# The Role of Apprenticeship in the Development of the Information Technology Workforce: An Economic Perspective

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## Introduction

The U.S. Department of Labor (DoL) recognizes that the development of the U.S. Information Technology (IT) workforce offers a substantial opportunity to boost American competitiveness. The size of the IT workforce is material to the U.S GNP. It contains 10 million people operating in a variety of specializations who receive relatively high wages. Perhaps more importantly, however, the IT field now supports virtually every business and every industry in the flow of vital information and communications with the potential for bringing continued productivity gains through automation. It does not require a tremendous leap of faith to conclude that productivity and quality gains in the IT workforce can have a substantial economic multiplier[1].

A critical predictor for a worker's success on the job in the Information Technology (IT) field is hands-on experience. Yet at the present time the IT industry possesses no standards or mechanism to objectively assess the amount and quality of a worker's on the job experiences and achievements. A casual glance at several of the IT job websites suggests that employers currently use the number of years of experience shown on a résumé as a key consideration in worker selection, hiring and wage offers. Yet in general, IT employers often complain that résumé's and job interviews alone are very unreliable indicators of workers actual performance on the job.

Until a decade ago the training standards for IT workers were based solely upon diplomas and certificates from schools (i.e. technical institutes, universities, community colleges, etc.) that relied upon completion of classroom instruction as the criteria for labeling workers as "industry ready". More recently, IT employers have included industry certifications (such as A+) and vendor (product certifications) as proxies for experience and have used these credentials as part of the decision criteria for hiring and salary administration. While industry and product certifications add to our ability to predict performance above and beyond diplomas alone, these certifications lack the ability to accurately gauge the amount and quality of a worker's actual learning on the job.

Certifications and diplomas miss a substantial component of competency assessment—i.e. the amount and quality of hands-on experience. Recently, research by industry-respected institutions, such as International Data

Corporation (IDC), has revealed the growing concern at the lack of hands-on experience by today's certified ICT individuals. Many employers have commented that it is much harder to find the right skilled worker today than it was a few years ago, due mostly to the changing environment and difficulty in assessing an individual's experience in certain key job functions within the corporation.

When we consider that a worker spends approximately 2,000 hours per year working on the job (translating to 90,000 hours over a 45 year career), we discover that possibly we are disregarding the single most predictive component of a worker's skill level i.e the quality and quantity of worker's on-the-job experience and learning.

Like many industries the IT industry has never tracked and rewarded a worker's on-the-job learning as rigorously as a worker's classroom instruction and graduation from a school. The adage that "people learn best by doing, not by sitting and listening" certainly applies in this instance. So we rightfully ask: does it make sense for us to rigorously track and measure the performance and quality of say 3,000 hrs of classroom instruction from an academic institution and then haphazardly gauge 90,000 hours of hands-on experience on the basis of a subjective résumé'?

Attempts by certain large IT vendors to expand worker testing to include a greater "hands-on" component have met with only limited success. The "hands-on" testing methodology advocated by these vendors requires candidates to solve infrastructure problems "on line" as part of the criteria for achieving certification on their specific products. This testing approach offers some advantages over multiple choice instruments, however, it does not measure the candidate's mastery of a job nor does it measure the quantity and quality of a candidate's prior work experience and on-the-job-learning.

Registered Apprenticeship is a well-established methodology for training and developing employees in the "construction trades" such as plumbing, electrical, sheet metal, etc. In a manner similar to the ISO 9000 registration, the DoL registers apprenticeships that meet specific standards of proven practices. By DoL standards an apprentice receives the delivery of a minimum of 2,000 hrs of structured on-the-job training under the tutelage of qualified "journey workers" and 144 hrs per year of related classroom instruction from a qualified training organization or school. Also, as part of the approach, apprentices start at entry-level wages and follow a progressive wage scale based upon their progress.

DoL has observed that most apprenticeship programs go beyond the minimum requirements and usually extend over a two to five year period. During this period the apprentice works on the job and attends classroom training. The essence of the apprenticeship approach is the requirement for a combination of classroom

instruction and on-the-job learning. *Moreover, the on-the-job learning (OJL) is tracked and administered as rigorously as the classroom instruction.*

To ensure that the quality of OJL delivered remains high, employer organizations register their programs and become qualified OJL providers. Like ISO 9000 the apprenticeship registration signifies something about the quality of the process. A registered apprenticeship signifies that the employer organization meets a quality standard to become a qualified OJL provider.

The possibility of using apprenticeship as a means of systematizing and linking OJL, diplomas, industry certifications and product certifications into a cohesive credentialing process has attracted the interest of both the Apprenticeship Training and Employer Labors Services (ATELS) department within DoL and the Computing Technology Industry Association CompTIA. A year ago ATELS began a joint project with the CompTIA to explore apprenticeship within the IT field. Thus far the pilot studies are confirming that apprenticeship can work as effectively in IT as it has historically worked in the trades. The efficacy of the combined classroom instruction and structured on-the-job learning appears strong. Based upon preliminary data both employers and apprentices report satisfaction with the process. In addition, the data indicates that learning occurs faster, quality of work rises more quickly and employee loyalty improves significantly under apprenticeship.

As a result of the success of this effort the two organizations (ATELS and CompTIA) are now co-developing an IT Industry Apprenticeship System (IIAS). The IIAS is currently being piloted and is scheduled for general release November 2003.

The purpose of this paper is twofold. First, we will show the need and the opportunity to use registered apprenticeship as a methodology to improve the productivity of the IT workforce. Secondly, we will describe the economic rationale and key tenets of CompTIA's IIAS infrastructure as a vehicle for deploying apprenticeship on an industry-wide basis.

**The Industry Problem**

To show in a simple fashion how apprenticeship can serve the IT industry, we will begin the discussion as a "thought experiment" (borrowing a technique from Albert Einstein), and put ourselves in the shoes of an IT employer. So let's start by assuming, for the moment, that we are a typical company (Company A) that employs some number of IT workers. Like any employer, Company A goes to the market to hire adequately competent IT workers and expects to pay a wage that reflects the IT workers' expected contribution and value to the company. During the search process company A reviews the résumés of say 25 people and decides to interview 10 of those who appear to have the best fit.

During the interviewing and negotiations process Company A must confront the problem of validating the true quality, competency and value of each applicant. Company A must deal with a myriad of questions. How should each candidate be compared to the others? Which of the candidates should receive an offer? What wage rate should be offered?

In a nutshell Company A shares the problem of all IT employers. Because Information Technology as an occupation is still in its infancy, it currently lacks both a comprehensive set of standards and a credentialing process that are adequately predictive of a job candidate's actual performance on the job. As a result, Company A makes hiring choices and salary offers based upon substantial guesswork which frequently results in disappointment, lost opportunity, lower than planned productivity and higher than planned cost. In short, Company A incurs the economic risk and the attendant cost of a system containing *ill-defined worker specifications.*

Organizations such as CompTIA have addressed the above dilemma by working with the IT industry to develop certifications that help employers reduce the uncertainty. Both vendor neutral and vendor specific certifications are an important part of measuring an individual's success, but they are only part of the solution.

