

## **A Critical Examination of the Effects of Enterprise-Level Quality Control Programs on Professional Work**

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### **Abstract**

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Over the last quarter century enterprise-level quality control programs such as Capability Maturity Model Integration (CMMI), Six-Sigma, and Lean have been altering the structural landscape of professional bureaucracies. Prior to these programs, professionals in these organizations enjoyed a great deal of freedom and autonomy in defining their roles and in assessing the quality of their technical products and services. This paper is an ethnographic study of systems engineers in a defense contracting organization both prior to and after the introduction of an enterprise-level quality control process. This serves as the empirical basis from which to consider the effects that shifts in the bureaucratic structure due to these programs have on professional workers. The hero emerged as an ideal type of professional in this setting that helps to highlight some of the key facets of alienation and non-alienation that are sensitive to enterprise-level organizational change programs. From the analysis we see that these change programs do have alienating effects that are generalizable to other technical professionals in complex organizations.

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**Keywords:** labor studies, management, organizational culture, self-determination, technological change

### **1. Introduction**

This ethnographic study examines the social effects of the introduction of an enterprise-level quality control program (CMMI) on professional engineers in a complex bureaucracy. It was found that while in many ways the professional engineer avoids certain forms of alienation often associated with wage workers, there are other, more social forms of alienation that are present and given unique shape by the introduction of CMMI. Marxist and Weberian framings of alienation provide a useful analytical context within which to examine the situation of the engineers in this setting. The hero emerged as an ideal type of worker instrumental in highlighting the various contours of alienation and non-alienation experienced by the engineers.

#### **1.1. Bureaucracy and the professional**

Max Weber was the first sociologist to fully grasp the social, political, and economic significance of the bureaucratic form of organization. He believed that, while on the one hand it would constrain individual freedom and creativity and be an "iron cage," on the other hand he saw that it was inevitable because of its efficiency. Nevertheless, he believed bureaucracies would select and perpetuate humans "lacking in heroism, spontaneity, and inventiveness" (Gerth and Mills 1946, 50). In many bureaucratic institutions Weber's predictions were found to be prescient. By the late 1920s large bureaucracies governed by professional managers were reorganizing the social and economic landscape of labor. Mechanical engineers in particular were the driving force behind the "systematization" that maximized the extent to which practices and processes were standardized (Shenhav 1995). Therefore, in terms of the work itself, this bureaucratization succeeded in narrowing creativity, autonomy, and latitude. Throughout the twentieth century the bureaucratic form continued to creep into most institutional arenas such as government, banks, schools, hospitals, the military, research, law, and manufacturing.

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This led to an explosion of research into the effects of bureaucratization on workers in general and on professionals in particular (Roy 1954; Braverman 1974; Burawoy 1979; Smith 1971; Bonjean and Grimes 1970; Matheson 2007; Bailyn 1985; Becker 1961; Dalton 1959; Gouldner 1954; Jackall 1988; Kanter 1977; Kunda 1992; Roethlisberger and Dixon 1939; Rohlen 1974; Rosen 1984; Whyte 1956). Over time doctors, lawyers, scientists, and engineers were no longer operating independently but within a bureaucratic context. Professionals are distinguished from other kinds of occupations/labor in that the professional draws upon an extensive and abstract body of knowledge to diagnose and treat “human problems amenable to expert service” (Abbott 1988, 35). Therefore given Weber’s perspective, professional work would seem to represent the ideals of autonomy, freedom, self-control, and self-determination (Gerth and Mills 1946). Therefore now that the professional was finding herself/himself within a rule-based, rationalized, and standardized bureaucratic social structure, researchers were keen to predict and discover what negative effects they might encounter.

