University of Central Florida – EIN 6950 Capstone Course

Integrated Training System Architecture:

An Organismic System of Systems

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November 22, 2016

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Abstract

The training processes in large organizations have focused mostly on assessing needs, developing content, delivering training (either via instructor-led classes, on-line/computer-based training, simulation, or practice-based/on-the-job training), and assessment. This paper examines the emerging need for integrating aspects of training processes and systems to planning, optimizing skills, managing trainers (when needed) and overall organizational outcomes from multiple stakeholder viewpoints. The result is a proposed systems architecture that could be leveraged across many organizations to enable a long-term sustainable life cycle for the overall system-of-systems.

Introduction

In the field of training employees for critical jobs in industry (such as healthcare, construction, manufacturing assembly, theme parks, military, etc.) there is much work regarding job-task analysis and training needs analysis, multi-platform training development, and assessments to ensure the trainee understands key material required to work a job. However, most research and technology does not adequately explore the integration of training data into the greater ecosystem of human capital management systems (personnel systems), including employee records, planning and scheduling systems and recruitment systems. In many organizations, this gap has symptoms of highly manual, expensive processes that are performed by human intermediaries. This gap also creates a lost opportunity for an employee to be more useful to the employer; and, the employer loses an opportunity to leverage existing talent for required work. This gap will be explored by applying principles of systems engineering to propose a holistic system architecture, taking into account the needs of all organizational stakeholders. The proposed architecture will consider both the transactional needs as well and the analytical needs, expressed via a series of decisions and business questions. The project defines a high level data model and a set of requirements to meet the business needs of a medium to complex multi-job environment. Because of the wide range of systems involved, the desired outcome of this research is a set of commonly agreed to interfaces that would enable standardization between the component systems to enable interchangeable parts provided by either technology organizations or third party OTC software providers to improve the overall process without needing to replace the entire system. By providing a more efficient way to increase the number of jobs an employee can work, their value to the organization increases, professional growth and income thus accrue that may contribute to addressing the income inequality challenges of the last decade.

Literature Review

In conducting the literature review, my research composed of the following themes from which I did the search:

- Basic Systems Architecture
- Experience perspective for each actor
- Stakeholder views
- Organizational Integration
- Decision Support Elements
- Planning Dimension
- On-the-job, classroom, multi-channel delivery models
- Interface standards

The initial reference for this research is the Zachman(15) model for Enterprise modeling. This project considers the first two levels of Zachman's Enterprise Architecture: Objectives/Scope and Enterprise Architecture; with some explorations to the requirements level. Many of the sources covered the basic architecture for learning and training systems. The most widely quoted source is the IEEE 1484.1 Standard for Learning Technology (7). This basic architecture is shown below:

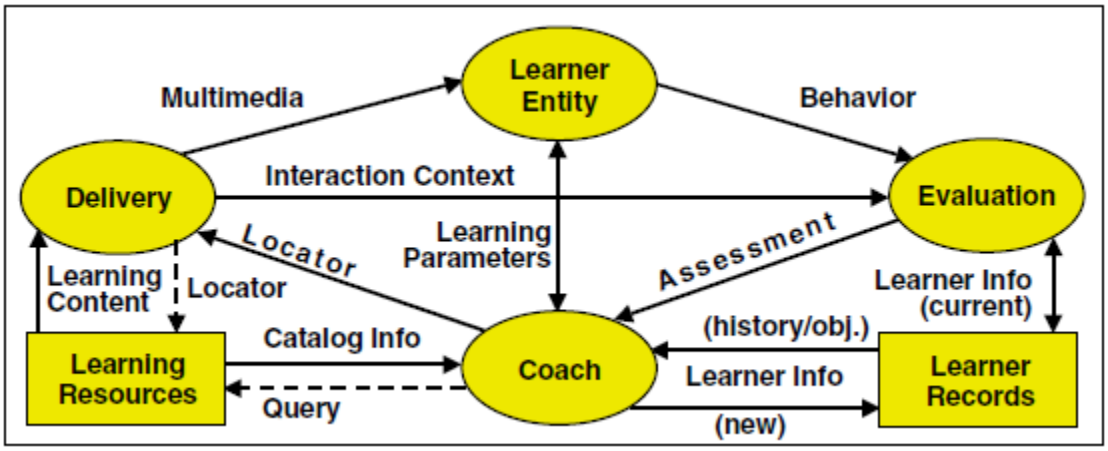

Figure 1: The LTSA System Components

While this covers a concept for multimedia technology-based learning, it leaves out any classroom or on-the-job components, as well as organizational and data components. Kumar (9) and Hadiputra(6) start with this framework and develop it further for e-Learning Systems and for Services Oriented Architecture (SOA). However, the latter two have similar gaps to the IEEE LTSA Standard. In Nor(10), a use-case unified modeling language (UML) approach is proposed, with a focus on user experience, and references to other non-training processes such as training scheduling, requesting training and training records, but it does not connect to job information or requirements. Cruz(5) also builds on the IEEE LTSA standard and introduces Agents and Components Oriented Architecture by taking the LTSA concepts to a formal technical architecture for web-based training. Cruz introduces the idea of a business intelligence overlay with references to metadata repository, but it is with respect to searching for content and training history for courses vs. making business decisions. Canales(3) and Peredo (12)

also provides a deep analysis for web-based learning architecture, but again, limited to the boundaries of the LTSA Standard.

Shaw (14) introduces a concept in learning management referred to as Knowledge, Process, Practice (KPP), but its focus is online education. Shaw's work does introduce the element of continuing professional element in the medical domain, but it has application to many other domains requiring regular update training. Shaw also makes a case for more effective evaluation and assessment as well as having a component for on-the-job or practice oriented evaluations.

Avgeriou (1) presents an early version of an architecture for an open learning management system – begins to address common APIs and communication between layered components for web-based learning applications. Unlike other sources, Avgeriou shows how his framework connects to corporate Learning Management Systems (LMS) and the limited scope of what LMSs can do. A broader look by Todd (14) touches on a broader organizational context, human capital management (HCM) for a very narrow industry (Shipbuilding) to address the loss of science and engineering skills from attrition and retirement. Many of Todd's concepts can be scale to encompass broader industry domains. Overall measures of effectiveness (OMOE) are developed by Todd, but require more refinement of the overall HCM architecture. A summary of the literature search is in Figure 2, below:

Article	Year	Basic Architecture	Experience View	Stakeholder Needs	Organizational integration	Decision Support Elements	Planning Dimension	On-the-Job/ practice component	Interface Standards
IEEE Standard for Learning Technology	2003	Yes	No	Yes	No	No	No	No	Some
Nor, A Requirements Model for Employees Training Management System	2009	Yes	Yes	Yes	Some	No	Yes	Yes	No
Hadiputra, Architecture of E-Learning Systems based on LTSA	2013	Yes	Yes	Yes	No	No	No	No	Yes
Peredo, Intelligent Web-based education system for adaptive learning	2011	Yes	Yes	No	No	No	No	No	Some
Canales, Adaptive and intelligent web based education system	2006	Yes	Yes	No	No	No	No	No	Some
Zachman, Enterprise Architecture: The issue of the century	1996	Yes	Some	Some	No	No	No	No	No
Practice (KPP) model for dirving the design and development of online postgraduate medical education	2006	No	Yes	Yes	No	No	No	Yes	No
Todd, A systems engineering approach to address human capital management issues in the shipbuilding industry	2008	Some	Some	Yes	Some	Yes	Yes	Yes	No
Avgeriou, An Architecute for Open Learning Management Systems	2003	Yes	Some	No	No	No	No	No	Yes
Learning and Development Leadership Counsel, Mapping L&D Innovations by Adoption, Current Impact, and Future Investment	2016	No	Some	No	No	No	No	Yes	No
Cruz, Architecture for development of WBES based on components and agents	2006	Yes	No	No	No	No	No	No	Yes
Kumar, Extending IEEE LTSA e-Learning Framework in Secured SOA Environment	2010	Yes	Some	No	No	No	No	No	Yes
Miller, Integrated Training System Architecture	2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Figure 2: Literature Review Summary

Background and Scope

The project idea proposed is a System Architecture for linking the domains of planning, training and scheduling through a process and data requirements and design. Today, there are well established processes and systems to manage schedules, develop training content based on roles, delivering training, and measuring effectiveness of training. There are, however, various gaps:

- **Inefficient tracking and recording**: When the training is complete, and the trainee is qualified to work a certain role, this information must travel to the relevant scheduling systems to enable scheduling. This path is complicated by the fact that scheduling most often takes place weeks in advance of a training event, so there must be provision made to assume an employee is qualified by a certain date to enable scheduling.
- **A lack of decision-support tools for who to train in what**: Additionally, there is often very little decision analysis related to the optimal number of people to train, based on customer demand and long term planning considerations. Subsequently, many organizations may be overspending on training or sub-optimally using their training resources.
- **Scheduling Training is highly manual and complex**: Training planning is also often problematic when it comes to scheduling training events, whether it is on-boarding, core training and especially on-the-job training. In many environments, there are at least three practices in training scheduling: schedules in the learning management system when the trainee is registered to take training, offline spreadsheets and databases with various training requirements tools, and standard work-based scheduling systems for service industry staffs. In many places all three are used in an inefficient make-shift fashion.
- **Data structure of the training components is not well architected and mapped to people**: for example, if there is an introduction to the organization, does that component need to be subsequently included in every position trained for in that organization (it often is).
- **Experience is cumbersome**: Finally, from the trainer and trainee perspective, it is often hard to get the relevant critical information such as 1) what is the required sequence of training events? 2) how the training/trainee scheduling can be adequately matched up on a timely basis (for OJT training) 3) what can be done to motivate or incentivize managers to take steps to ensure training does not expire or employees do not work without a credential.
- **Cross functional data is not easily available**: Given the role of information management across the planning, scheduling and training processes, this proposed domain is a good candidate for a data warehouse or central data repository that can be advanced to answer various critical business questions that traverse these three areas.

The idea that I have proposed is the ***integrated training system*** for how schedules and working can be more compatible in the service industry in the United States. While not generally thought of as a "system" per se, when all the component parts are put together, we have a system of workers, trainers, employers, institutions, policies and software/systems that create some negative emergent outcomes such as increased elapsed time to make a new worker productive, over or under investing in training, safety and legal implications if a recorded qualification is not in place before working a position and a lack of a clear decision process for understanding how many people to train in which roles to maximum operational efficiency. This can best be characterized as an open societal system-of-systems due to its large scope and reach.

Purpose and general scope characteristics – The purpose of the proposed system is to ensure adequate planning and integration of key activities and data related to planning, scheduling, training and working. The focus of the system architecture will be more about the inter-connection between systems and establishing what may eventually be industry standard interface protocols between components.

The system architecture will not delve deeply in the well-developed training processes related to needs assessment, instructional system design (ISD), testing to confirm knowledge or job-task analysis activities as these are all sub-system elements of the training process. Training delivery is also reflected as a broad collection of traditional classroom instruction, on-the-job training, computer-based training, online training, simulation and many other emerging techniques with new technology. The architecture will only go as deep as inter-system integration would require. Similarly, in scheduling, there is much advanced research in optimal scheduling techniques (e.g. simulated annealing heuristic), but not in the area of a decision process to manage skills in a workforce for optimal planning, scheduling and service delivery. Finally, in planning, many tools integrate demand planning, translating staffing requirements to financial costs, but not a lot of decision analysis around whether to hire or train a skill required to meet customer demand.

Today much of the research and advancement of technology occurs within one of the three components, but little work has been done to establish common integration or connecting points. Solving this system of system has implications for how organizations efficiently provide opportunities for workers to learn new jobs, increase their value to the organization and perhaps enable increase hours of work (and thus income) and/or learn more jobs that may increase potential for a higher rate of pay and thus ultimately impacting income inequities in our current political/economic environment.

The **Stakeholders** include:

1. Private employers and their shareholders – incentivized to driver higher profits or lower costs (non-profits have followed these practices to keep their costs low). This stakeholder group also has many sub-stakeholders including Operations, Finance and Human Resources organizations who formulate policy, processes and systems related to planning, scheduling and training.
2. Service workers – Their stake in this process is making themselves more valuable to the organization by knowing more jobs to enable either more hours of productive time (and therefore more pay) or ability to learn more new or higher paying jobs.
3. Unions – in many environments, unions set rules for classifications of jobs by which employees are paid. These must be considered for planning, scheduling and training and are often not clear or visible for many organizations. Also, related to training and skills, unions often determine the parameters around utilizing workers across various job classifications and whether such flexibility should be compensated or not. Unions also often specify parameters that inform the rules and guidelines for transferring to other positions. This is important to our scope as these transfers are usually a trigger event for scheduling. An important aspect of the transfer process is the decision to fill a staffing gap with a transfer, a hire or retrain existing workers to make them more productive.
4. Training Organizations – these may also have sub-organizations that
    1. develop operational procedures or guidelines content that serve as the content to train to for various jobs,
    2. training content developers to design training components and architect curriculums
    3. delivery organization to deliver the training to users – includes on-line, simulation, classroom and practice/experiential/on-the-job based