**OJL Is the Gap, and Apprenticeship Fills the Gap**

The solution to the problem facing Company A can be approached in a simple way. To explain this approach, we continue with our thought experiment, but now imagine that we are in the shoes of an IT industry association that bears the responsibility of ensuring that an adequate supply of new, incoming IT workers exists for the year 2008. Since the present date is 2002, that gives us a six year period to work with.

To start the analysis the industry association must consider that a sizable number of IT workers who are currently employed in the IT field will retire by the year 2008. As a result the association must concern itself with the development of the pool of potential incoming workers who will replace those retiring workers. Moreover, the association must consider that the industry will grow and that the overall supply of workers must expand to fill the anticipated number of new IT positions. By considering the above points and with some careful analysis the industry association determines that a cohort of *x* number of new, incoming workers must be developed and prepared to enter the IT workforce by the year 2008.

The cohort of x number of potential new workers is now, for the most part, untrained and operating at a wide range of IT skill levels. In fact, if we were to plot a distribution of the cohort's skill levels, it would probably look something like the graph shown in Figure 1 below. Note: the reader should bear in mind that the

cohort x consists only of potential new workers who will be needed to fill the open IT positions in the year 2008. Our task is to prepare this group to fill the open IT positions which will be available at that time.

As shown in the graph, most of the cohort would now fall in the “Extremely Limited” to “Partially Proficient” skill level ranges of IT competency. This is understandable since most of these workers have not yet have been trained nor do they have any experience in the IT field. However, due to the law of large numbers the cohort membership varies dramatically. In fact a relatively small fraction would already be able to perform at a “Competent” to “Highly Proficient” level without any additional training or experience. For whatever reason, this relatively small fraction of prospective workers is already “industry ready”. However, the bulk of the cohort membership currently clusters in the “Extremely Limited” to “Partially Proficient” range of performance as shown.

The graphical analysis of Figure 1 helps us define the overall task at hand. Since the association is responsible for developing this cohort and transforming it into a certifiably “industry ready” group, it must somehow figure out a way to **improve the average** skill level of the group and **reduce the variation** (spread) of the distribution. Refer to Figure 2.

Figure 1-Hypothetical Distribution of Current (2002) Skill Levels Of Incoming IT Workers For 2008

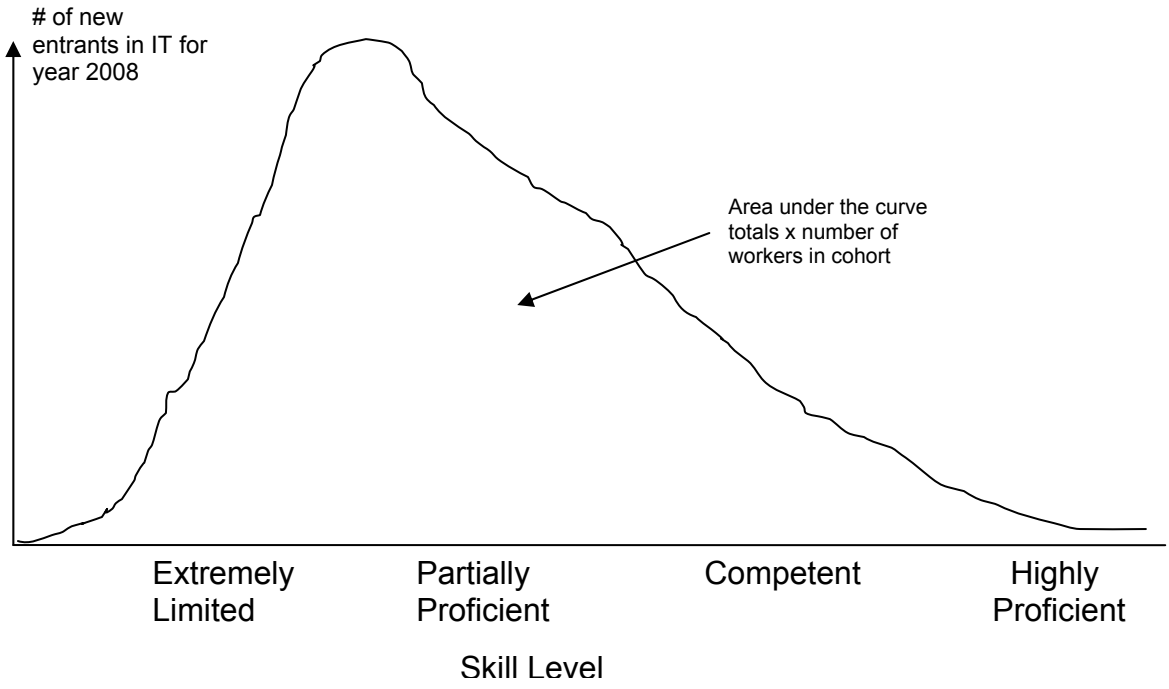
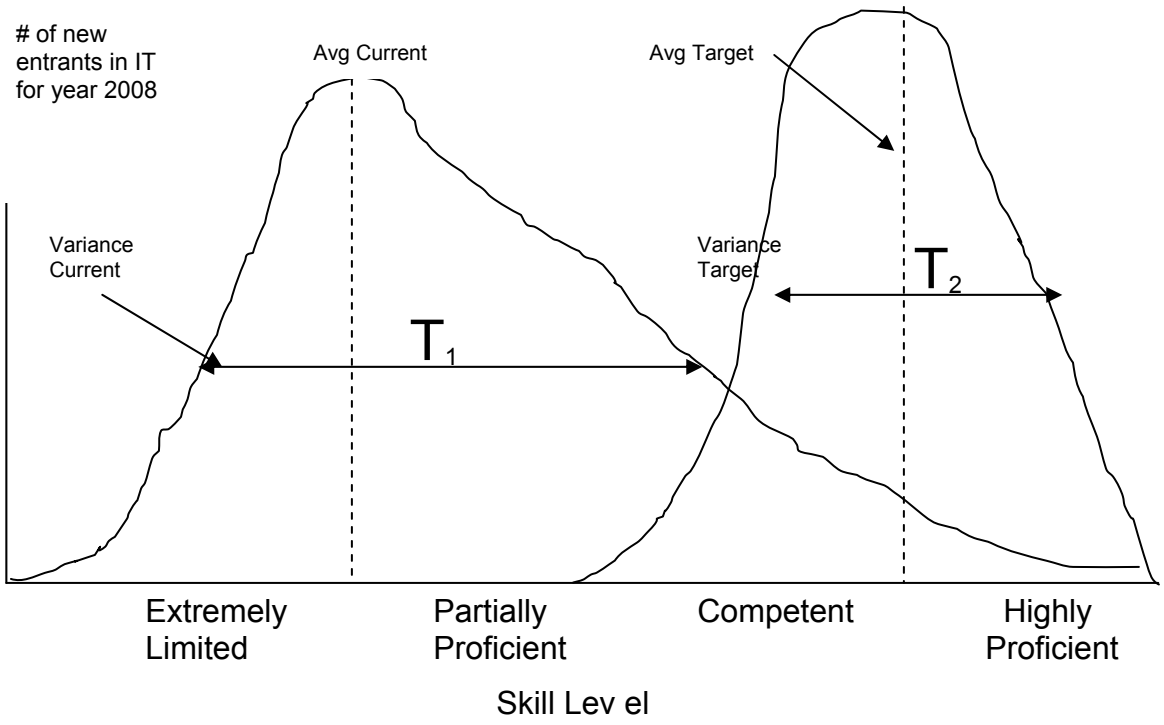


