

ONTOLOGY BASED INTEGRATION OF TRAINING SYSTEMS

The Electrical Power Production Operators Domain

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Abstract: An ontology based approach to loosely integrate independent training management systems is presented. The three systems are: the traditional training management system, the labour skills management system and the talent and innovation management system. The method first represents the data of each of the three independent systems using a simplified ontology structure, and then the integration relationships among the systems are specified and implemented.

1 INTRODUCTION

Derived from governmental policies related to competitiveness and considering its strategic planning objectives, CFE (Comisión Federal de Electricidad -the National Electric Utility in Mexico, a 70,000 employee power company) has established an strategic program to improve its human capital and to align it with its mission and future vision. This program promotes learning and innovation at CFE which is the enterprise responsible for generating, transmitting and distributing electricity through out the Mexican nation.

Continuously, CFE has invested significant amount of work to train and develop its human capital related to electric power generation, with efforts mainly concentrated on learning acquisition (to enhance the specialization level), the workers academic grades improvement, and the value contribution through innovation as the basis for competitiveness.

During the last 5 years, CFE has evolved its training system by integrating its traditional administrative model with training based on competences. The implementation of this new system is supported by powerful computer systems where

- Information is managed to follow up both face-to-face and on-line training.

- Information is maintained on the training alignment with the mission and functions of the company
- Applicable labor skills standards to electricity generation are registered
- Labor competence certificates granted to the workers are registered
- It is supported the elaboration, storage and recovery of instructional contents for self training trough Internet
- The talent and innovation management is supported

With this new Human Capital Management System (HCMS) for the electrical generation operators, the workers are involved in a repetitive cycle between the learning (training) process and the innovation process (Miller, 2007) with emphasis on value creation to guaranty financial profitability.

In this paper we describe the ontology based approach used to integrate the traditional training model and the competence based training model with the talent and innovation management to manage information about human capital.

Section two presents the HCMS model that integrates learning, talent and innovation management, the model is described both from the conceptual and functional points of view. In section

three, the management systems are described and the ontology models for each system is introduced, and finally the integration method is presented.

2 THE HUMAN CAPITAL MANAGEMENT SYSTEM

The Human Capital Management System can be described using two models: a conceptual model and a functional model.

2.1 The Conceptual Model

As mentioned in (Miller, 2007), learning stimulates innovation, in the form of information and knowledge. And in return, innovation gives birth to new learning and knowledge. One way to experience the relationship between learning and innovating is to tune into our own breathing rhythms. Learning and innovating go together just like inhaling and exhaling:

- *Inhaling* = learning: acquiring, creating and sharing new knowledge; converting knowledge to wisdom.
- *Exhaling* = innovating: generating, deciding upon, implementing and celebrating innovative responses to opportunities and challenges.

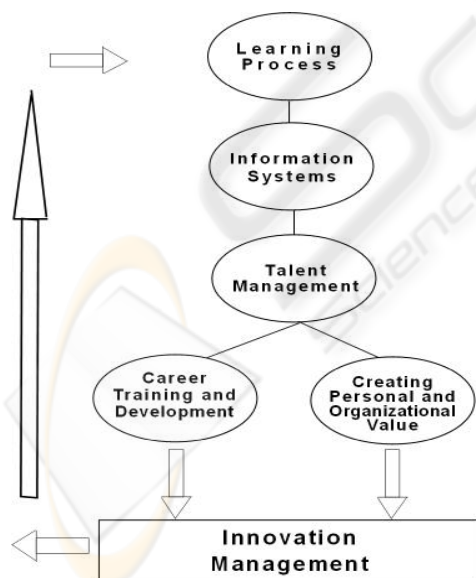


Figure 1: Learning, Talent and Innovation.

The HCMS conceptual model is shown in figure 1.

The aim of the Learning Process is to train and develop human capital.

With the Talent Management Module CFE identifies the capacity of the workers and using career training and development preserves their talent.

The innovation management system supports decisions about the workers value contributions to CFE stimulating the creation of personal and organizational innovations.

The information systems integrate learning, talent and innovation using interactive technologies as explained in the following section.

2.2 The Functional Model

From the functional point of view, the HCMS is composed of an integrated set of four interactive information management systems as shown in Figure 2: the traditional training management system, the competence based training system, the talent management system and the innovation management system.



Figure 2: Information Systems.

3 ONTOLOGY MODELS

This section describes the component systems of the HCMS and their ontology models.