    4. Training administration teams that track, schedule and confirm training or certificates were executed.
5. Planning Organizations (4 weeks to one-year time horizon) – these groups are in the business of planning the right number of staff by position required to meet future needs, based on employee turnover, business growth or redeployment of resources for strategic objectives.
6. Scheduling Organizations (2-3 weeks planning horizon for worker schedules) – these organizations provide the detailed schedules by day for both workers and often for trainers (in some cases the training scheduling also or alternatively occurs in the training administration organizations outlined above.
7. Operations – workers ultimately reside in operations as do (in many organizations) the on-the-job trainers. Operations also has the responsibility "at the moment of truth" to ensure that no employee works in a role without a proper recorded qualification.
8. Legal – the legal organization has a stake in this system architecture to ensure that the organization has put in place well documented procedures to ensure the organization exercises policy and process to ensure safety training. Legal's stake reflects a desire to demonstrate that the organization was dutiful to provide a clear process to provide and record training vs. being negligent by not having an established system of record for training. By accomplishing this, large negligence law suits can be avoided.
9. Safety – similar to legal, the safety organization has a vested interest in ensuring those working various safety-critical positions have been fully qualified to do so. Adequate training is a key element of any systematic approach to safety (REFERENCE). Many training initiatives start from a "close call" caused by someone who may have not been qualified for a role, but was put in the role regardless. (REF)
10. Software vendors – These are the providers of several of the system components referenced above and can include (but not limited to)
    1. Labor forecasting/scheduling software (e.g. Kronos, JDA/Red Prairie, Workforce, Infor, Verint)
    2. Training content/procedure content (e.g. Hummingbird, eDocs, etc.)
    3. Learning management software – usually is the official system of record for training in an organization, but often also includes scheduling and capacity management for classes, a platform for e-learning (where online training can be automatically recorded) and the reference framework and architecture for training items, curriculums, and training verifications (for on-the-job training) (e.g. Plateau, Success Factors)
    4. HR system of record/ employee life events software – keeps a position hierarchy of jobs linked to organization entities and compensation data mapped to the jobs. (e.g. WorkDay, Dayforce, SAP-HR, Oracle-HR, Ultimate Software).

System Type Review - Because it is a system of systems, the classification between mechanistic, organismatic, or social systems will not fit neatly into one box. Certainly the methods of planning, scheduling, training and working are largely mechanistic and systematic with centralized control. However, the internal policies and systems for deciding whether to transfer, hire or retrain talent and how that is done are more organismic to drive to an outcome of efficiently meeting customer needs. Finally, from a public policy perspective and **looking at the components as a whole, a social system may be a more appropriate classification given the goal of improved value an employee can provide to the organization and perhaps the satisfaction of being more useful to the organization**.

Functional overview: The functional system of system scope includes:

- Learning management systems

- Employee system of record systems
- Work recording systems to provide record of work experience in a job, task or location
- Labor forecasting and/or scheduling systems (these can be one system or multiple)
- Planning systems to plan hires over a 3 month to one-year time horizon
- Data Warehouse to link data from these disparate systems in order to answer critical business questions to support key decisions for training.
- Operational decision making around when to train some one
- Employee decisions around requesting training or taking appropriate action if training has expired
- Technology organizations and system integrators that try to integrate these various human capital management components.

From a broader context and recognizing that with many organizations pursuing part-time workers, the training system record could potentially span multiple employers. This is certainly a perspective from an employee's viewpoint, but perhaps there is an opportunity for a third party service to manage the positions and training across employers (as it is happening already today) – or perhaps there is a potential technology (similar to Lyft or Uber) that might identify a needed skill or qualification across employers for incremental hours of work and match supply with demand and manage recency of skills to ensure workers are still qualified for various positions available at various employers who sign up for the service. Another greater contextual perspective may be from a national employment skills management – perhaps (similar to healthcare) there can be a central database of people with various skills in order to manage supply and demand of needed skills to those who are out of work. This may help the process of transitioning old industries to the new jobs that are plentiful, but lack qualified applications. The concepts developed here may also address this greater question for how workers can be trained in different jobs and optimally match qualified candidates to open jobs or shifts.