Figure 2 illustrates that the workforce development challenge for our association is twofold. First, by using policymaking and market mechanisms, the association must improve the mean value of cohort competency. This will require shifting the distribution to the right end of the skill level scale. Secondly, it must reduce the variation (spread) of the distribution as measured by the statistical term variance or sigma ($T$) so that no significant fraction of the workforce falls in the "Extremely Limited" or "Partially Proficient" regions. In other words, the goal is to raise the aggregate competency of the cohort to an acceptable level. Ideally we must also ensure that no one in the cohort falls below the region of minimum competency. Here we assume a "Competent" skill rating is the minimum competency.

Figure 2-Hypothetical Distributions of Current (2002) Versus Target For 2008




The association also seeks to achieve a third key objective that is not quite so obvious. This third objective calls for our association to identify and understand the sources of target variance $T_2$ so that it can appropriately categorize, separate and compensate commensurately those employees who fall in the differing competency levels of competent and highly proficient respectively. This work is necessary since it seems likely that an IT employer, such as Company A mentioned above, will need a mix of workers at differing competency levels. So for instance, Company A may be looking to hire and compensate commensurately two Competent workers and five Highly Proficient workers. Consequently our industry association needs reliable criteria to predict the

varying levels of skills among a generally competent workforce. Remember, the workers' résumés will not be good predictors of their skill levels, so we need an instrument that will be a more accurate and reliable predictor.

To identify the predictors we must first identify and isolate the critical drivers of cohort variance so that $T_{2=}\ f\ (T_A+T_B\ +T_C+T_D+T_E\ +T_F\ +\ldots\ldots\ldots\ldots)$, where $T_A$ etc. is the variance of driver A, driver B and so on. Then, we can assess each individual worker in relation to his/her performance on those drivers. So, even though we cannot judge workers' skill levels directly from résumés, we can predict their performance based upon their standing, accomplishments and progress on variables that significantly affect the overall variance of the distribution. What are these variables?

The variables that we refer to are causal factors such as differences in the workers' educational attainment in IT, differences in their years of experience in IT, differences in their product knowledge, differences in their abilities to deal with customers, differences in their abilities to show up for work on time, differences in their abilities to meet deadlines, and so on. These variables significantly influence the competency variation among individuals within our target cohort (as measured by $T_2$). These variables *drive* or *cause* variations in worker competency and are therefore useful for creating standards and for driving improvements in the aggregate competency of the cohort.

These drivers are extremely important for our association because they are the policy variables that enable one to shift the mean value of competency and reduce the variation of the target distribution. Since our thought experiment calls for us to transform this cohort into an "industry ready" group of workers, we (the association) are very interested in knowing what variables (factors) will give us the best chance of producing results.

Both CompTIA's and DoL's experiences in the workforce development arena suggest that the following five causal factors drive the development of an IT worker's competency:

1) The worker receives adequate general, personal and basic skills training and socialization to communicate and participate in a work environment
2) The worker receives an appropriate amount of classroom instruction in general IT concepts as well as in one or more information technology areas of specialization
3) The worker obtains adequate familiarity with key vendor neutral IT systems concepts in one or more areas of IT specialization
4) The worker obtains adequate hands-on experience in an Information Technology occupation
5) The worker obtains adequate familiarity with key vendor-specific IT products

Undoubtedly the list is not exhaustive. However, based upon industry experience the five factors have proven very useful as yardsticks to predict skills and competency. The critical point for our discussion is that providing workers with high-quality, hands-on experience is at least as important as providing them with classroom instruction, industry certifications and product certifications. Perhaps more importantly, by adding high quality information about a worker's hands-on experience (i.e. OJL), we become far more able to predict a worker's performance than by just considering the worker's classroom training record and industry/product certifications.

After reviewing a description of the above five causal factors, the reader may question whether or not each of the five is truly independent (in a statistical sense) and wonder if they really refer to the same thing. In other words, we must ask ourselves if knowledge of each factor significantly adds to our explanatory power and ability to predict skill levels and performance on the job. Would we lose anything by dropping one or more of the five? And to the point, does knowledge about the quality and quantity of a worker's OJL experience really provide anything additional beyond knowing a worker's record of classroom instructions and product/industry certifications?

Based upon available information from DoL and preliminary first-hand experience from IT apprenticeship pilots, the authors conclude that information on each of the five add, at least to some degree, to our ability to predict an IT worker's competency as *long as standards are attached to each*. Moreover, available information suggests that a structured on-the-job learning component (factor #4) provides a rich and powerful source of learning that is unique and distinct from classroom instruction and certifications. Conversely, by omitting information about a worker's OJL history, we substantially diminish our ability to predict how well that worker will perform on the job.

Of special importance to our discussion is the separateness and complementarity of classroom instruction and on-the-job learning. Classroom instruction provides the worker with both subject knowledge and task knowledge that are required for worker competency. On-the-job learning, on the other hand, focuses on the workers task performance. *It is the combination of subject knowledge, task knowledge and task performance that leads to a full learning experience for the worker*. By relying upon classroom instruction alone, the worker looses the critical task performance component of the learning process.

As stated earlier, standards are also necessary to make the above causal factors operational. Standards enable us to control quality and uniformity in the application of the factors. We can attach standards to each of the five factors as shown in the simplified example below.

| Factor # | Description | Standard |
|---|---|---|
| 1 | Adequate general, personal and basic skills training | Receipt of High School Diploma or GED |
| 2 | Appropriate classroom instruction | Graduation from an accredited technical school or program |
| 3 | Adequate familiarity with key vendor neutral systems concepts | Receipt of an industry certification |
| 4 | Adequate hands on experience | Sign-off of on the job training from an approved OJL provider |
| 5 | Adequate familiarity with specific IT products | Receipt of a vendor certification |

Having made an argument for including both OJL and standards into the workforce development process, we now return to our thought experiment. Our industry organization is ready to use the above five *standards* as a vehicle for improving the aggregate competency of our workforce by the target year 2008. It is now up to the association to communicate and deploy these standards to the workforce stakeholders including the IT worker cohort, the IT employers and the IT training and educational providers. The pursuit of these standards will *cause* the cohort to become competent (which of course is our goal).