## 1.2. Studies of professional bureaucracies

While Marxist forms of alienation fit wage workers (non-professionals) like a glove (e.g., Roy 1954; Braverman 1974; Burawoy 1979), they often failed to accurately explain what professionals were experiencing in the emerging dominant form of social organization – bureaucracy. To Weber, this would be because Marx’s framing of the problem was too narrow and applied to a special case of capitalist production. Some studies were able to identify correlations between the degree of bureaucratization and the degree of Marxist alienation experienced by the professionals (e.g., Smith 1971; Bonjean and Grimes 1970; Matheson 2007). But for the most part formal bureaucratic control of the professionals was found to be minimal and control over their product was achieved through informal organizational and professional norms and negative experiences, if they were found at all, tended to result from ambiguity and political conflict (e.g., Bailyn 1985; Becker 1961; Dalton 1959; Gouldner 1954; Jackall 1988; Kanter 1977; Kunda 1992; Roethlisberger and Dixon 1939; Rohlen 1974; Rosen 1984; Whyte 1956). In these studies it is not loss of control over one’s material labor but rather the chronic tension between the impersonal demands of the bureaucracy for rationality and the actual social reality that organizational life is rife with conflicting expectations, personality, informal culture, and ambiguity (Jackall 1988).

These studies found bureaucracies to be fertile grounds for achieving professional status and success provided that one could navigate the conflicting demands and ambiguity and use them to one’s advantage (Dalton 1959; Jackall 1988). In *Men Who Manage* Dalton describes the “weak” men as those who embrace the bureaucratic logic and remain rule-bound alongside the “strong” men who bend the rules to achieve their political goals (Dalton 1959). Yet these outcomes come at a price that ultimately supports Weber’s view on the effects of rationalization. Therefore while Marx’s theory of alienation applies very well to lower-level or wage workers in the bureaucratic context, the professional largely avoids these forms of alienation (Blauner 1964; Kirsch and Lengerman 1972).

Some scholars argue that this is because Marx’s theory of alienation is overly romantic, individualistic, and materialistic and therefore fails to acknowledge the roles that social factors such as status and identity have on alienation (Tripathi 1976; Blauner 1964; Kirsch and Lengerman 1972). Especially within the bureaucratic context, groups determine the *value* of the professional’s output, skills, knowledge, personality, and creativity and therefore one’s overall status and alienation is therefore primarily a function of losing such status or failing to achieve it to begin with (Tripathi 1976). In other words, as opposed to Marx’s assumptions, the value of one’s work or the value of one’s role is not an objective function of some fixed “human nature” and exchange, but rather is relative and responsive to group norms.

If we are to accept this relaxation of alienation’s meaning, it comes as less of a surprise that subsequent researchers began to examine how bureaucracies are, indeed, not the “iron cages” that Weber had feared but rather have the potential to enable “heroism, spontaneity, and innovativeness.” For example Perrow (1988) argued that bureaucracies are the only form of social organization to date that, based upon its rules and impersonal role definitions, has been able to reduce social injustices and unfairness relative to gender, race, sexual orientation, and ethnicity in favor of merit. Other studies show how the informal forms of control can be encouraged to better span boundaries across bureaucratic organizations (Weiner et. al., 2015).

More to our purposes here, other scholars have stressed the non-coercive and enabling facets of modern bureaucracies (e.g., Adler 2012; Adler and Borys 1996). Bureaucracies offer social contexts within which professionals can develop themselves and achieve social status through the respect and admiration of their peers. In conclusion, professionals in bureaucracies, at least throughout the twentieth century, have been largely able to avoid alienation and, to the extent that they are “strong,” in Dalton’s sense, and able to navigate the informal side of the organization successfully, enjoy high levels of power, status, meaningfulness, autonomy, self-control, and self-determination.

### 1.3. The emergence of enterprise-level quality control programs

Research on the alienating effects of the bureaucratic form on the professional reached its peak in the early 1990s. Since then, scholars have been more interested in the effects of new Information Technology (IT) and Information Systems (IS), in general, on the professional. For example the trend toward hiring temporary professionals alongside permanent professionals creates shifts in attitudes, extra-role behaviors, and job scope (Ang, 2009). Other studies show us how the shift in knowledge/skill from the professional to expert systems also create a shift in accountability and control (Bovens, 2002; Burton, 2008; Gilbert, 2005; Constantinides, 2012; Pawlowski, 2004; Levina, 2005).

