

Giving Feedback to Engineers: A Systematic Review

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Abstract

The present signature project investigated the topic of giving feedback to engineers through a systematic literature review. This review found twenty-four articles on the topic of feedback where the subjects of focus were engineers. An interpretation approach was used to synthesize the evidence. The interpretation helped reveal themes of effects on performance, perceptions, validity, and opinions. A summary of the salient finding follows.

There are performance benefits when engineers receive non-threatening, constructive feedback. This occurs when engineers are able to engage in their own assessments, receive objective-oriented feedback, and receive personalized feedback. When engineers view feedback as sincere and constructive, they also perceive their performance appraisals to be more fair and accurate. In one study, a supervisor's knowledge of the subordinate's work, development of action plans related to performance weakness, and subordinate trust in supervisor, explained 42% of the variance in perceived fairness and accuracy. In addition to perceived fairness and accuracy, validity informs on actual fairness and accuracy. Supervisors that have more opportunity to observe an engineer's performance give appraisals that have greater validity. Organizations that have employees rated within the top tier or bottom tier of performance, and the race of employees also have implications for validity. The paper concludes with a discussion and recommendations for practitioners.

Giving Feedback to Engineers: A Systematic Review

In the profession of engineering, individuals and teams must understand complicated systems and consider a plethora of components and information in order to successfully perform their roles as designers and project managers. Designing and configuring large buildings, mechanical systems, or electrical distribution grids are complex tasks that have interrelated and critical components. It is easy to overlook details. Checks and reviews by a second engineer, or sometimes a second engineering team, mitigate risks associated with errors and omissions that could cause issues such as improperly sized components, safety hazards, or missed components.

Engineering managers must learn the skills to manage large-scale projects and their professional staff. There are various concerns that face engineering managers. Performance appraisals are a difficult task for engineering managers (Farris & Cordero, 2002), among others (Murphy & Cleveland, 1995). Another relevant issue is motivation. From a compilation of 41 articles published by the *Research-Technology Management* journal, Coates (2008) draws the conclusion that engineers do not respond to motivation in the same way that non-technical employees do. An engineering manager well informed on providing feedback should be better able to direct these complex tasks.

The current best thinking on feedback includes influential research and theorizing by Kluger and Denisi (1996). They completed a historical review and meta-analysis on the effects of feedback interventions on subsequent performance and they proposed a feedback intervention theory (FIT). The meta-analysis included 131 papers with a total of 12,652 participants and 23,663 observations. Their work showed an overall positive effect on

performance, but with large variability, and their FIT further informed on the construct of feedback intervention (FI).

The meta-analysis showed that feedback interventions have a positive, but variable effect on performance. The effect size was 0.4 of a standard deviation (Kluger & DeNisi, 1996). There was, however, large variability. In one third of the cases, feedback interventions reduced performance. In contrast to assumptions that feedback is good, we must recognize that feedback interventions can have positive, null, or negative effects on future performance (Kluger & DeNisi).

Kluger and Denisi (1996) proposed a FIT to explain the conflicting evidence found. Described simply, a key feature of the FIT involves FIs changing the subject's locus of attention among three hierarchal levels in the regulation of task performance. The three hierarchal levels from the top down are: meta-task processes involving the self, task-motivation processes involving the focal task, and task-learning processes involving the task details of the focal task. The subject usually directs attention to the middle on the focal task unless the FI causes a shift to a higher order or lower order. The test of the model was through a moderator analysis of their meta-analytic data. The moderator analysis provided some support for FIT. Many FI cues that seemed to change the locus of attention to meta-task processes attenuated FI effects on performance, whereas several FI cues that seem to change the locus of attention to task learning processes augment FI effects on performance. Kluger and Denisi concluded that there was support for the FIT model, but further research was needed.

Kluger and DeNisi (1996) also confirmed that although there has been much work done on feedback interventions there are many unanswered questions. For example, they had concluded that the nature of the task moderated FI effects but that the task properties that moderate FI remain poorly understood. Although FIT provides some practical guidance for managers, its unanswered questions and the complexities of engineering management form the basis of the present investigation into providing feedback to engineers.

Professional Engineers (engineers) rely on feedback during their work to modify such things as technical competency and professional behaviours. Given that public safety is at stake, technical competency of engineers is critical, and learning through feedback is necessary. Successful delivery of feedback is an inherent aspect of most work places, and engineering is no different.

Managers and peers can better provide feedback through an enhanced understanding and increased knowledge. The current state of academics and the best thinking on providing feedback to engineers can inform engineering managers in practice. A comprehensive review of existing evidence is also important for directing future research efforts. "When it is tough to determine what is known and what is not, it is even tougher to know what is important to know next" (Rousseau, Manning, & Denyer, 2008, p. 480).

The strategy and methods used for this signature project involved the execution of a systematic review and the synthesis of the evidence found. Systematic reviews use a framework to conduct a thorough and exhaustive search for the discovery of literature that answers a research question. The review also usually involves a synthesis of the evidence.