As we consider deploying the standards, we must rely upon the "invisible hand" of the market to work its magic. We must construct a market mechanism whereby each of our key stakeholders will participate due to self interest. The workers in the cohort will have an incentive to go through the process of meeting these standards because the employers will demand it. The schools and training organizations will train to these standards because the workers will demand it. Finally, we (the association) will achieve our objectives (i.e. shifting the mean of the competency distribution and reducing the variance) because the workers will become competent as they go through the process of meeting the standards.

Also as hoped, the above system gives us a vehicle to reliably discern between the "Competent" and "Highly Proficient" workers. For instance, we could develop a simple competency measurement algorithm that defines: a "Competent" worker as one who meets two of the five standards, a "Highly Proficient" worker as one who meets all five of the standards. (Note: in reality this is of course a highly oversimplified and arbitrary way of discerning skill levels, and is useful only for explanatory purposes at the moment.).

We should now be pretty happy with ourselves as an industry association. We have figured out a strategy to meet our objective of making our cohort "industry ready" by 2008. We have also created a mechanism whereby workers at varying skill levels will be paid commensurately with their skills. But before we start celebrating, we have to first confront two more problems.

The first problem that we must confront concerns infrastructure. At present no mechanisms, standards or tracking infrastructure exist for delivering **on-the-job learning**. The on-the-job learning component will be important to the efficacy of our model (factor #4), yet we have no way to go about implementing it.

Our second problem concerns time. As an industry association our assignment is to develop a competent workforce cohort in six years (between 2002 and 2008). The normal industry practice is for workers to attend school for two to four years or longer and then the workers enter the IT workforce with no experience which could add several more years for competency attainment. So, it seems that the attainment of our objective may be in jeopardy if we follow the usual approaches for worker training and development. It could be 2010 by the time most of our cohort members go through their formal schooling and earn enough on- the-job experience to become fully competent. In order to fully achieve our objective by 2008 we will need a training methodology that works faster than the traditional methods.

As we will see below both of our problems can be resolved by formally adopting a ready-made product into the credentialing process and the training process. This product is called *Registered Apprenticeship*. Registered Apprenticeship includes a structured process for administering and tracking on-the-job learning. Also, because of the efficacy of Registered Apprenticeship as a training methodology, it can also be used as the solution to speed up the learning process for our cohort.

**The CompTIA/ATELS Design of an IT Apprenticeship**

CompTIA in collaboration with ATELS has defined IT Apprenticeship in the following way:

> An IT Apprenticeship is a structured process for employees to progress within one or more IT work specializations from entry level through mastery level. The apprentice receives a minimum of 2000 hours of OJL and a minimum of 144 hours per year of related classroom instruction. Apprentices are employees (full time or part time) and receive wages on a progressive scale that are tied (at least partly) to the achievement of certifications.

The framework of the IT Industry Apprenticeship System includes several key design parameters as shown in Figure 3 below. First, an apprentice must satisfy specific entrance criteria. The apprentice must: 1) be at least 18 years of age, 2) possess a high school diploma or GED certificate and 3) have basic keyboarding skills. Secondly, the apprentice must have received at least some minimal IT training to become employed. We call this minimal competency (Level 0). Typically, Level 0 competency can be achieved by receiving formalized training, but the critical point is that the person is able to demonstrate adequate value to a an employer that he/she can become employed and earn a wage.

Next, if the worker has secured employment from an employer that is an authorized OJL provider organization, he/she can register to become an apprentice in the IT Industry Apprenticeship System that is administered by CompTIA. This means that the apprentice will become a member of an industry-wide system in which credit will be awarded for hours of OJL received. In

addition, CompTIA will maintain a transcript for the worker that documents in summary form the worker's educational achievements, hours of OJL and related classroom instruction as well as industry and product certifications in all key IT areas. Refer to Figure 4 below. CompTIA will also register the apprentice with DoL, which is the official apprenticeship registration body for apprentices in the U.S.

Once registered, the apprentice accumulates OJL hours by working on the job under the tutelage and supervision of person(s) who verifies the following:

1) That the apprentice actually spent time working on-the-job on specific IT-related tasks,
2) That the apprentice had the opportunity to ask questions and receive answers,
3) That the apprentice's work was inspected and that the apprentice received feedback enabling the correction of errors and resolution to problems,
4) That the apprentice receives sign-off and evaluation on the key components of his her job.

