension. Routledge & Kegan Paul, London
Polanyi M (1976) Tacit knowledge. In: Marx M, Goodson F (eds) Theories in contemporary psychology, 2nd edn. Macmillan, New York, pp 330–344
Rong G, Grover V (2009) Keeping up-to-date with information technology: testing a model of technological knowledge renewal effectiveness for IT professionals. Inf Manage 46:376–387
Rosen B, Jerdee TH (1985) A model program for combating employee obsolescence. Pers Adm 30(3):86–92
Silzer R, Dowell BE (eds) (2010) Strategy-driven talent management: a leadership imperative. Jossey-Bass, San Francisco
Steiner DD, Farr JL (1986) Career goals, organizational reward systems and technical updating in engineers. J Occup Psychol 59(1):13–24
Trimmer KJ, Blanton JE, Schambach T (1998) An evaluation of factors affecting professional obsolescence of information technology professionals. ACM SIGCPR Comput Pers 19(3):4–19
Waight C, Stewart B (2009) Exploring corporate e-learning research: what are the opportunities? Impact: J Appl Res Workplace E-learn 1(1):68–79
Wingreen SC, Blanton JE (2007) A social cognitive interpretation of person-organization fitting, the maintenance and development of professional technical competency. Hum Resour Manage 46(4):631–650
Zelikoff SB (1969) On the obsolescence and retraining of engineering personnel. Train Dev J 5:3–15