A systematic review is only as good as the protocol to carry out the review. A well-designed protocol helps to reduce bias and yield results that are more credible. A poorly designed systematic review may be no better than a literature (or narrative) review, which are prone to incorrect conclusions. In 1974 a Nobel Prize laureate doctor, after conducting a literature review, concluded that people should be getting 100 times more vitamin C than was being recommended. It was 30 years later when a systematic review was completed that the Nobel Prize winning doctor's conclusion was found to be incorrect due to the omission of fifteen articles (Bettany-Saltikov, 2010). The desire for better use of available evidence is at the heart of recent recommendations to conduct systematic reviews of management literature to support applied and scholarly work (e.g., Rousseau, Manning, & Denyer, 2008).

There are four methods of synthesizing evidence in a systematic review: aggregation, integration, interpretation, and explanation (Rousseau, Manning, & Denyer, 2008). To combine research; aggregation increases the sample size used to estimate effect size(s) and a meta-analysis is the typical method for aggregation syntheses (e.g., Kluger & DeNisi, 1996). Integration is the synthesis of evidence by comparing and contrasting results from different data collection methods. Interpretation involves looking at the results of articles, and generalizing them together into new themes or new ideas. This method attempts to tell the story of the research. The explanatory approach involves identifying casual mechanisms and how they operate (Rousseau, et al., 2008).

The synthesis of the evidence in this systematic literature review will use an interpretation approach. Whereas the Kluger and DeNisi (1996) meta-analysis focused on

aggregating evidence bearing on FI-performance effects across diverse settings, the present systematic review examined a broader array of evidence related to FIs within a particular professional group. The present systematic review compiled and synthesized available evidence relevant to the provision of feedback to engineers. The review uses a protocol to find literature relating to providing feedback to engineers. The protocol included a search strategy, inclusion and exclusion criteria for article selection, and quality assessment of articles.

The purpose of this signature project is to undertake a systematic literature review and synthesize the evidence available on providing feedback to engineers.

The research objectives were to:

- Learn to design and perform a systematic literature review
- Gather and synthesize available evidence on the topic of providing feedback to engineers
- Generate implications for practice based on the available evidence
- Identify potential directions for future research

Method

Systematic Literature Review

Searching Electronic Databases. The method of searching for evidence was the University of Prince Edward Island's electronic databases. UPEI's databases were accessible and include databases likely to reveal a sufficient amount of research on the topic to conduct a systematic literature review. While they may not contain all of the

available evidence, this approach contains a sufficiently comprehensive set of resources to serve as a basis for a signature project.

On December 5, 2010, a list of current databases available to UPEI students was made. To find articles a search was undertaken of the 166 electronic databases. The results of each search of the databases were tracked in a spreadsheet. The spreadsheet contained the recorded information: date of search, keywords used in the search, the number of potential articles found, and the number of articles considered relevant. Table 1 shows the setup of the spreadsheet. A search of each of the databases offered by the UPEI library for relevant articles was completed.

The database searches required a method to create a list of potential articles. The method used to search the databases was to break the topic into two components and use the best combination of search terms to return comprehensive results.

The two inclusion criteria for articles were that they had to include the concept of providing feedback *and* the study participants must be engineers.

For the concept of providing feedback, a search of the term feedback on its own found the synonyms used in a particular database. Through a process of trial and error, and using database tools, a list of synonyms was made for each database. The search terms were then used to look for matching keywords in the database articles. The “or” operator was used to incorporate synonyms. Thus, the first component yielded all articles in the database that related to the topic of providing feedback.

The search term engineer was then added with the “and” operator as a secondary full text search. Adding the full text search of the term engineer limited the search for

articles related to providing feedback to those articles that also had the word engineer appearing somewhere in the text. The term engineer is very specific and did not need synonyms.

Searching Review Lists. This method of searching with the two components of feedback and the term engineer yielded reasonably sized review lists. Each list was reviewed and sorted to include and exclude articles from the study based on the criteria described above. The list contained titles, abstracts, and citations. In some cases, the title provided enough information to determine if the article was relevant, otherwise it was necessary to read the abstract. When it was not obvious if an article should be included, a review of the full text was completed to make a determination.

Results

Table 1 shows the databases that yielded relevant articles and Appendix A shows the complete list of databases searched. The size of the review list ranged in size from 0 to 493 potential articles. Business Source Premier (BSP) had the largest number of potential articles (493), and BSP yielded the highest number of relevant articles (13), followed by PsycINFO (12). Many of these articles, however, overlapped such that only nine articles were unique to BSP and three to PsycINFO. The complete list of articles is included in Appendix B.