Figure 3: Key Parameters of the IT Apprenticeship Framework

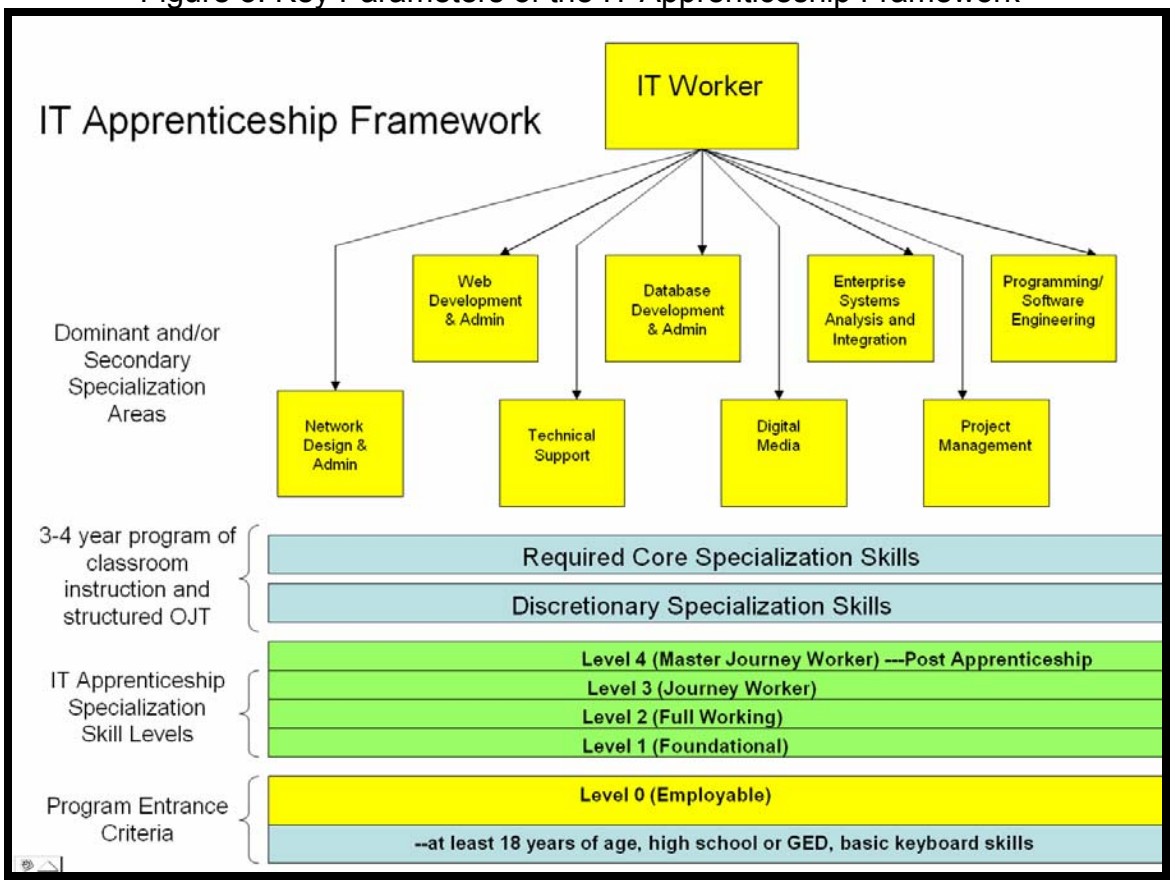
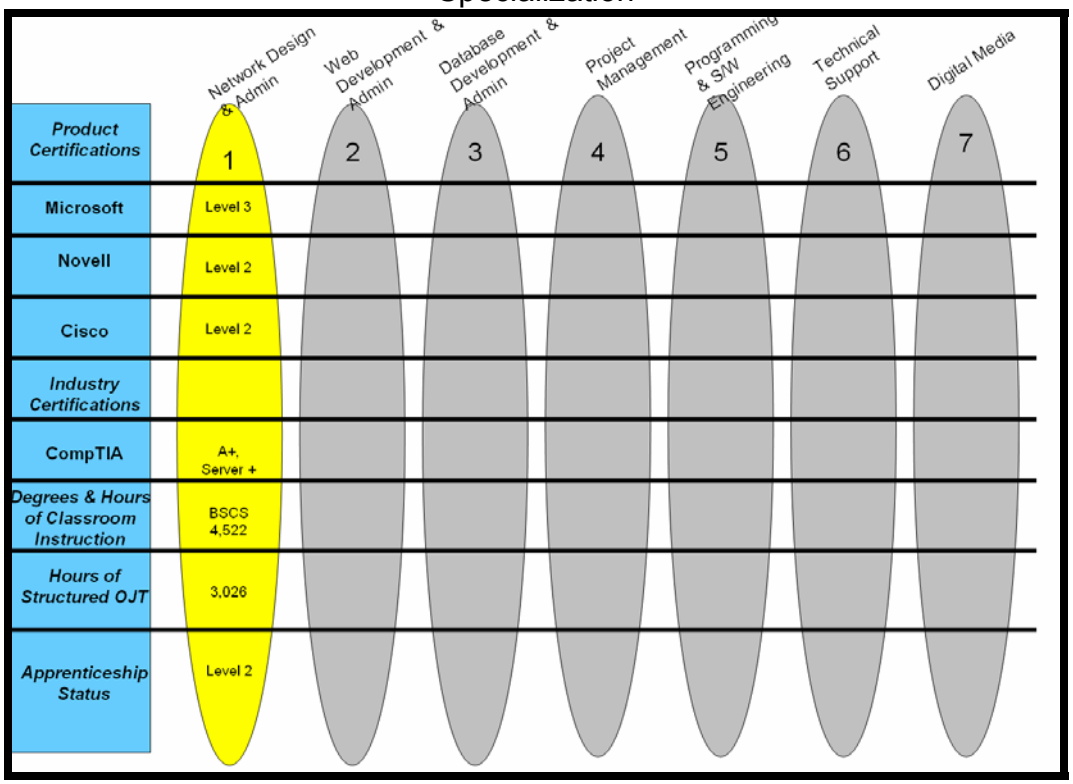


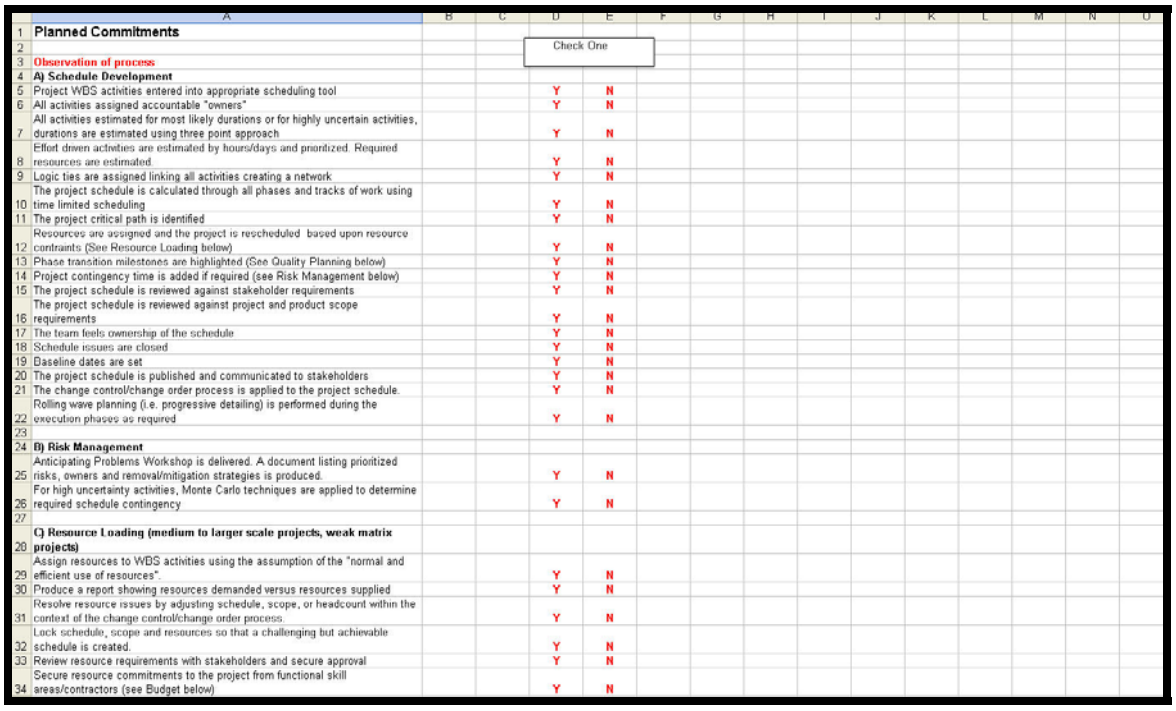
Figure 4 Sample Transcript For IT Networking Specialization




The key tool for documenting the sign-off of an apprentice's progress is the OJL task list. Figure 5 below shows a partial example of an OJL task list for IT Project Management.