However less attention has been paid to other emerging bureaucratic structures that also have the potential to influence professional work. Beginning in the 1990s enterprise-level quality programs such as *Lean*, *Information Technology Infrastructure Library (ITIL)*, *Six Sigma*, and *Capability Maturity Model Integration (CMMI)* have gained widespread adoption in large professional bureaucracies. Prior to these enterprise-wide programs, the reach of formal quality control practices in bureaucracies was limited to the kinds of products and services being produced by machines or by wage laborers. Introduced by the quality gurus Deming and Juran, Quality Control (QC) and Statistical Process Control (SPC), programs were implemented to account for the “natural variation” of mostly automated production processes and take corrective action if statistical anomalies indicated the emergence of an unwanted “special cause” of variation (Software Engineering Institute 2006). Yet until the 1990s, these quality control models were not applied to the professional and his or her labor. Rather, the quality of the professional’s output was defined and controlled by more informal means such as normative expectations, obligations, customer satisfaction, professional ethics, etc.

With the arrival of CMMI, Lean, ITIL, and Six Sigma came the opportunity to formally measure, systematize, and control the professional’s work quality. As this represents a substantial shift in, or strengthening of, the bureaucratic form for many professional organizations, it offers us a new line of inquiry. Given the types of alienation discussed earlier, do these new quality control programs introduce alienating effects on professionals? If so, what types of alienation? Are the new forms of alienation more of the materially-grounded variety espoused by Marx, or could they be more responsive to rationalizations of bureaucracy espoused by Weber, or to the social forces identified by Blauner (1964), Kirsch & Lengerman (1972) and Tripathi (1976)?

## 2. Method

A participant observation study was conducted by the primary author over the span of a thirteen years between 1998 and 2015 at a large defense contracting company (“Defense Systems”) in a small New England city. A subset of a larger corporate entity, the organization of approximately 1200 managers, engineers, and technicians designs, assembles, and integrates launch control systems for Trident II submarines and guidance systems for nuclear missiles. Over 70 percent of the employees are professionals (engineers and managers). It is estimated that over the course of this study that greater than 90% of the systems engineers were white males. Work direction is organized in a matrix structure in which program managers oversee project cost, schedule and budget while functional managers are responsible for maintaining a pool of skilled/experienced workers to execute firm-fixed price or incentivized contracts. The systems they design are integrated into larger systems requiring extensive coordination with other organizational units, with customer (Navy) organizations, and other government contractors.

The manner in which subjects are framed and represented in ethnographic research has become a pivotal question in what some scholars refer to as the ontological turn in ethnography (Kelly 2014). On the one hand, one of the ideals of science is to develop objective and universal theories to explain observable phenomena. Yet on the other hand the practice of science has been shown to be grounded in the social constructions even in the “hard sciences” such as biology and physics (Latour 1984; Knorr-Cetina and Mulkay 1983). Claims of scientific objectivity/universality become even more problematic with the social sciences in which the objects of study are human beings (subjects) and editors of journals such as this one have made calls to further contextualize data gathered in technical work settings (Te’eni, 2015).

Anthropologists are continuing to struggle with the epistemological and ontological implications of this relationship. For example this healthy tension is reflected in a recent conference exploring these topics using the viewpoints of leading anthropologists Bruno Latour and Philippe Descola (Kelly 2014). Descola claims that anthropology needs to be distinguished from Clifford Geertz's influential framing of ethnography as "thick description" and instead be viewed as a way to "understand more generally how particular beings, humans, operate, detect, and transform their environments, with remarkable but not infinite diversity, and thus how worlds are composed." (Kelly 2014, 261).

If we are to think of human actors as composers of worlds, then Latour takes very seriously the question of how researchers may come to encounter and understand these compositions. He is very sensitive to the potential for researchers to consciously or unconsciously impose their own (external) understandings of the world onto the subject's and therefore misrepresent these compositions. For example with respect to the scientist as a subject, he argues "[s]cientists themselves are better able to reflect on their material than the best epistemologists in the world" (Serres 1990, 29) and that the central question becomes "How did the abstract come to a group of men at a given, well-known moment?" (Serres 1990, 30). Latour and his colleagues argue that this demands a strong commitment to relativism and that the researcher "learns the actor's language, records what they say about what they do, and does not appeal to a higher 'structure' to 'explain' the actors' motivations" (Texas Theory 2015, 1). This has led to a consensus among some anthropologists that these compositions are never objective and universal but rather is "situated" and "partial" (Kelly 2014; Haraway 1988). This is a useful perspective for this study as the systems engineers in this setting develop and maintain their own local language and systems of meaning that help them to make sense of and communicate the social, political, and technical facets of complex systems.