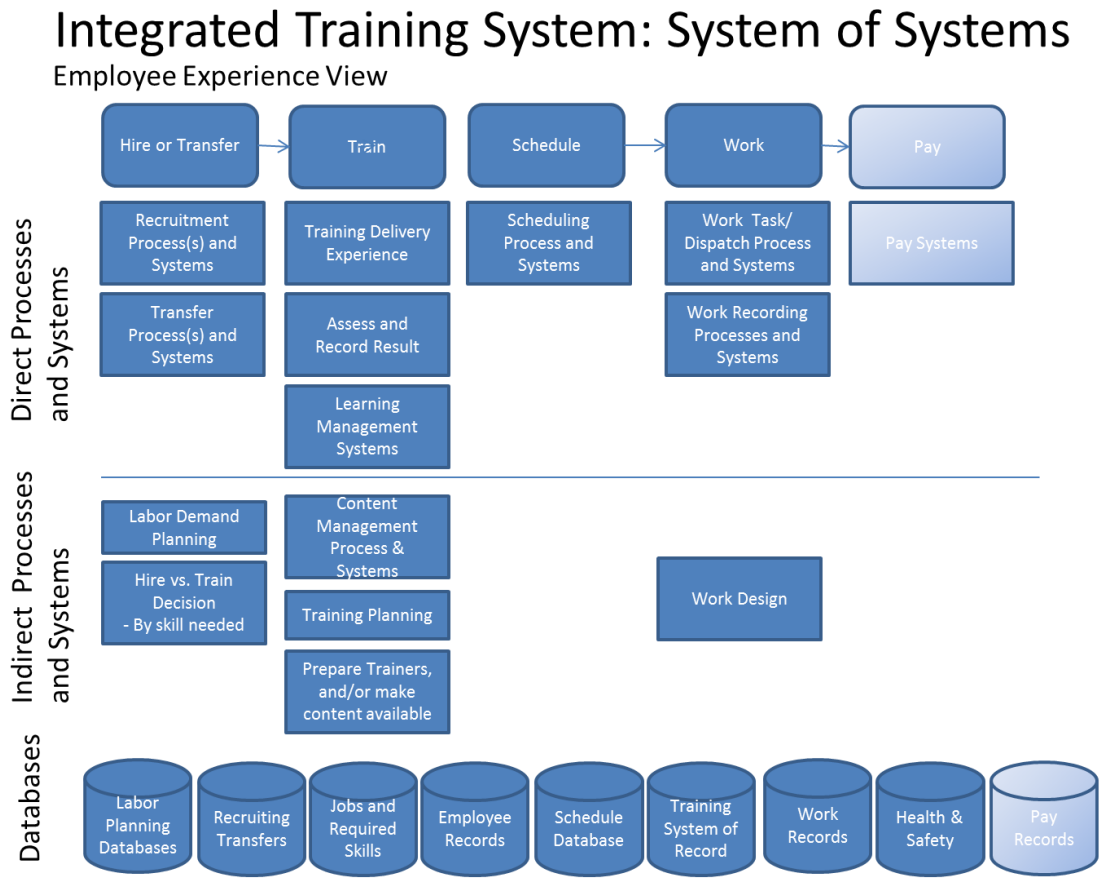

Figure 3: Integrated Training System View

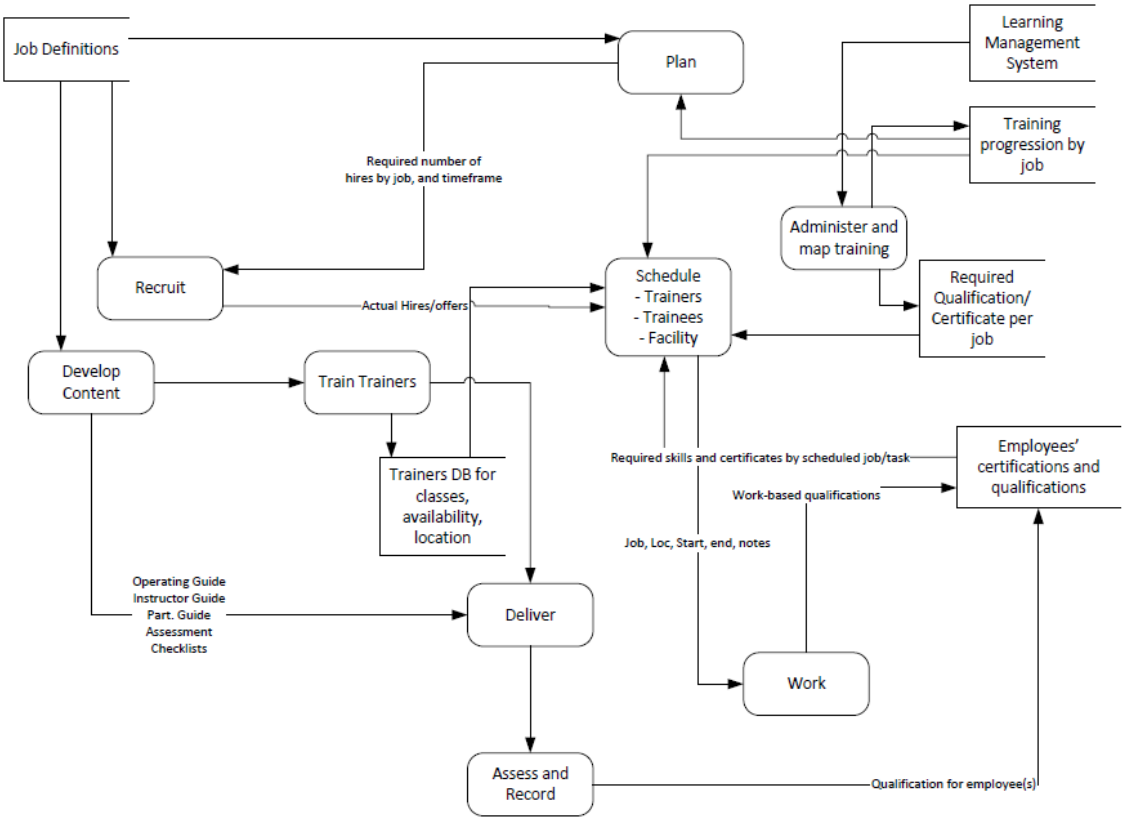

Figure 4: Integrated Training Data Flows

Concept of Operations

Desired Outcomes:

- Optimized decisions for whether to hire vs. train, and how many to train for each job, as measured by frequency of working in jobs for which employee are trained. This answers the questions of "Was the training used or was it a waste because the job was not worked?"
- Cycle time from hire/transfer to trained and effective/productive is minimized/improved. Metric is the amount of time from hire or transfer to being a trained productive employee. Organizationally, this is critical to support new products or services in response to dynamic changing competitive pressures.
- By knowing more jobs, employees maximize their income potential to get to full schedules and increased opportunity for additional hours past 40, if desired. Metric for this is percent of employees working more than one job or location vs. number of worked hours (to confirm that more skills/job training means more income potential).
- Training planning and scheduling is streamlined and lean, using a minimum of resources by being systematic and intuitive; not just requiring elaborate automated business rules, but also taking a lean process design and leveraging behavioral nudges i.e. to go from cumbersome central planning model to an open, market-based model of employees acting in their self-interest to initiate the learning of new skills and jobs.
- New developments in instructional design and training delivery are easily plugged into the training system architecture.
- Replacement scheduling, learning management, personnel records and work recording systems can also be plugged in with minimal disruption to enable continued currency for the entire process and system of systems.
- Job satisfaction and employee engagement increases as employees obtain a sense of value and usefulness to their employers; employers gain by greater utilization of their workforce and thus greater efficiency and profitability.
- Societal benefit of employees with deep marketable skills which can be leveraged through various economic cycles by having a varied set of competitive skills.

Assumptions

- Multiple jobs for which to train are available and have counter cyclical demand patterns (enabling one worker to learn a skill and work as excess availability allows).
- There are minimal or no constraints to learning and working multiple positions.
- Established practices exist for proactively planning hiring (vs. only hiring when a vacancy occurs).
- Most likely candidates for this solution are service-related industries with multiple jobs in operations such as
    - Healthcare
    - Broadcasting/Networks (NABET contract has over 50 roles in broadcast industry)
    - Military
    - Amusement parks or cruise ship operations
    - Construction trades (electrical, carpentry, plaster, plumber, painter, cement)

- Some element of on-the-job or apprentice training is assumed as the most extreme complexity (e.g. how and when do experienced practitioners train?). This is also referenced as a learn by doing model.

Viewpoints:

- Legal:
    - Confidence that every employee working has a recorded qualification record
    - Organizational processes to ensure qualified employees is robust enough to show intent that only trained employees can work (i.e. mitigate customer or worker compensation claims to prove organization has not been negligent in establishing a process to ensure properly trained employees are working).
- Employee View:
    - Training is time efficient, worthwhile and, if recruited properly, and leveraging an appropriate level of effort or practice, can pass training and perform job.
    - Employees are interested in obtaining additional skills to gain more hours and greater pay.
    - Choices to learn more skills and/or work more jobs
- Planning Viewpoint
    - Process is intuitive and straightforward – not intricate and fraught with exceptions.
    - All required data will be available for decision making
- Information Technology Organization View
    - Clear integration points to ensure no one single point of failure
    - Ease in replacing component systems over lifetime of the system
- Leader/manager View
    - Adequate skill coverage to staff operational needs
    - Efficient cost of labor base (usually the most controllable cost in an operation).
- Behavioral and Functional Views and Scenarios:
    - Growth vs. Contraction Scenarios
    - Variable vs. more fixed/predictable work
    - Seasonal vs. steady demand
    - Discretionary product or service vs. non-discretionary
    - Union contract work constraints vs. flexibility across job functions
    - Demographic scenarios – do all solutions consider age or disability scenarios?
    - Skill levels: high vs. low and short vs. long learning curve
    - Cultural: Are employees motivated to learn more skills and work more? (not true in all cultures); if not, then how can behavioral “nudges” be put in place to incentivize participation?