In practice, the apprentice updates the task list for the duration of his/her apprenticeship, obtains sign-off on task completion as well as sign-off on effort hours. The apprentice then periodically sends the information to CompTIA for transcript updating.

**Figure 5: Partial View of an OJL Task List for IT Project Management**



| | A | D | E |
|---|---|---|---|
| 1 | **Planned Commitments** | | |
| 2 | | Check One | |
| 3 | **Observation of process** | | |
| 4 | **A) Schedule Development** | | |
| 5 | Project WBS activities entered into appropriate scheduling tool | Y | N |
| 6 | All activities assigned accountable "owners" | Y | N |
| 7 | All activities estimated for most likely durations or for highly uncertain activities, durations are estimated using three point approach | Y | N |
| 8 | Effort driven activities are estimated by hours/days and prioritized. Required resources are estimated. | Y | N |
| 9 | Logic ties are assigned linking all activities creating a network | Y | N |
| 10 | The project schedule is calculated through all phases and tracks of work using time limited scheduling | Y | N |
| 11 | The project critical path is identified | Y | N |
| 12 | Resources are assigned and the project is rescheduled based upon resource contraints (See Resource Loading below) | Y | N |
| 13 | Phase transition milestones are highlighted (See Quality Planning below) | Y | N |
| 14 | Project contingency time is added if required (see Risk Management below) | Y | N |
| 15 | The project schedule is reviewed against stakeholder requirements | Y | N |
| 16 | The project schedule is reviewed against project and product scope requirements | Y | N |
| 17 | The team feels ownership of the schedule | Y | N |
| 18 | Schedule issues are closed | Y | N |
| 19 | Baseline dates are set | Y | N |
| 20 | The project schedule is published and communicated to stakeholders | Y | N |
| 21 | The change control/change order process is applied to the project schedule. | Y | N |
| 22 | Rolling wave planning (i.e. progressive detailing) is performed during the execution phases as required | Y | N |
| 23 | | | |
| 24 | **B) Risk Management** | | |
| 25 | Anticipating Problems Workshop is delivered. A document listing prioritized risks, owners and removal/mitigation strategies is produced. | Y | N |
| 26 | For high uncertainty activities, Monte Carlo techniques are applied to determine required schedule contingency | Y | N |
| 27 | | | |
| 28 | **C) Resource Loading (medium to larger scale projects, weak matrix projects)** | | |
| 29 | Assign resources to WBS activities using the assumption of the "normal and efficient use of resources". | Y | N |
| 30 | Produce a report showing resources demanded versus resources supplied | Y | N |
| 31 | Resolve resource issues by adjusting schedule, scope, or headcount within the context of the change control/change order process. | Y | N |
| 32 | Lock schedule, scope and resources so that a challenging but achievable schedule is created. | Y | N |
| 33 | Review resource requirements with stakeholders and secure approval | Y | N |
| 34 | Secure resource commitments to the project from functional skill areas/contractors (see Budget below) | Y | N |

Returning to Figure 3 above, as the apprentice accumulates hours of structured OJL, he/she also takes classroom training (usually on his her own time, not the employer's time). The apprentice also takes the appropriate industry and product certification exams to demonstrate IT competency in general as well as competency in his/her chosen areas of IT specialization. CompTIA records all of this information on the apprentice's transcript. Also, if the apprentice had received classroom instruction prior to employment, those hours would be transferred into the transcript in a manner very similar to that executed by a college or university registrar.

The apprentice continues in the apprenticeship throughout a three to four year period and progresses through three levels of competency. The first level is considered a foundational level. The second level is a full working level, and the third level is a mastery level. In order to move from one level to the next, the apprentice satisfies exit criteria consisting of accumulated hours of classroom instruction, hours of OJL, product certification(s) and or industry certifications. Also, as the apprentice progresses from one level to the next, he/she receives wage increases as an incentive.

After completing the three-tiered apprenticeship, the worker then becomes an IT journey worker in his/her areas of specialization. The journey worker can then begin accumulating hours and certifications toward level four—master journey worker. The "master journey worker" status may take an additional two to four

years to achieve following the apprenticeship period depending upon the chosen specialization area(s).

**Why Employer Organizations Should Become Registered OJL Providers**

Okay, we have come a long way with our thought experiment. From the perspective of our hypothetical industry association that is charged with the task of making the cohort an "industry ready" group by 2008, we have made some real progress in developing a strategy. First, we have demonstrated the importance of ensuring that our cohort receives both classroom instruction and structured on-the-job learning. Secondly, we have indicated the importance that the cohort members obtain industry and product certifications. Thirdly, we have developed an infrastructure (IT Industry Apprenticeship System) that can be used to administer a registered apprenticeship program that is tied to DoL standards for apprenticeship. The infrastructure that supports the apprenticeship system will enable the tracking of the workers in our cohort on all of the key components that drive competency.

One task still remains, however. We still have to convince the IT employers to become registered OJL providers. Before approaching the IT employer organizations and asking them to join the Apprenticeship System, we must ask ourselves two important questions.

- What are we really expecting from Company A? (and other IT employers like company A), and
- What are the potential benefits for Company A that would convince the company to participate in this apprenticeship system?

Technically speaking the registration process for company A is relatively straightforward. First, the company completes and submits a form to CompTIA indicating that it will provide a structured OJL experience for those workers who register to become apprentices. To assist the employer with the administration of OJL, CompTIA provides a list of OJL activities that are tied to skill standards. In addition, there is adequate allowance for company A to add OJL activities that are company-specific.

In operation as an apprentice executes his/her OJL tasks, the apprentice's supervisor or journey worker mentors the worker as required and signs off on the worker's OJL list attesting that 1) the work was actually performed, 2) that the work was inspected and 3) that problems were resolved. It is <u>not</u> necessary that the supervisor/journey worker spend a large fraction of his/her time with an apprentice. Rather, the role of the supervisor or journey worker is to mentor the apprentice as needed and to check on the results of the apprentice's performance. People learn by doing and apprentices are encouraged to work independently as soon as practical, without the supervisor standing over his/her shoulder.