While much of the debates in ethnography and anthropology revolve around the ontological and epistemological problem of an outsider gaining access to the meaning systems used by the insiders, the primary author of this study encountered the opposite problem. The primary author was, prior to the study, already a full-time systems engineer employed in various roles including requirements definition and system architecture design at the system, sub-system, and software component levels. Therefore gaining access and developing rapport were not issues. The primary author already enjoyed "back-stage" access to and familiarity with social realities in meetings, customer reviews, peer reviews, and casual hallway conversations and was well aware of who the "key informants," or those most in tune with the organizational cultures, were. Field-notes were recorded on an ad hoc basis and focused on contexts and discrete interactions in work activities and at meetings as well as capturing engineers' reactions to the introduction of new processes and technologies such as CMMI. These notes were initially hand-written in a journal but elaborated in computer word processing files at the end of the day. Over thirty interviews, lasting approximately one hour each, were recorded and transcribed over the research period. Thirteen of these occurred prior to the introduction of CMMI and the remaining were conducted about five years after its introduction and after it had been certified at the highest level of maturity.

Ethnographic interviewing methods were utilized in the data gathering phases (Lofland and Lofland 1984; Spradley 1979). Consistent with these methods each interview began with "grand tour" questions such as "Can you tell me about when you came to the company and the different positions you have held?" and "Please describe what your current role, whom you work with, and the nature of your work interfaces and interactions." Probes were used to encourage the interviewee to elaborate on points or for clarification. Subsequent questions focused upon concrete work interactions that the interviewee recalled as being representative of good or poor working relations. Grounded theory methods (Strauss and Corbin 1990) were adopted to evolve codes and to develop theory. The early coding phases were intentionally flexible and reflexive – allowing the data to stimulate thinking about theoretical categories and relationships while also allowing the emerging theory to focus the subsequent data gathering. This phase expanded on categories of interpersonal communication embedded in the work activities that correlated to what the respondents would describe as healthy or unhealthy work relationships. The interview questions also explored the manner which the members interpreted and experienced the introduction of new organizational processes.

### 3. Analysis

In the defense contracting field organizations bid for contracts to develop specific systems to be deployed or fielded on an array of platforms such as ships, submarines, airplanes, military bases, and general war arenas. The contracts may be firm-fixed-price where any overrun results in a loss of profits to the contractor, or they may be incentive based where the costs/savings of overruns/under runs are shared by both the procuring defense entity and the contractor and monetary incentives are in place to exceed contractual budget, schedule, and/or quality requirements (Moore 1967). At Defense Systems, most of the traditional long-term Submarine Program contracts were incentive based, while some of the newer Surface Ship programs were firm-fixed price.

As a matrix organization, Defense Systems is organized such that the cost, schedule, and quality of each contract (program) is managed by a particular manager (program manager), while engineers are organized into departments by function and are managed by functional managers whose responsibility it is to hire and maintain a pool of engineering expertise to be applied across programs. A systems engineer, therefore, is accountable to both the program manager and to the functional manager for their performance and expectations. Functional managers and program managers work together to balance these "human resources" and often move engineers between programs to meet program demands or for cross-training purposes.

With the complexity of the customer expectations and technical requirements, a great deal of the systems engineer's time is spent formally presenting his or her designs to stakeholders in peer-review meetings or customer review meetings, or informally communicating ("socializing") their latest work ideas with programmatic or technical experts. Therefore one of the central themes emerging from the data is that social skills and the ability to understand complex social and technical environments are central to the effective systems engineer. In describing skills unique to systems engineering, one engineer, Todd, stated: This is a group of people that deals with the customer, deals with outside organizations... there are people in a lot of key roles like ... If you look at John, his big skills are being able to delegate things effectively, to be able to disseminate information efficiently to the extent needed and being able to understand various problems and communicate them – again, very efficiently because he doesn't have a lot time to come up on things and then he goes off and presents something to the customer – *represents* that. So his skill set is probably again –less technical although it is *based* on technology. But the skill set he applies is more personal attributes than anything else; something that isn't as readily developed by studying.