Form: What the system is

- An integrated collection of employee centric systems that use standardized integration between component systems with a planning and analysis layer to support integrated decision making and monitoring results (see figure 5)

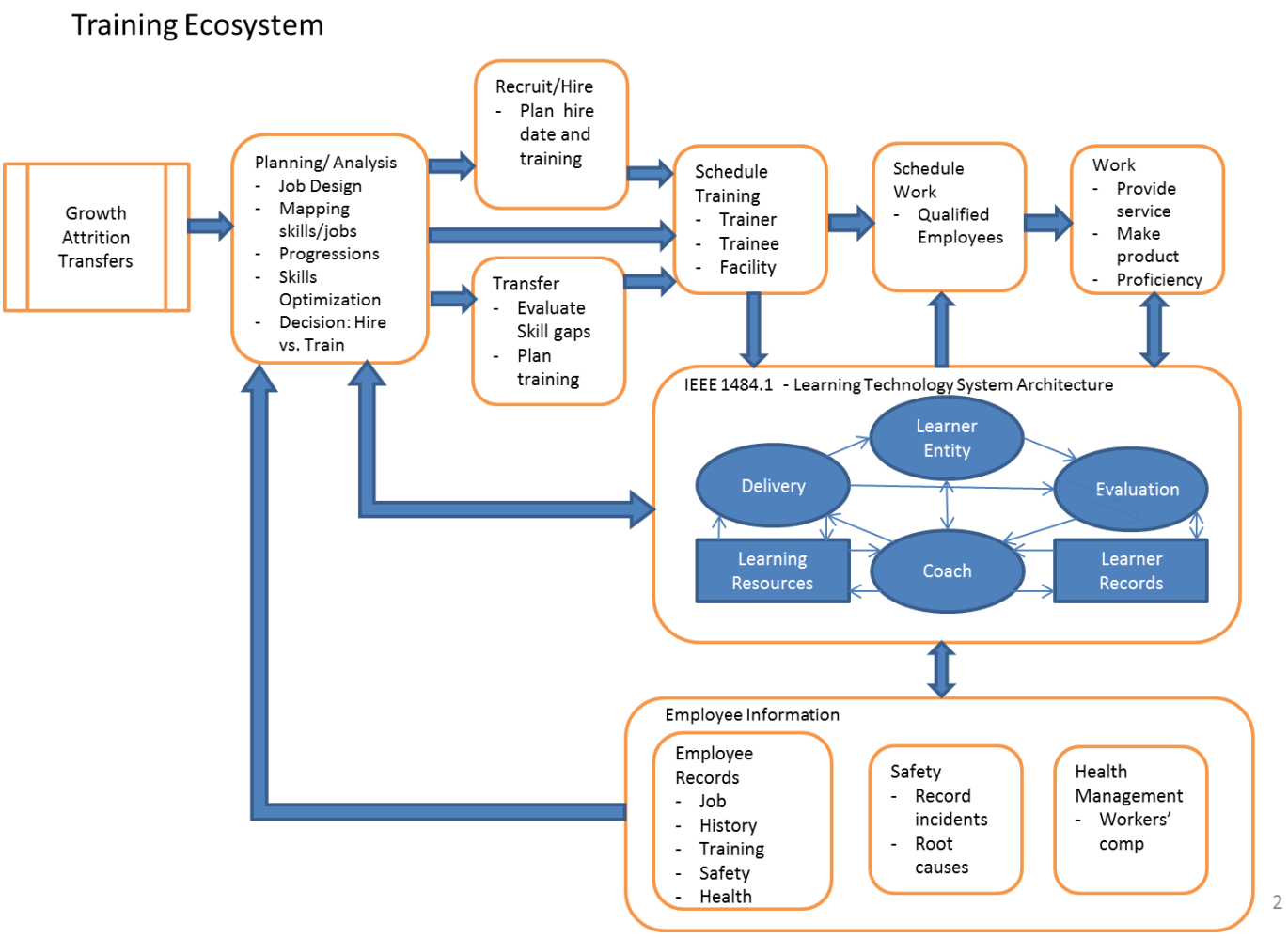

Figure 5: Training Ecosystem

Scenarios for consideration

As we move to consider the ecosystem architecture, there are several scenarios for consideration that must be included:

- Is the organization in a growth or contraction mode? For industries such as domestic ship-building, space engineers or train transportation where there has been no hiring for a long time, these activities may have to take place due to the impending retirement of a critical mass of talented employees.
- Is the employee marketplace an employers' market or an employees' market?
- What is the nature of the population of employees across many dimensions:
    - Highly educated or non-educated (e.g. high school education, some college, etc.)
    - To what degree are temporary employees considered such as interns or seasonal hires?
- Job considerations may include components such as learning curve difficulty and duration (high skill vs. low skill)
- Training delivery may take many forms and is in a state of changing:
    - Web-based/ mobile delivered training

    - Simulation
    - Class-room (still used in many industries)
    - On-job/ apprentice training – learning by doing - used for many safety critical high risk jobs to ensure assessment confirms ability to do job (e.g. surgeon, train conductor, ride operator, welder, fork-lift operator, machine operator, skilled model-maker, ship-building)

  This model is such that these are included in the "Delivery" module of the IEEE LTSA standard.
- Job standardization may emerge over time as jobs may become interchangeable between employers. Envision work for a food service employee who is certified to work in any quick serve restaurant or non-competing retail in a geographical area
- The level of technological change in a job or the level of stability in a field. For example, in many fields, digitalization makes skills and training a moving target for how employees interact with consumers who are transacting on-line or through devices. In order for organizations to keep up and deliver on a digital transformation, the people interacting with customers must be well-trained and integrated into the solution (vs. a technology-only approach)
- Nature of the work may also impact the nature of the planning and analysis integration of the training ecosystem:
    - Is the work transactional processing (most service industries and manufacturing)
    - What level of judgment is required for each role?
    - What are the frequency of the situations for which training is required?
    - Is the work on-going operational (service, manufacturing, retail, food service) or project-based (construction, defense, development)?

Life Cycle and Behavioral Considerations

In a single organization, jobs and positions are often confounded, and over time multiply and bifurcate into various groupings due to:

- Collective bargaining agreement definitions of jobs
- Recruiting classifications for pools to recruit for
- Convenient scheduling pools of like jobs or skills
- Pay scales: starting pay, pay progressions/scales, maximum pay, duration to reach top pay
- Competitive considerations: hard-to-fill jobs such as truck drivers, nurses, housekeepers, lifeguards, pest control

For a long view of this process, there should be a planned cycle of comprehensive regrouping of jobs and the subsequent mapping of skills, certifications and training to the jobs.

Jobs may also make sense to organization into a logical taxonomy or progression in terms of increasing value to an employer from entry-level to revenue or value producing jobs where there may be aligned incentives to contribute to the company's long term viability.

The theme of this capstone is for considering training in a broader organizational ecosystem, with a layer of planning and analysis over the training system itself, but with integration (via a central data repository) to Employee information, Health and Safety information, scheduling information and actual work data.

One other consideration is cultural – are employees strictly used as interchangeable parts as the outcome of central planning? Or are they organized into teams or "platoons" where teams are motivated to ensure the team's performance plays to each member's strengths and where team members can substitute for each other and go where the demand is. With this in mind, as employees and/or teams become more valuable, is the organization willing to compensate and share a portion of that increased value?