3.1 The Traditional Training Model

For more than 20 years, CFE has executed a training program that includes a coherent and comprehensive group of standards developed internally and aimed to achieve the training of its 70,000 employees and with the contractual objective of offering 10 training days per year for each employee. The norms are

classified in four groups:

Planning:

- Position Profiles
- Training Batteries
- Training profile per worker
- Individual Knowledge Matrix
- Individualized Training Program
- Specific problem solution oriented program

Organization and Integration:

- Revision, consolidation and authorization of the annual training program
- Instructors' development

Execution:

- Execution of the annual training program
- Budget
- Reports
- Statistical

Control:

- Construction and application of diagnostic evaluations
- Creation and application of partial evaluations
- Application of reaction evaluations
- Elaboration of the courses reports
- Transcript release of credit courses
- The worker's evaluation in his position
- Transcript release of labor abilities (aptitude record)
- Transcript updating of labor abilities and their upgrade for the current position and/or immediate superior position.

The objective of the traditional program is to obtain an annual training program of individualized courses with impact in the productivity indexes.

CFE classifies the hundreds of employee positions of its organizational chart into organic groups or levels (from I to XII) depending on the position responsibility (director, manager, department boss, operator, clerk, etc.), the position participation in business processes (generation, transmission, distribution) or support processes, if the position is unionized, and the remuneration level.

Each position in the organization has an assigned profile that it includes one or more specialties, for example,

- Maintenance (mechanic, instrumentation, elec-

tric)

- Operation (analysis and results, engineering, chemical)
- Planning (supply, analysis, studies)
- Services (billing)
- Etc.

The specialties are classified in levels that match with the academic levels: secondary, high school, primary technician, secondary technician, bachelor, graduate, master, and doctorate.

In this fashion, the annual training needs are detected to proceed to the assignment of dates for each course and to conform the training program which typically includes approximately 40,000 courses per year. The aptitude records are good for performance evaluation, to cover vacancies, or for incentive assignments.

The ontology model to describe the data for the traditional training model is shown in figure 3.



Figure 3: The Ontology Model for the Traditional Training Model.

3.2 The Labor Skills Model

A competency or labor skill is a specific capacity to perform a productive function in different labor contexts on the basis of obtaining quality results in the corresponding productive sector. A productive sector is a part of the society that specializes in some type of activity, for example, agriculture, health, or energy.

In contrast with a traditional training system, the main objective of a job skills management system or program is to certify individuals in knowledge, skills, expertise, abilities, and attitudes appropriate for specific enterprise productive functions independent of how they acquired them. This means that a labor competencies program may or may not be supported by a training system.

The ways and means that a person uses to acquire his skills is not the concern of a labor competency program, however, this program has to have evaluation tools and systems to make sure that a candidate for certification has or not the knowledge, abilities and attitudes required for performing a position for a particular productive function.

The Job Skills Technical Standard (JSTS) management module of the system includes the productive functions map for the electric sector, the collaboration mechanisms for the JSTS development, printing and publishing, and the content structures to manage their storage.

A Job Skill Technical Standard (JSTS) is defined and developed by a Job Skill Standard Committee (compose of methodologists, technicians and specialists, among other) authorized by CFE, and approved by the National Council for Job Skills Standardization and Certification (CONOCER, Spanish initials) and sanctioned by the Public Education and the Work and Social Affairs Secretaries of State. A JSTS establishes, for repeated and common use in the whole Mexican States territory, the characteristics and the guidelines for the evaluation of capacity or labor competence.

In Figure 4, a semantic model is shown for the normalization management that has been implemented with a relational database management system.

The methodologists generate the knowledge included in a JSTS; they are the experts in a productive function contained in the company's functional map. Roughly, the functional map of the CFE is a functions hierarchy or tree where the functions corresponding to the highest level are four:

1. To operate the equipment for electric power generation, transmission, transformation and distribution.
2. To maintain the equipment for electric power generation, transmission, transformation and distribution under operating conditions.
3. To manage the operation and energy transactions of the Power Electrical System.
4. To provide the electric power utility service.