Now to the question: Why would company A want to become a registered OJL provider company? Based upon its work with registered apprenticeships across a wide variety of industries, the DoL has found that apprenticeship offers employer organizations eight compelling benefits. In addition, CompTIA has added attributes to the IT Industry Apprenticeship System that solve several existing workforce problems in the IT industry. These combined benefits of registered apprenticeship in generally and specifically to the IT Industry Apprenticeship System are summarized in the table shown below:

| Number | Benefit Description To IT Employer | Productivity & Quality Impact |
|---|---|---|
| 1 | The structure of an apprenticeship program gives employers a ready-made methodology to define and create a career path for mission critical skills. | • For many companies the creation of a career path for certain mission critical skills can take substantial time and resources. Apprenticeship is a ready-made methodology for "kick-starting" a career path process within a a shorter period of time and at lower cost. |
| 2 | Apprenticeship forces good supervisory and employee development practices | • Reduced rework,<br>• Fewer errors,<br>• Fewer "messes" to clean up. |
| 3 | Apprenticeship as a training methodology enables workers to learn faster | Workers can begin working independently in a shorter period of time. Over the long term this enables the supervisor to become more productive. |
| 4 | Apprenticeship enhances the employer organization's ability to attract and retain high quality workers. Good workers will be more likely to stay with a company that is "authorized" to sign-off on structured OJL tasks and hours. Also, apprenticeship increases worker loyalty to the employer. | • Reduced turnover<br>• Attract and retain the highest quality workers<br>• High productivity over a sustained period of time |
| 5 | Apprenticeship supports a "pay for performance" wage scale. Wages will be commensurate with demonstrated ability and experience. | • Employers will be less likely to overpay<br>• Wages will be more closely tied to real employee value<br>• Less guesswork in hiring and salary administration |
| 6 | An employer's participation in the IT Industry Apprenticeship System gives the employer access to a verified transcript of an applicant's academic, OJL and certification records. The employer will no longer have to rely upon résumé's, which have no verifiability. | A verifiable record of an applicant's achievements reduces the risk of hiring people who have inaccurately represented their credentials. |
| 7 | An employer's participation in the IT Industry Apprenticeship System gives the employer access to | Benchmarking data is of value in helping employer companies |

| | | |
|---|---|---|
| | diagnostic reports regarding the qualifications of his/her own company workforce compared to industry and regional benchmarks. | with assessments of their own workforce. |
| 8 | Apprenticeship formalizes knowledge transfer in an organization. This helps companies reduce the risk that knowledge of critical work processes is not shared. | Reduced risk of loosing workers with mission<br>critical process knowledge |

Let's look at the above items in detail from the perspective of Company A.

Item #1 highlights the point that apprenticeship is an effective vehicle for a company to use when a shortage exits in certain mission critical skills. Company A, for instance, may discover that IT project management is a mission critical skill that is in short supply. To resolve this problem company A may create a project management career path to attract and retain internal staff in this career category. Apprenticeship is ready made to help Company A establish this career path quicker and with less cost.

Item #2 shown in the above table reinforces the point that Company A would be interested in using apprenticeship because it forces good managerial and supervisory practices to occur. Apprenticeship simply requires employer organizations such as Company A to develop employees by using good supervisory and management principles that contain structure and that are tied to standards.

By using both structure and standards employers follow efficient, common sense ways of developing employees. The use of an OJL checklist, for instance, is a simple yet very effective way of ensuring that an employee has spent time learning and working on key work activities, equipment and tools. Checklists do not require a major investment in time or dollars on the part of an employer company, yet usage of checklists helps ensure that learning has occurred, which minimizes mistakes and rework. In this regard the tools and techniques of apprenticeship function as quality assurance aids for supervisors.

Company A should also be interested in adopting apprenticeship because of the efficiency and speed in providing knowledge transfer (Item #3). Apprenticeship is a time proven method of job instruction that supports an elegant and robust set of principles regarding how workers learn. Under a structured OJL process, critical tasks are taught following a four-step process[2]:

1) Prepare the learner
    - Put the learner at ease
    - State the task and find out what the learner already knows about it
    - Get the learner interested in learning the task
    - Explain why the task is important
2) Present the operation

- Tell, show and illustrate one important step at a time
- Stress each key point
- Instruct clearly, completely and patiently, but no more than the learner can master

3) Try out performance
   - Have the learner do the task—correct errors
   - Make sure the learner understands
   - Continue until he or she knows
4) Follow up
   - Put the learner on his/her own. Designate whom to go to for help
   - Check frequently encourage questions
   - Taper off extra coaching and close follow up

Jacobs and Jones have documented the three delivery vehicles available to provide workers with training on the job in the structured manner shown above. Jacobs and Jones label these vehicles as: self-directed discovery, coaching and on-the-job training. The authors define each structured approach as follows[3]:

| Self-Directed Discovery | Coaching | On-the-Job Training |
|---|---|---|
| Employee learns by doing, using information engineered into the work setting to guide learning. Employee can trust the system to help make the learning easier and to reduce frustration. | Employee learns by working alongside or nearby and experienced employee, who uses systematic knowledge of the task to know when and how to intervene. Training outcomes are relatively predictable. | Employee is trained by an experienced employee who has expertise as a trainer and in the task to be learned. Training content, methods, and outcomes are consistent across employees. |

Given the scarcity or unavailability of expert level workers in many organizations, a typical IT apprenticeship would use a combination of the above OJL vehicles. The critical aspect is that each approach is delivered in a structured manner.

Sometimes managers fear that using apprenticeship in his/her company would take too much time and reduce productivity. In fact just the opposite is true. Productivity rises with apprenticeship. W.E. Deming's key arguments about quality apply equally to apprenticeship. These are:

- Doing things right the first time is always the least costly way to operate
- If you don't do things right the first time, you will end up doing things over

Apprenticeship makes these basic quality principles operational for IT employers such as Company A. By identifying and structuring a worker's job, the employee learns faster is less likely to make mistakes and incurs less rework. The combination of self-directed discovery, coaching and on-the-job training provides

efficiency in the use of people's time. Under apprenticeship the role of the supervisor or journey worker is to mentor the apprentice only as needed, to check on the results of the apprentice's performance and to give feedback. Apprentices are encouraged to work independently and use self-directed discovery as soon as practical allowing the supervisor/mentor to work on other tasks.

Item #4 shown above is a strong motivator for an IT employer such as Company A. Through years of experience in working with registered apprenticeship programs, DoL has observed that worker loyalty to the employer increases under apprenticeship programs[4]. During the decade of the 1990's IT employers were plagued with high turnover and difficulty attracting and retaining good quality workers. Apprenticeship helps mitigate this problem. In addition, the best workers will be attracted to IT employers who are "authorized" to credit them with OJL hours.

IT employers such as Company A will also be attracted to the "pay for performance" aspect of apprenticeship (Item #5). Apprenticeship operates under the principle the workers begin with entry level wages and follow a progressive wage scale based upon demonstrated performance. Under apprenticeship each level of an apprentice's path is anchored in standards. Therefore, employers are expected to pay only for demonstrated performance that is tied to an objective standard. This process removes the arbitrariness of wage administration and helps ensure that employers will obtain value without overpaying. In addition, it provides a tool to help the Company with forecasting employee costs.