This systems level work environment creates a broader social context in which one's work can be seen and appreciated by a variety of coworkers and customers. Therefore respect emerged as a clear theme for these engineers as reflected again by Rita: [With] anything I do I want respect from the people that I'm involved with, and that's probably one reason why I like my job too is because I like dealing with the customer and I feel respect from them. I feel like I'm respected in Systems and I suppose if I didn't have that I might want to consider doing something different, but I'm totally content with what I'm doing and enjoying what I'm doing. The data also show that there is a difference in the nature of the work depending upon the contract type. Firm-fixed price contracts create a context in which systems engineers are expected to perform more of the functions traditionally reserved for management such as defining and work tasks and allocating resources. In this environment management is explicit in their inability to define work and the resources that are required and therefore the activities necessary to gain this level of understanding falls to the systems engineer and usually requires face-to-face contact with engineers and managers in other organizations. According to Carl, a manager,

In fact I get pissed when I find out that somebody didn't go *see* their counterpart in [other contracting organization] in Baltimore. [critical tone] 'Why weren't you there? They're developing software with you, I went to see the schedule and I didn't see where you guys hook up. Did you go down and see him?' 'No' 'Well you *should*. You need to. Don't hesitate, you do more when you're together.' Problem is that some people really don't foster where they have to *create* their own understanding of the need of what to do. And, think *way* outside of the borders of what we've got. And I think he was more of a, 'please tell me my job and I'll do it really well,' kind of guy and he's probably brilliant. But we can't tell you your job because frankly we don't know. We know what your *end-product* needs to be. The systems engineering work, then, is characterized by a high level of boundary spanning (Levina, 2005) and job satisfaction based on broader understandings, a perception of respect (social mirroring) from others in the program community, and a high degree of autonomy to determine both the requirements and the design facets of new systems.

### 3.1. Organizational “heroes”

The data revealed that the terms “hero,” or “A-player,” or “key player” in this organizational culture were frequently used and reserved for those engineers who were seen by management as possessing the knowledge and skills to “save the day” and get projects that were “getting into trouble” back on track. Therefore the hero, in this setting, is not one who enhances or innovates but one who averts crisis. Unlike crisis averting heroes from the broader culture who protect others from harm using their skills with a sword or axe, the skills needed in the systems engineering setting are centered on social, technical, and political knowledge and action. To understand these roles and these categorizations within the organizational culture, however, requires an elaboration of the social, technical, and political nature of the professional engineering work. Managers develop and maintain formal and informal assessments of systems engineers and are keenly aware of those that stand out and are considered the “A-players.” Those in this category are routinely called upon for heroism to “put out fires” or salvage programs that are getting into budgetary, schedule, or quality crises. As their evaluations are not publically made, knowledge about them from the engineer’s point of view remains somewhat ambiguous, localized, and limited.

According to Todd, one of these A-players: Somebody that also displays that level of commitment to a project tends to have a similar level of commitment towards maintaining and developing their skill set. Whereas somebody else is perhaps more pegged as ... a “body” really. And they have the categorization of A, B, C players and so forth and they have people they pegged as A players... I don’t know how formal it always is... it’s become a little more formalized when they do the rankings and so forth. But even outside of the rankings there’s a sense of who the A players are and they tend to get floated around projects perhaps a little bit more evenly a little more conscientiously. And when something gets in trouble they tend to throw a bunch at a project and finish pulling it off. In addition to identifying these A-players and assigning them to heroic roles, management is also keenly aware that many engineers desire to prove themselves as heroes and are looking for opportunities where they can be perceived in this light by their peers. Furthermore, heroes are important role models in the organization. Carl states: Plus you look at the leadership. I mean I’m pretty energetic anyway. [But consider] Bill Miller. The guy’s fantastic. I mean talk about lead by example – he’s fantastic. We just have the kind of people that the people around them respect and, like, “I want to work for that guy.” And it’s been infectious. Therefore, heroes do emerge in these contexts and are extremely valuable to the organization for executing contracts, getting programs out of trouble, and being role models for others.