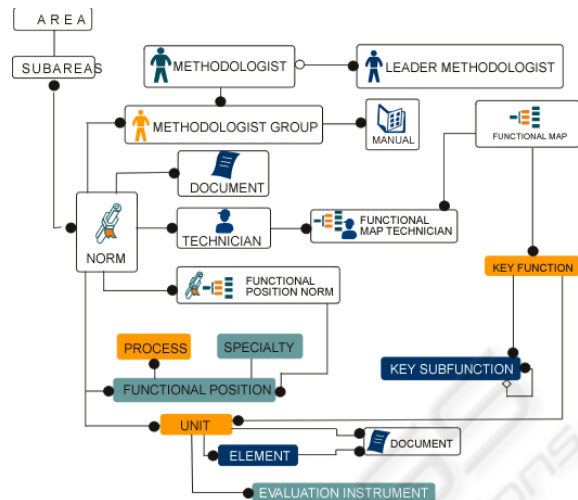


Figure 4: Semantic Model for job skills normalization.

It is not the intention of this paper to show the complete functional map for each one of the four mentioned highest level functions, it would be very extensive. All functions are composed of sub-functions; a short fraction of the tree for the function 2 is as follows:

- 2.1 To plan the maintenance of the equipment for electric power generation, transmission, transformation and distribution.
- 2.2 To carry out the maintenance of the equipment for electric power generation, transmission, transformation and distribution.
- 2.3 To determine the maintenance effectiveness of the equipment for electric power generation, transmission, transformation and distribution.

Breaking down function 2.2 we reach (sub) function 2.2.1.4.2 "To carry out the mechanical maintenance of steam turbines" where several standards is at hand, one of those is the norm:

CCFE0628.01 Mechanical maintenance of steam turbines with high and low pressure cylinder.

In this way, CFE had to elaborate a JSTS for each one of the lowest level productive functions of the company (approximately two hundred norms). In turn, the elements of a norm include evaluation instruments that are the performance criteria related with categories, in such a way that for an element different skills evidences can be assessed, either for abilities, for knowledge or for attitudes. One can observe that to work in a company position, a person will have to be certified in several labor competences.

Each standardized competence or labor skill has assigned a performance level according to the

English NVQ system (National Vocational Qualification). This classification of the competences is in five performance levels, based on different variables: complexity of the behavior, variety of acting in different contexts, autonomy and responsibility, requirement level, and of the collaboration management of other people and resources.

The levels imply progressive domain of these variables as the competence level increases, the smallest level of complexity and of variation is level one, and level five is the highest.

Level 1: Competence performance is of different labor activities most routine and predictable.

Level 2: Competence is in a significant scale of labor activities carried out in different contexts. Some are complex not routine. It should demonstrate certain responsibility and autonomy and frequently collaboration of others (team work).

Level 3: Competence is in a wide range of activities, in different contexts. Most complex and not routine, should demonstrate responsibility and autonomy, frequently to control and to direct.

Level 4: Competence is in a wide range of labor activities, in very different labor contexts, great responsibility and autonomy, to take the responsibility of the work of others and for assignment of resources.

Level 5: Competence implies the application of great quantity of fundamental and technical principles in varied unpredictable contexts. It demands the employee's autonomy, to take the responsibility in great measure for the work of others and considerable assignment of resources.

The elaboration of a specific norm is assigned to a group that is integrated with a leader and a certain number of technicians. The group uses a methodological manual that contains a set of templates or formats for the elaboration of standards.

The ontology model to describe the data for the Labor Skills model is shown in figure 5

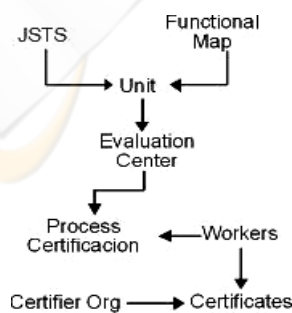


Figure 5: Ontology for the Labor Skills Model.

3.3 The Talent and Innovation Model

The talent management model, conceptually integrates the talent flow in periods that a worker passes through from his entrance to CFE, until his retirement (Figure 6). The training processes and professional development, should consider the talent management aspects that guarantee the investment profitability as part of the intellectual capital of the organization.

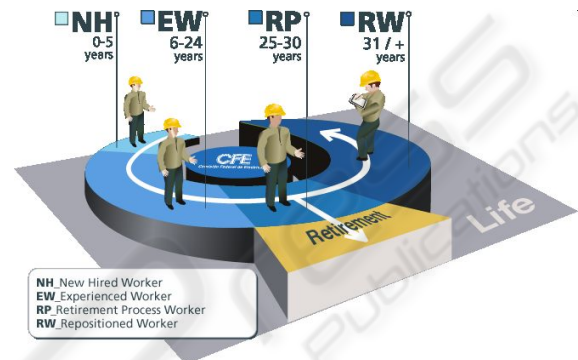


Figure 6: Worker Talent Flow (from hiring through retirement).