Design Requirements Specification

The mission of integrated training planning is:

To integrate training activities into a broader organizational context through a strategic planning and analysis overlay of

- *Increasing employees' value to organizations through knowing more jobs, resulting in greater growth and income opportunities,*
- *Planning and optimizing the number of people trained for jobs, based on future demand,*
- *Flexibility and speed to manage and integrate the planning and scheduling of various forms of training delivery, including on-the-job, computer-based, simulation, and classroom,*
- *Decision analysis for train vs. hire decisions, and long term considerations for skill retention,*
- *Integration of a feedback mechanism to facilitate performance improvement in terms of customer satisfaction, assessments, job performance, revenue, safety and health*

Through a central repository of critical employee information, analytical tools and standard interfaces between key training components, related data domains (e.g. scheduling, recruiting, safety, health, operations) and standard job and skill definitions.

Stakeholder Needs and Requirements

1. Service Workers

Needs:

- Job security through a set of skills or certifications that make them most useful to their current employer and/or in the marketplace to ensure employment.
- Flexibility to add more skills/jobs to increase their growth and income
- Future growth by retaining and adding job skills.
- Flexibility to choose between staying in one job/skill set or work in multiple jobs as needed or be retrained, depending on workers' desires, motivations and personal/life situation

Requirements:

1.1 Ability to elect to be trained in new skills or jobs needed by the company to increase working hours.

1.2 Ensure that cross training is not duplicative if they have several components already in their training record.

1.3 Ensure that training requirements for positions are easily accessible and transparent.

1.4 Ensure that cross training for additional work hours at the same employer is not dis-incentivized by hour limitations due to benefits' thresholds or union contracts.

1.5 Ensure that new hire training is easy to register for either through the recruiter or self-service with clear requirements and outcomes communicated.

2. Unions

Needs:

- Ensure employees' interests in pay and job security are advanced through collective bargaining agreements.

Requirements:

2.1 Ensure that as employees make themselves more valuable to an organization there may be increase hours of work or pay.

3. Training and Documentation Organizations

Needs:

- Integrated information to make decisions and answer business questions such as:
    - How many people must be trained for each job to meet current and future demand?
    - How can training curriculum design be broken into components to avoid duplicative delivery of similar modules
    - What is optimal facility and instructor capacity to on-board a large number of employees over a compressed time period?
    - What are consistent training progressions by job to bring new workers in an area up to proficiency in as short a time as possible?
    - What is the breakage for training i.e. how many people have been trained in a job only to never or rarely work it?
    - Where are training shortages causing overtime for those already trained or shortage of work hours for areas with too many people trained in the same job?
- Flexibility to introduce new forms of training delivery without retooling the entire infrastructure. Work documentation (operating procedures and guidelines) and training delivery is changing radically via digital technology and the ultimate system must enable a degree of interchangeability of new components to avoid constraining more effective tools.
- Learning management systems must easily integrate with scheduling, planning, recruitment and employee systems.
- Multiple delivery methods must be integrated, including classroom, web-based/online, simulation, and on-the-job.

Requirements

3.1 Provide an integrated data store to connect critical employee and planning information, including

- future demand by skill set and job,
- training skills data for employees,
- Jobs mapped to skills needed to work that job
- Training mapped to skills to work a job or task
- Jobs and/or tasks worked history information by employee,
- Recruitment information i.e. expected hires by job or skill set
- Training demand forecasting,
- safety incidents by job/employee,
- health/ workers compensation information by employee and job,

- performance information by employee and job

3.2 Ability to test and adopt new training delivery, content management, recording, and coaching methods and technology as interchangeable pieces to the training ecosystem

3.3 Enable decision support processes to evaluate decisions on how many people to train in a skill, timing of update training (risk of delaying vs. cost of doing now), hire vs. retrain decision and other related decisions

3.4 Optimize the capacity (using linear programming or other optimization techniques) for training demand for ongoing hiring/transfers or the onboarding of large groups for a store or operational start-ups.

3.5 Ensure that the interfaces between components are simple and persist over time to enable the interchangeability as technology advances. For example, if on-the-job training is done by simulation, the record going to the learning management system is the same no matter what the technology is (or is not).

3.6 Ensure critical information for training decisions, planning and analysis is graphical, easy to understand and has clear organizational objectives for decisions and actions.

3.7 Ensure learning management systems can plan training activities with respect to class, trainer, facility and participants, including all delivery methods classroom, online, on-the-job (identified trainers/instructors), or other digital methods.

3.8 Ensure that learning management systems use the same position/job/skills hierarchy as is used in recruitment, scheduling and planning

3.9 Ensure that the learning management system can export actual and planned training information related to schedules, attendance and completion to scheduling and recording systems.

3.10 Ensure that part of training planning includes a mapping of each job to a credential that references all related components (on-line, classroom, on-the-job, simulation) and pre-requisites.

4. Planning Organizations (4 weeks to one year time horizon)

Needs:

- Ensure long term labor demand is planned according to the same job classifications used by recruitment, training and scheduling to ensure alignment and consistency.
- Identify long term gaps in skill sets and mitigating strategies along with metrics to monitor the effectiveness of each strategy
- Understand the trade-off of strategies that are training-heavy (e.g. high turnover casual or seasonal employees or college internships) vs. quantifying value of longer longevity (higher paid and benefitted) employees who may work multiple positions as demand dictates
- Understand employee engagement impact or non-impact in revenue, customer service/loyalty/retention, attendance, safety or efficiency can be quantified and whether more flexible jobs or work increases or decreases employee; in short, do additional training investments to work more jobs pay off or not?

Requirements

4.1 Jobs, positions, skills, certifications, qualifications, locations, cost centers have consistent definitions and are standardized across recruiting, scheduling, financial reporting and training

4.2 Scenario planning must be enabled to test various strategies using techniques such as simulation, optimization, decision analysis, stochastic analysis and the time effect of employee longevity (i.e. employees cost more the longer they stay).

4.3 Employee contribution and value to the organization must be quantified as job performance, attendance (shows up and is not late), customer "wins", safety (prevention, incident mitigation, improvements), revenue, efficiency/productivity, and engagement criteria (e.g. participation in programs such as paid-time-off, education reimbursement, commuter assistance, discounts, clubs, etc.)

4.4 Planning information by job category must be available, including growth, attrition, temporary employment planned, benefit cost, etc.

5. Scheduling Organizations (2-3 weeks planning horizons for schedules)

Needs:

- Ensure no one is scheduled without a recorded qualification that confirms the employee's ability to do the job.
- Efficiently schedule training based on training components needed (progressions or refresh or updates needed).

Requirements

5.1 Ensure that on-the-job trainers/coaches are easily identified with their training activities shown in their schedules (in addition to their regular work schedules)

5.2 Ensure that training schedules for trainers and trainees can be loaded into the scheduling system.

5.3 Ensure that a warning or a no-save option is available if an employee is scheduled without a qualification.

5.4 Ensure employees can review the jobs they are qualified to work and upcoming training to keep their ability to work up to date

5.5 Enable a process to let employees see areas where demand has indicated more people with skills are needed and let them request more training to enable them to work shifts in that area.