IT employers such as Company A have long complained about the unreliability and inadequacy of résumé's in the employee selection process (Item #6 above). An employer's participation in the IT Industry Apprenticeship System gives the employer real time access to a verified transcript of an applicant's academic, OJL and certification records. Access to this information substantially reduces the employer's risk during the employee selection and hiring process.

Participation in the IT Industry Apprenticeship System also gives employers such as Company A access to analytical and diagnostic reports regarding the qualifications of his/her own company workforce compared to industry and regional benchmarks (Item 7). For instance, employers can receive reports comparing their workforce to others across dimensions such as:

- The number of IT workers in their organization with certain product or industry certifications compared to comparably sized companies in their industry
- The distribution of workers in their company across various apprenticeship levels compared to comparably sized companies in their industry
- The average hours of OJL delivered per IT worker per year in comparably sized companies in their industry

The above lists only a few of the many possible diagnostic and analytical reports that could be made available to help an IT employer benchmark his/her company across workforce related dimensions.

Finally IT employers like Company A should be interested in apprenticeship because it formalizes knowledge transfer in an organization (Item #8). Quite frequently IT organizations have one or two employees who have knowledge of mission critical processes. Moreover, these processes would be put in jeopardy if these people were to leave the organization. Because apprenticeship formalizes general knowledge transfer, it helps mitigate the employer organization's risk exposure of loosing these certain key employees.

The implications from our observations thus far are profound. When we consider that a worker spends approximately 2,000 hours per year working on the job (translating to 90,000 hours+ over a 45 year career), we discover that on-the-job learning offers the potential to become a new space in the spectrum for providing worker training.

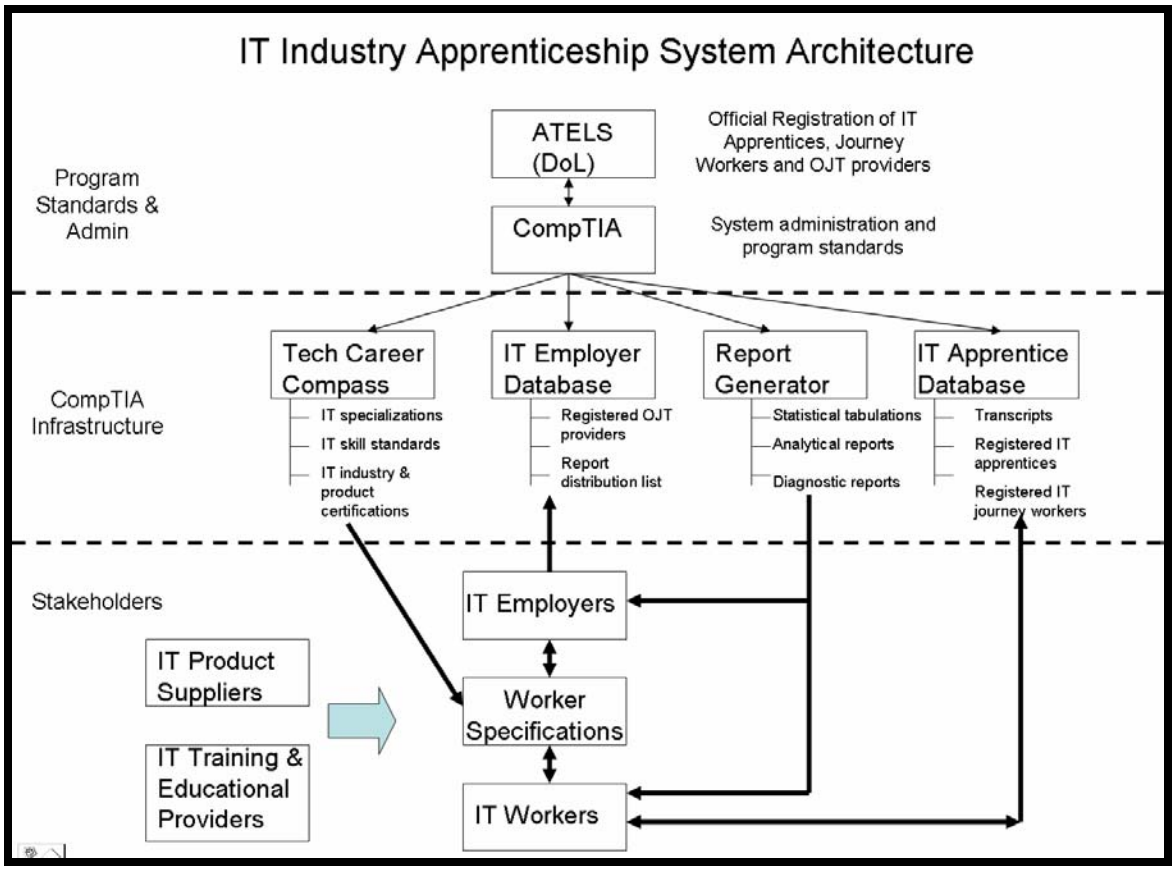
Again, we place our attention on a fundamental paradox that exists. Why is it that we rigorously design, track and reward the 3,000 to 10,000 or so hours of classroom instruction a worker receives over a career, yet we virtually ignore the 90,000 hours of on-the-job experience the worker receives? Similarly we ask, is it not possible that one can design a system to efficiently use the time a worker spends on the job as a resource for providing structured learning? As we will see below, CompTIA's registered apprenticeship system (IIAS) is an industry-wide infrastructure that is designed to tap this potential opportunity for the universe of IT workers.

**Elements of the CompTIA/ATELS IT Industry Apprenticeship System (IIAS)**

Well, let's step back and review where we are in our hypothetical journey toward building a fully competent cohort by the year 2008. First, we identified the causal factors that would enable us to set meaningful standards that included classroom instruction, OJL and certifications. Second, we have migrated those standards into the IT labor market whereby the worker specifications are tied to the standards. We used the economic "invisible hand" to drive the standards into each of the three major stakeholder groups: IT workers, IT employers, as well as IT training and educational organizations. Third, we adopted Registered Apprenticeship as a vehicle to drive the delivery of on-the-job learning. Fourth, we created an infrastructure to administer the entire process. We call that infrastructure the *IT Industry Apprenticeship System*. Fifth, we built adequate incentives into the system for IT employers to participate in the process. We are now ready to go.

Okay, now let's remove ourselves from our thought experiment and discuss the present state of reality. CompTIA, in collaboration with ATELS, is in fact developing the IT Industry Apprenticeship System (IIAS) containing the product attributes described above in our thought experiment. The architecture of the system is described in Figure 6 shown below. The first release of the product is scheduled for November 2003, and detailed information about advance participation in the system can be found at CompTIA's website at www.compTIA.org and TCC.CompTIA.Org.

**Figure 6**



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