### 3.2. Heroes as resources

While it is clear from the data that those engineers who are A-players or heroes find their work to be personally satisfying and enjoy the social status they have within the organization, they nonetheless lack control over their own program and role assignments. Given a task or role, as we have seen, they enjoy complete autonomy over how to accomplish their goals because management often lacks the depth of understanding required to define the tasks, yet at any time management has the bureaucratic power and justification to move them from one role/program to another. This emerged from the data as a “downside” to the professional’s experience in this setting. For example, one A-player, Bill, was coerced into a move from the software engineering department into the systems engineering and resented the coercion: Yea. And then about a year ago I was asked to go over to Systems. They pitched it as a *broadening* [rhetorical tone] experience – something that would be *good* for me. There was a little bit of a guilt factor involved. They had to ramp down software to systems and put together of a list of people they were willing to take and... there was no pressure, but “If you don’t, we’re going to have to get rid of somebody [laughter]” So, I don’t know. So I figured I’d give it a shot [laughter]. Therefore while the engineers accept this loss of control as part of life in a professional bureaucracy, it often takes them away from work that they prefer or forces them to work in areas that they dislike. According to Robert, a seasoned engineer: Part of [the problem] I think is that I’d like to spend more time on the process side of things, but because they think I’m good at what I do, they tend to overload me with work and I can’t spend time doing process stuff. Furthermore, in a corporate bureaucracy this loss of control is not limited to non-managerial engineering roles. For example, one senior manager, John, shared stories about being assigned to a new division and being somewhat apprehensive at first, but began to enjoy learning new programs,

customers, and technologies. Shortly after taking the position he and his team were informed that one of their major contracts that they had been awarded year-after-year for decades was now being lost to a competitor.

Rather than accepting defeat he motivated his team to do everything possible to indirectly challenge the award and further demonstrate that they were the better choice for the contract. After a few weeks the decision was overturned and the manager was beaming with personal satisfaction in not only achieving this outcome, but also in having set a new precedent for his team to work in new and innovative ways. However within a week he received a phone call while he was on vacation from his superior informing him of a re-organization and that he would be reassigned to a role similar to the one that he had come from but with a larger scope primarily because he already had very good relationships with those customers. He was visibly upset and stated how unsettling it was “to be moving in one direction and investing my heart and soul into it and loving it” and then having everything change and having “absolutely no control over it.”

### 3.3. Formal process and heroism as symptomatic of failure

The concept of heroism can be a double-edged sword for professional bureaucracies. On the one hand, the large scope and high complexity of the work often lead to budget, schedule, or quality problems (Peck and Scherer 1962) and heroes are called upon to get things back on track. However the goal of formal enterprise-level processes such as CMMI is to eliminate these problems and therefore the *need* for heroes. CMMI assesses process maturity at five levels ranging from the lowest (Level 1) in which the organization relies on heroes for success, to the highest (Level 5) in which processes are well-defined and optimized through data gathering and statistical quality control techniques. During the data gathering period, Defense Systems had achieved the highest Level 5 rating and this introduced a dilemma to management. Despite some quantifiable gains in predictability and performance, programs continued to run into trouble and heroes continued to be called upon to get them out of crisis. This explicit move to eliminate the need for heroes is common to other organizational process frameworks as well (e.g., McKeown 2010).

To many the motivation behind the adoption of CMMI is primarily for the organization to be viewed as less expensive and more predictable to customers and to achieve a level of legitimacy but they also believe it does not necessarily produce a good product. According to Todd: My own personal opinion of CMMI from a business point of view in a competitive environment, it is critical to have that as a shingle hanging on the door. It gives the *appearance* of a certain amount of predictability, it gives the *appearance* of manageability and control. To some extent you have manageability and control *artifacts*, but your product is *not* a set of artifacts. Your product is a system that works in the end. You know, if your system does not work but you have beautiful artifacts, it did no good whatsoever. Indeed, even though the organization had been granted Level 5 CMMI status and had sustained this status through the production of metrics and artifacts, most engineers believed that the “true” nature of the work will always require heroes and engineers who understand what is required to produce a satisfactory system. When asked if CMMI changed the way we do the engineering work, a senior systems engineer, Fred, replied:

No, not at all. It changed the artifacts that are produced, it changes individual *accountability* for producing *artifacts*. It drives up the costs in terms of the number of hours you have to expend- that cost has to be absorbed by the individual developers because costs can only go down – never up. The rationale is that this is going to make us *cheaper*. They really just put more pressure on individuals to follow more religion, produce more artifacts. So what it comes down to is software is *always* developed the same way and you can tell that by watching a project. Projects typically start up, they get in some degree of trouble and how do they react when they get in trouble? And even senior management, even the evangelists and advocates of CMMI will start pulling people off of one project onto something else. Whenever something's going on, they always look for – and they take names that are associated with – that have a particular *reputation* associated with them. And they start throwing them on there. The heroes haven't gone away, although they [management] don't really admit it openly. At the same time, they do have these kind of quiet, *covert* almost, awards that go on, where, ‘OK, if you pull this off and meet this particular goal, there's like a \$1000 bonus’ or something – you know, the management awards. So, that still exists – a hidden layer.

Heroes, then, continue to emerge and continue to be resources for managers to “put out fires” with, but their status as heroes within the organization is, to some extent, covered up and not made public to the broader organizational population. CMMI, then, represents a new layer of bureaucracy that has evolved from the quality control paradigm that makes strong assumptions about engineering processes and practices.

These assumptions include an expectation of machine-like consistency and predictability in a complex work environment that can never meet this expectation and therefore heroes will continue to be important resources for managers yet, as they are symptomatic of the bureaucracy's failure, their existence and use must be kept hidden.

#### 4. Discussion

The analysis sheds new light on the ways in which a particular type of professional, the systems engineer, experiences his/her labor in the context of a changing bureaucracy. Let us now consider whether the results from the analysis reflect forms of alienation for these professionals. In Marx's first form of alienation man becomes alienated from the product of his own labor when the *creation of* the product is not under his/her control. In the analysis we saw that, in particular with the Surface Ship program, that management explicitly admits that they do not have the level of understanding and embeddedness in the social/technical contexts to be able to know what the product needs to be. They insist, rather, that the engineers do the boundary-spanning and be responsible for developing these understandings. Therefore as programs succeed because of decisions that the engineer has made based upon their autonomous activities, they feel personal ownership over the product and its successes. The A-players and heroes, in particular, express a strong identification with and a deep sense of satisfaction from the roles they play in supporting what is often referred to as a program community consisting of customers, coworkers, managers, and fellow contractors.

A consistent theme in labor studies and the deskilling hypothesis is that engineers are rarely framed as the victims of this phenomenon (Whalley1984). They are traditionally portrayed as being socially and culturally aligned with the interests of management, internalizing their values and goals, and being the ones who design and implement the automations that shift the skill away from the laborer's body and brain (Braverman 1974; Blauner 1964; Burawoy 1979; Clawson 1980; Perrow1986). Our analysis of systems engineers reinforces the notion that there is little of this kind of deskilling taking place and that the engineers are skilled boundary-spanners and embrace a broad understanding of the social, political, and technical facets of their complex production environment. Indeed, the analysis indicates that as projects become more time-critical, such as the Surface Ship program, management enlarges the engineer's spheres of task responsibility, autonomy, boundary spanning, and required knowledge.

Other forms of alienation are responsive to the social themes emphasizing how workers are social mirrors to one another and in so doing define one another. The branch of sociology named *Symbolic Interaction's* expands on this theme. For example George Herbert Mead wrote about how society can be viewed as the composite of individual thoughts and values, while the individual is the product of society and therefore each determines the other in a mirror-like mutually constituting way (Mead 1934). More recently others have extended these lines of inquiry to develop the concept of the *looking glass self* in which one is acutely aware of (and therefore defines oneself) based upon how they imagine others are seeing them and interpreting them (Cooley 1994; Manis and Meltzer, 1972). Therefore, to the extent that one's labor or product becomes objectified and observable by others, or perhaps the extent to these are shielded from others, becomes a potential source of alienation.

The results of the analysis have interesting implications for this form of alienation. Heroism occurs often in the systems engineering contexts as programs get into trouble and engineers with unique knowledge and skills are called upon to save the program and avert crisis. While on the one hand this can lead to the hero as being seen by his/her coworkers as a hero leading to identification with and satisfaction through that social mirroring, on the other hand the newer organizational processes such as CMMI pressure management to conceal the fact that acts of heroism were needed. As we saw in the analysis, for management to explicitly rely upon heroes is to acknowledge that programs are routinely getting into trouble and this is unacceptable to the logic of the formal process (e.g., CMMI) that assumes machine-like consistency and predictability in the production process. Therefore, while programs still get into trouble in such a complex production environment, managers continue to use heroes and reward them, but they keep this hidden from the workers themselves so that the hero can no longer be seen (mirrored) as a hero by his or her coworkers. He or she becomes mirrored as a hero to management, but not directly to the broader organization.