5.6 When a qualification is no longer valid make sure that the employee and their leader is notified in advance by 1-2 weeks and enable the employee to select a time to do the training.

5.7 Enable an ability to record when managers let someone to work without a qualification due to operational circumstances.

6. Recruitment Organizations

Needs:

- Hiring needs by skills or job category
- Accessibility to plan new-hire training
- Positive experience for new-hire transition to a productive employee to mitigate new-hire attrition

Requirements

6.1 Ability to plan hire dates with respect to any training capacity constraints or in reverse, be able to plan hire dates and have the training process owners adjust accordingly.
6.2 Ability to send new-hire information (including any scheduled training) to scheduling systems and/or process.
6.3 Have clear guidelines and ease of use for assigning training.
6.4 Ensure integration of hired jobs/positions are consistent with the planning for training by job/position.

7 Operations Organizations

Needs:

- Ensure a supply of well-trained employees is available for work.
- Ensure a well-trained employee is less likely to have a safety incident or accident

Requirements

7.1 Minimize the learning curve for making a new employee productive
7.2 Ability to make efficient cross-training decisions to meet demand and provide growth opportunities for employees
7.3 Ensure training is not for too many roles (that may never get worked) or too narrow number of roles (or as contract constraints may dictate).

8 Legal

Needs

- Ensure the organization has clear processes, procedures and records to show due diligence to ensure the organization has made the best good-faith effort to have trained employees doing work.
- Avoid lawsuits for negligence or abrogation of duties to train employees.

Requirements

8.1 Ensure that an accurate record of up-to-date training exists in an official system or record
8.2 Ensure that no employee works without a recorded qualification.

9 Safety and Health Organizations

Needs

- Ensure that job procedures provide safe, proven methods to conduct a task.
- Ensure that in after-accident reviews, changes to training are implemented on a timely basis
- Ensure that measures driven by prevention efforts are quickly integrated into changes in procedures and training.

Requirements

9.1 Training records are accurate and up-to-date
9.2 Training recording reflects the latest changes to training to meet safety goals on a timely basis
9.3 The process of updating training content, execution and re-evaluation is timely from an end-to-end perspective to prevent future incidents.

10 Software Vendors

Needs

- Provide a viable products that can integrate with scheduling, content management, training, planning, and recruitment
- Ensure records are timely and accurate.
- Ability to standardize product to sustain profitability

Requirements

10.1 Establish standard interfaces between sub-systems integrated with the training eco-system.

Functional System Architecture

In considering the overall functional system architecture for integrated training, many areas have fairly mature definitions, such as scheduling and the core learning activies (Learning Technology System Architecture). While these continue to evolve as technology advances, they both have well established frameworks and a rich body of research associated with each. For the purpose of this initial research, two of the largest gap areas will be reviewed and analyzed in terms of describing the function/process, inputs, outputs, critical design outcomes and verifications/validations to monitor effectiveness.

The two key areas are

- Integrated Training Planning and Analysis, and
- Integrated Training Scheduling,

These areas are depicted below in the Integrated Training Ecosystem

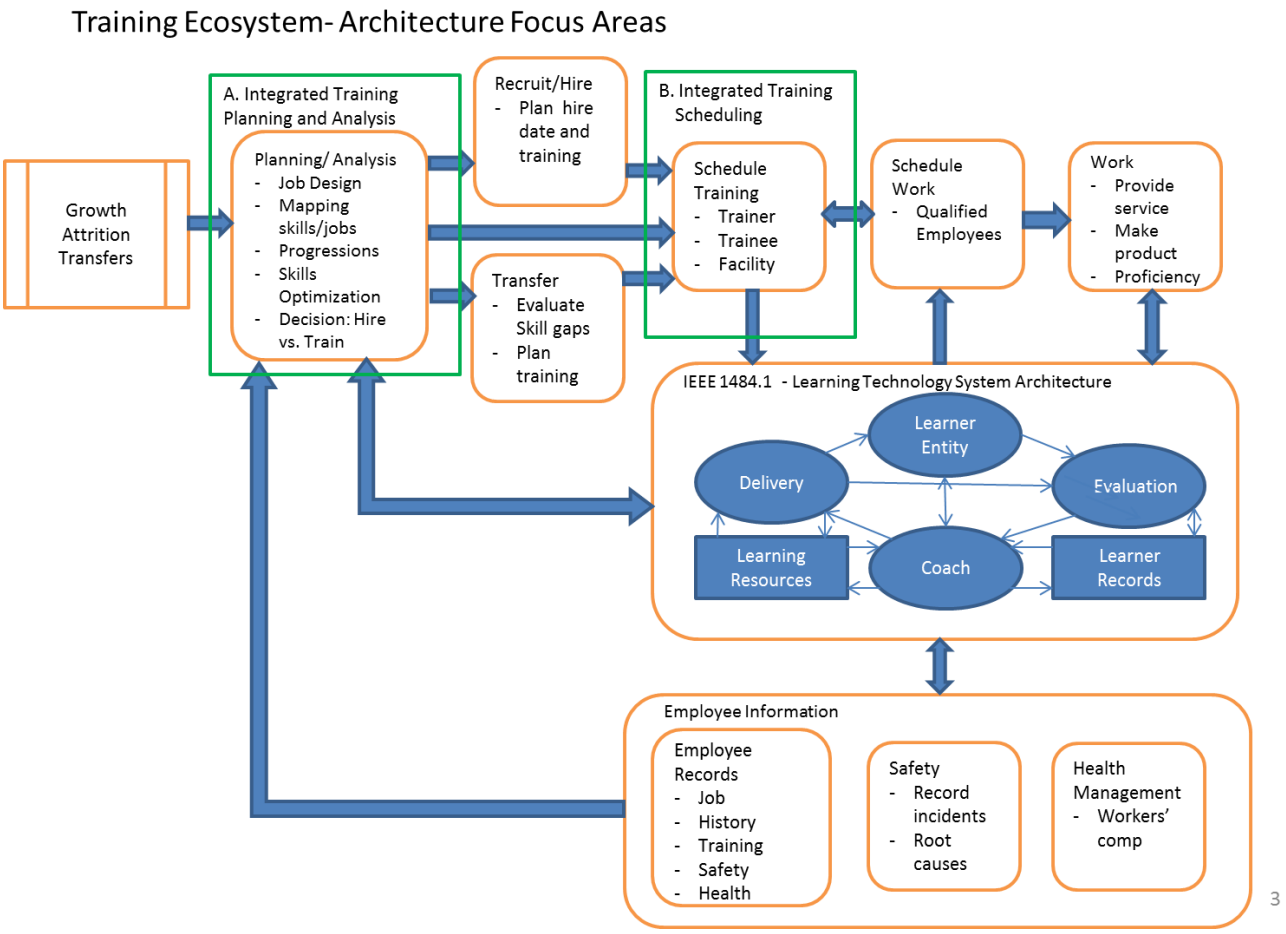

Figure 6: Initial Focus Areas for Integrated Training System

A. Integrated Training Planning and Analysis

The core part of Integrated Training Planning and Analysis is having the right data from a variety of sources organized in a central data repository. While many data elements are provided by various systems, many others may be included in the planning and analysis domain, such as

- Training Progressions
- Mapping qualifications to jobs

Business Questions and Decisions (examples)

How many people must be trained in a specific skill in order to meet current and future demand and optimize hiring vs. cross-training?