As talent management, we classify the time periods of the worker trajectory in:

NH: New Hired Worker

Worker identified in their attitudes according to generations M or Y with time value to be classified this way between 1 and 5 years of employment.

EW: Experienced Worker

Worker identified in their attitudes like generation X with a time value to be classified this way between 6 and 24 years of employment.

RP: Retirement Process Worker

Worker identified in their attitudes like generation X or B-B with a time value to be classified this way between 25 and 30 years of employment.

RW: Repositioned Worker

Worker identified in their attitudes like generation B-B with a time value to be classified this way between 31 or more years of employment.

These time periods mentioned can be defined in agreement with specialists, so that they can be changed according to the perception that the company has of them in a given moment.

The structural elements of the talent management model are shown in figure 7.

The training (knowledge, abilities and attitudes) and the development represent or describe the worker's talent throughout their trajectory or flow in the company.

Training generally follows the worker's position training battery and the battery of the immediately higher position. The training is mainly aimed to increase knowledge.

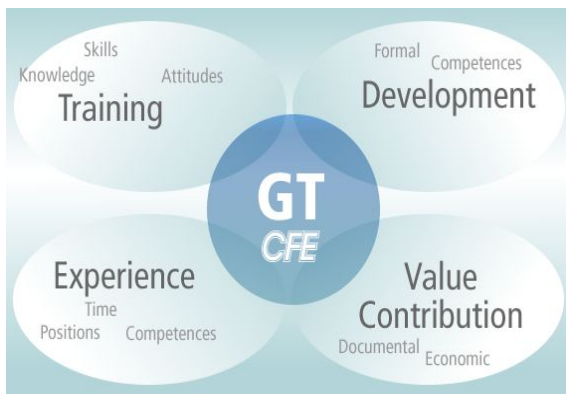


Figure 7: Structural elements of the talent management model.

The skills training is of field practices with low, high and very high intensity, with improvements verification in the field, as well as the new approaches of mental and psycho-motion abilities.

The attitude is what is expected on the part of the worker in the various stages belonging to the corresponding period of his labor trajectory. Examples of attitudes are: personal interest toward work, interest to participate in their position, involved in work groups, and concern to engage in a career plan.

Other attitudes are: to assume responsibility in CFE, will to accept new challenges, to accept responsibility as value and will to innovate and create projects and improvements as well as to promote learning and positive criticism for improvement. Each attitude can show up in levels:

ATTITUD LEVELS:

- Level 1 - Reception
- Level 2 - Answer
- Level 3 - Appraisalment
- Level 4 - Organization
- Level 5 – Characterization

The development includes the opportunities offered to the worker during the corresponding period, development examples are: technical careers,

bachelor and graduate degree levels, technical, administrative and executive competence certification, and global competences, also, specialization, short courses, research, author, tutor, instructor and advisory skills development.

Experience is a key indicator in a talent management system and the experience is measured with the time dedicated to activity, where results were obtained and there were a productive performance in the different positions and competences of the worker (xxxxx see section of indicators).

The worker acts with objectives and clear indicators, he knows the tracking processes, he commits to his achievement and it accumulates merits for results of his experience in the work.

The worker manages information and locates a great deal of knowledge objects with related value to the context of his work, like procedures, work instructions, training manuals, recordings, presentations, maps of contents, frequent searches in internet and outstanding places, glossaries, initials, data or corporate contents, convenient web links, publications, historical information, norms, real cases, examples, references to books, indexes, summaries, etc.

The worker can contribute value to the company by creating new knowledge objects or documents, and this contribution can be evaluated financially through a cost benefit analysis of the contribution.

For innovation management, we propose a variation of the Values Analysis Model Process that is the precursor to the *Measure, Analyze, and Improve* process that in turn is the basis of the Six Sigma improvement process. The HCMS innovation process is composed of the following phases:

- A creative idea is captured through a corporate portal
- Headquarters pre-evaluates the idea
- An assigned operating area evaluates the idea
- A community of practice approves the idea and sets up a project to implement the innovation

The ontology model to describe the data for the talent model is shown in figure 8.

The talent and innovation management indicators are a way of measuring the talent that the company has, some indicators are an indirect way to express the possible benefits of the value that the company can obtain from its workers contribution.