The analysis showed that the heroes and A-players in particular experienced relational forms of alienation at deep emotional levels. As they worked closely with a group/team and developed a strong reputation with those specific others, they had very little control over whether or not they could stay in that group. Rather they came to identify with themselves as resources (human resources) for managers to move from one area to another as they saw fit.

The word *unsettling* is perhaps the most appropriate way to describe the workers' experience of this form of alienation. The implementation of CMMI and the manner in which artifacts are gathered and used only reinforces this modularity and redistribution of human resources. If we focus now on the more social forms alienation just presented, we see that both of them have less to do with how the work itself is structured and more to do with the social dimensions of bureaucracy. The professional has wide latitude over how to conceive of and execute task domains. This means that from Marx's materialist conception of production that these professionals avoid alienation and experience ownership and pride in their work. Yet Weber encourages us to relax Marx's assumption that material production is the sole cause of human alienation/actualization. We see now that it is the bureaucratic structure itself, an *idea/ideology*, that perpetuates impersonal role definitions and the rationalization of work at all levels. It is rational for management to hide the fact that they must use heroes because the need for heroism signifies bureaucratic failure. In this sense, Weber's fear that the 'iron cage' would stifle spontaneity, heroism, and individualism is being realized in more mature forms of bureaucracy even if, in crisis, the organization continues to cultivate them and use them.

Furthermore, in a bureaucracy it is clear that the professional is granted a great deal of latitude in performing his or her professional craft, but it is the bureaucratic rationality of resource reallocation and redistribution, strengthened by CMMI, that removes virtually all control that the worker might have in determining what project and with what groups it will be practiced. Therefore with the relatively recent widespread adoption of enterprise-level quality control programs we see that those professionals who were previously able to escape the 'iron cage' are now suffering from the forms of alienation we have described. While Perrow (1988) and other have seen opportunities for personal development and freedom with the bureaucratic structure, we are seeing an opposing trend. Perhaps most critically, we see that the professional's output is now being measured and recorded in a formalway within a system that monitors for statistical variations. The professional in this context is more likely to feel as though he or she is part of an impersonal system in which evaluation of one's labor output is no longer under one's jurisdictional control but has instead shifted or become appropriated by the formal process and its owners. More unsettling, perhaps, is that these systems set a nominal level of performance around which control limits are applied, leaving the professional with little or no say over these levels.

In summary, it is important to acknowledge that the proliferation of enterprise-level quality control programs such as CMMI, Lean, Six Sigma, and others represent a field-wide strengthening of the bureaucratic form that is likely to alienate professionals in the ways that we have observed in this study. We saw that these professionals, especially the most outstanding ones, lost control over their work assignment, heroic performances needed to be hidden and rewarded in secret, evaluations of quality have been shifted from the worker to the bureaucratic system, and the overall responsibility and accountability for collective success (or failure) have been taken away from the professional. Together these suggest that we take more seriously Weber's point of view in which it is the rationalization and objectification of work (and the world) and constraints on freedom that may lie closer to the heart of alienation. In this sense, we can see a *structural* move in the direction of Bentham's panopticon (Foucault, 1977, Leclercq-Vandelannoitte, 2014) as well as a fundamental modification (objectification) of human subjects/observers (Bourdieu, P. & Wacquant, 1992) that is becoming the source of professional alienation. Bureaucratic systems objectify raw materials, processes, and "human resources" and their meaningfulness becomes, as we have seen, more and more a *function of the system* in which they are a part, as opposed to meanings that could arise from elsewhere – from the individual professional or work group.

The heroes haven't gone away, although they [management] don't really admit it openly. At the same time, they do have these kind of quiet, covert almost, awards that go on, where, 'OK, if you pull this off and meet this particular goal, there's like a \$1000 bonus' or something – you know, the management awards. So, that still exists – a hidden layer.

– Systems Engineer at Defense Systems

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