What should the structure of training items in the learning management system be to avoid duplication and overlap and enable customization by person?

How long should an experience credential (working a task or job) be allowed before it expires?

How many people should be trainers to meet the required demand for training?

What is the impact on productivity of a temporary workforce (e.g. seasonal or college internship workers)?

What is the spread of skills (supply and demand) throughout a day, and where are the gaps to fill via changes to availability?

What portion of training resources (people, dollars) are spent on on-boarding new-hires vs. transfers and on-boarding vs. refresh/update training?

Inputs

- Labor Demand (in hours) by job (optional: by task) by skill group). This may also be referred to as workload or labor forecast. For example: a food service business might have task quantified for cashiering, filling, cleaning and cleaning at the task level, but the job may just be called front-of-house associate.
- Labor Supply: employees by job, qualifications and availability; this is a three-way query by employee system of record, learning management system and labor scheduling systems.
- Training Items/curriculums and related hierarchy: from learning management systems
- Master list of jobs, tasks and positions: provided by employee system of record and demand planning (usually done at the task level)

Core Data

- Table of jobs and optionally tasks mapped to required qualifications (skills or certifications). Skills are a credential that does not expire; certifications are skills that have an expiration date. Certifications may include experience (i.e. working in the job or task) within the last X days.
- Training Progressions – key training events and elements needed to meet overall qualification for a specific job or task.

Core Functions

- Map training components (items, curriculums) to a single credential for each job.
- Develop training progressions for each job in terms of the sequence and duration for making a new employee productive in a new job.
- Optimize the level of skills by each job

Outputs

- Employees interested in adding skills to their portfolio. Sent to the integrated training scheduling system.
- Answers to business questions listed above
- Training effort required for on-boarding new-hires and transfers, and refresh/update training vs. on-boarding.
- Clear training progressions and requirements for working any job
- Clear information on what jobs or tasks employees are eligible to work.

Critical Design Outcomes

- Determine if new labor demand can be met by existing labor force based on open availability to work (or willingness to flex schedule) or if a hire will be necessary.
- Determine where there may be a shortage or excess of skills in an organization and a plan to mitigate.
- Process to share results with employees who wish to have more skills to increase their value to the organization

Validation

- Determine the number of people trained in a role but have not worked in that role or used the skill
- Determine the portion of overtime or short hours due to over or undersupply of a skill.

B. Integrated Training Scheduling

While this may be an extension of the output from Integrated Training Planning and Analysis, this process takes the training demand requirements and matches it to the available training resources, trainee availability, facility availability (if needed) and timing (required completion date).

Inputs

- Forecasted Hiring Plan: planned hires, by job, over a rolling six-month time horizon. (Recruitment system)
- Trainer availability, jobs trainers are qualified to train (Training database – likely from Learning management system)
- New hire availability and job (work scheduling system)
- Employee experience and training record (including jobs currently trained for)

- Required qualifications (skills and certificates) by job reference table (part of Integrated Training Planning and Analysis module above)
- Training progressions by job – what training activities are required and in what sequence. (Output from the Integrated Training Planning and Analysis module above).

Outputs

- Optimized utilization of training resources: instructors/trainers and facilities
- Training schedule by individualized employee – sent to scheduling system for publish
- Training schedule for trainers and facilities with lists of who is attending for what training components.

Critical Design Outcomes

- Automated process to assign and schedule trainers, on-line content and trainees to make workers productive in as little time as possible, with given constraints in the number of facilities, number of trainers and availability constraints of workers and/or trainers.

Validation

- Cycle time to train and a new hire or transfer until they are productive.
- Availability of trainers over time to meet need to train new hires.
- Level of intervention required in lieu of automation (e.g. what percent of schedules require changes after automating the assignment of training plan?)

Summary Feasibility Discussion

The system has a high potential for feasibility, given that many large organizations have all the building-block parts and fledging attempts at integration via off-line processes and spreadsheets. The ultimate outcome of this work may be a software that has standard interfaces and extract methods to obtain the required data to produce the outputs above.

One limitation that may exist are the constraints of what each organization may have implemented in the way of a learning management system and the legacy hierarchy of training items and curriculums. These must be well thought-out and mapped to the appropriate content to make this architecture feasible.

Another limitation may be the extent to which such a process may be automated. In applying some lean process design principles, automation cannot be enabled unless a standard set of business rules can be established and then automated. In many organizations, these processes are often more of an art with a hodge-podge of inconsistent business rules.

Future Work

Future work includes

- Data design of the training, planning and analysis model and the training scheduling modules
- Development of clear user use-cases and stories to ensure a customer-centric design
- System design based on this architecture
- Develop a lean/agile system prototype to test the processes and refine the application
- Field pilot test to validate the use on first a limited and then mass scale

Discussion, Conclusions, Recommendations

The original subject turned out spread its tentacles far into many aspects of Human Capital Management or HRIS systems. This characteristic made this effort limited to setting up the concept and the architecture, with further steps to follow as additional pieces of research and/or development.

Critical conclusions

- The topic of integrated training systems is very large and spans many human capital systems
- Decision analysis and answering business questions related to training are at an early stage
- Business benefit may be multi-faceted including
    - increased utilization of existing employees, thus leveraging investments in benefits and reducing the need to hire more employees,
    - reduced training breakage (training for something but not using it),
    - increased efficiency in the on-boarding process, and
    - reduced risk of legal exposure and/or safety incidents due to employees working in a position for which they are not qualified.

Recommendations include developing the architecture further and pursue the future work outlined above in the following sequence:

1. Clearly define the key data domains in the integrated training planning and analysis database and potential sources from each input (build on Figure 4).
2. Refine and expand the business questions and decisions outlined in the functional architecture above; develop dimensional modeling to understand and identify information needed to drive decisions and answers to the business questions.
    a. For the planning, analysis and decision components, determine if there are decision modeling templates that will fit the training decisions with respect to cost/benefit analysis of training more or less and what risks are mitigated or increased via the decision.
    b. For the Training Scheduling model, develop detailed optimization models to understand capacity constraints of facilities and trainers (using linear programming or similar techniques). Inputs would be training demand required by date and output would be schedules for facilities and trainers.

    c. Propose standard data interfaces for each of the two modules to facilitate usage across many organizations and software, as well as to initiate the beginning of a standard that might be deployed for business systems.
3. Develop detailed user stories for both people managing the process, front-line managers and employees for using the planning and analysis module and the training scheduling module.
4. Develop a detailed data model for both the modules
5. Develop via prototype a working application to test the design through an agile development process
6. Develop a working pilot to use for a small area in an organization with large volume of training activities. Once the pilot has been iterated to meet specifications and usability, expand to the greater organization.

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