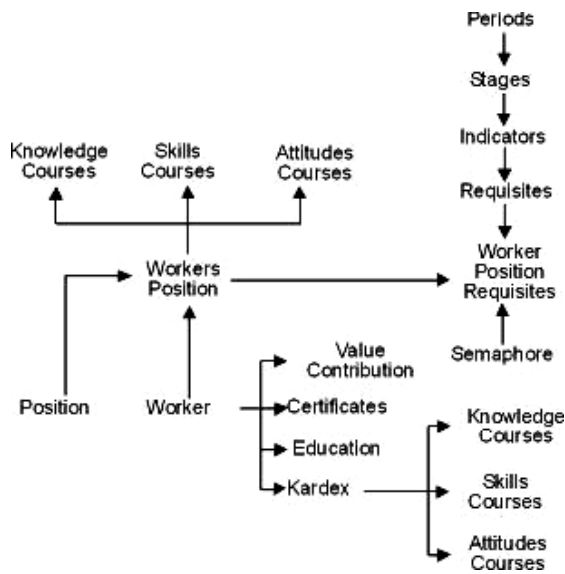


Figure 8: Ontology for the Talent Model.

The indicators are defined for the individual worker and they can be integrated or accumulated hierarchical or globally for the working center, region and nation.

The proposed indexes of talent and innovation management are:

Tenure in CFE (years of employment)

Experience, is the time and number of exercised positions (functional and organic).

Labor period where the worker is (NH, EW, RP, or RW)

Knowledge (Training)

- Current expenses in training
- Days of training
- Training percent in primary, secondary and complementary functions
- Depth level of cognitive area (1, 2, 3, or 4)

Certified Competences or Skills (complexity levels: 1, 2, 3, 4, or 5)

- Practice percent (in primary, secondary and complementary functions).
- Depth level in the psycho-motion area (1, 2, 3, or 4)

Attitude

- Depth level in the attitude or affective area (1, 2, 3, 4, or 5)

Education, highest academic degree

Value Contribution and Innovation per worker (documented cost benefit).

3.4 Integration

The real power of ontologies lies in the ability to create relationships among classes and instances, and to assign properties to those relationships that let us make inferences about them (Jepsen 2009). As mention in (Janev 2009), one application of ontologies is on data integration, and data share and reuse.

The Human Capital Management System loosely integrates the Traditional Training Management System (TTMS), the Labor Skills Management System (LSMS), and the Talent and Innovation Management System (TIMS). The information systems that implement these models were developed independently; however, to obtain data consistency and integrity among the systems a data integration effort was pursued.

The approach used was to develop an automatic data extractor that gets data from one system and inserts the data in another system, and if necessary performs some processing on the data before the integration into the other system. Table 1 shows some examples of data extractor specifications of source and target data items and the required processing.

Table 1: Source and target data items.

TALENT (Target)	Definition	Source	Processing
<i>TRAINING BATTERY</i>			
KNOWLEDGE	Knowledge training hours for a position profile	TRAINING BATTERY (TTMS)	Sum of the knowledge training hours from a position profile
SKILLS	Skills training hours for a position profile	TRAINING BATTERY (TTMS)	Sum of the skills hours from a position profile
ATTITUD	Attitude training hours for a position profile	TRAINING BATTERY (TTMS)	Sum of the attitude training hours from a position profile
<i>TRAINING PROFILE (KARDEX)</i>			
KNOWLEDGE	Knowledge training hours of an employee	TRAINING PROFILE (TTMS)	Sum of knowledge hours from the training profile (kardex)

Table 1: Source and target data items. (Cont.)

<i>TRAINING PROFILE (KARDEX)</i>			
SKILLS	Skills training hours of an employee	TRAINING PROFIL (TTMS)	Sum of skills hours from the training profile (kardex)
ATTITUD	Attitude training hours of an employee	TRAINING PROFILE (TTMS)	Sum of attitude training hours from the training profile (kardex)
<i>OTHERS</i>			
VALUE CONTRIBUTION	Artefacts (courses, articles) that the employee produces in order to increase the company value	ARTEFACTVALUE (LSMS)	None
CERTIFICATES	Certificates awarded to the employee during his trajectory	CERTIFICATES (LSMS)	None
EDUCATION	Employee's education level	TRAINING PROFILE (TTMS)	None

4 CONCLUSIONS

An ontology based approach to loosely integrate independent training management systems was presented. The three independently developed systems were loosely integrated: the traditional training management system, the labour skills management system and the talent and innovation management system. The resultant Human Capital Management System allows users to interactively access information from the three systems without the need of knowing which system they are consulting.

The ontology analyses help us to integrate the data and to support data share and reuse.

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