Table 1. Database search results showing databases yielding relevant articles

Database	Date Searched	Keywords	# of Articles in the Review List	# of Relevant Articles
Business Source Premier	24-DEC-10 26-DEC-10 29-DEC-10 30-DEC-10	Feedback (psychology), EMPLOYEES -- Rating of, EMPLOYEES --Coaching of, job evaluation	493	13
Academic Search Premier	16-Dec-10	Feedback (psychology), performance evaluation, employees -- rating of, Job evaluation, job performance, professional employees -- rating of, peer review	381	5
PsycARTICLES	5-Jan-10	Feedback, performance appraisal, job performance, personnel evaluation	104	4
PsycINFO	5-Jan-10	Feedback, personnel evaluation, peer evaluation	91	12
CBCA	2-Jan-10	Feedback, performance appraisal, management reviews	30	1
JSTOR	4-Jan-10	Feedback, performance appraisal, job evaluation	111	1
LISTA	4-Jan-10	Feedback (psychology), performance evaluation, peer review (professional performance), professional employee --rating of	2	1
SAGE Premier Collection	6-Dec-10	Feedback, performance appraisal	42	1

The systematic literature review resulted in 24 articles. The articles ranged in date from 1963 to 2009. Ten articles (42%) have been published since 1999. In the field, there were multiple works by some authors. John M. Ivancevich published four articles in the early eighties and a group of authors published three articles in 2001, 2007, and 2009. Examination of the extant literature revealed four broad themes used to organize the

discussion of findings herein. The four themes are performance, perceptions, validity, and information and opinions.

The performance of an engineering organization and the performance of its employees is an important topic as it is what drives most for-profit companies. Engineering performance is, of course, also relevant for effective public sector and non-profit projects. Performance measurements such as income, innovation, or efficiency can all be significant to a firm's success. Whereas performance can come from an employee's personal ambitions, the management practices of a firm also have an impact on employee's performance. Providing feedback to an engineer can affect employee performance, and thus is of interest to an engineering firm.

Employee perceptions with respect to feedback are important for an engineering manager to understand. After giving feedback, the perceptions an employee has can influence the employee's attitudes about the company and the manager. Feedback is often part of a personal interaction between a supervisor and an employee, and the employee's perception of their treatment, or their perception of the manager, may be more important to them than the validity of their appraisal. It is useful to be informed about employee perceptions of feedback given to engineers.

Validity was the topic most widely covered in the systematic literature review. The topic of validity included the following sub-themes: forced choice rating scales, management practices, two-tailed ratings, and inequality.

Six articles were found in which the authors offered informed opinions or useful information related to providing feedback to engineers. Informed opinions and case studies

can offer insight and help make sense of the evidence that is available. The opinions can add richness and flavour to the evidence presented in empirical research.

Feedback Effects on Performance

The systematic literature review revealed three articles that were directly related to the effects that feedback has on employee performance. The three articles were:

- Performance appraisal: Managers beware (Thompson & Dalton, 1970)
- A longitudinal study of behavioral expectation scales: Attitudes and performance (Ivancevich, 1980)
- The effects of goal setting, external feedback, and self-generated feedback on outcome variables: A field experiment (Ivancevich & McMahon, 1982)

Thompson and Dalton (1970) researched technology based companies and they recommend an objective-focused approach to performance appraisals. They argued that performance appraisals should be focused on a performance assessment against goals and offered three recommendations: 1) resist the temptation to devise one grand performance appraisal system to serve all management needs; 2) in providing feedback to the individual, use many kinds of feedback, and avoid zero-sum comparisons; 3) keep the company's approach to performance appraisal open and future-orientated (Thompson & Dalton, 1970).

Ivancevich (1980) found improved performance in engineers when the subject company they worked for switched to a behavioral expectation scale from a trait based scale. He measured attitudes about performance evaluation properties, job related tension, and scheduling performance. After a twenty-month period, the ratees showed improvement on scheduling performance, as well as the other two measures.

Ivancevich and McMahon (1982) investigated seven outcomes on six groups of different combinations of goal setting and feedback. The six groups were: goal setting and supervisor feedback; goal setting, supervisor feedback and positive praise; goal setting and self-generated feedback; co-worker feedback; no goal setting; and no formal feedback. Findings from the Ivancevich and McMahon study, along with those noted above, are described below with respect to common themes that were identified.

Non-Threatening (Constructive) Feedback. Two of the three articles that examined effects of feedback on subsequent performance provided support for a non-threatening type of performance appraisal. Consistent with FIT (Kluger & DeNisi, 1996), findings suggest that care must be taken not to shift the engineer's locus of focus from the focus task to a higher order level of meta-task processes involving the self. Thompson and Dalton (1970) said that the performance appraisal is one of the most emotionally charged business activities, and it has a strong impact on an employee's self-esteem and on "his" subsequent performance. They argue that companies should avoid peer comparisons and rankings amongst employees. They refer to this as a zero-sum game. Ivancevich and McMahon's (1982) research found that employees who used self-generated feedback had higher performance levels than the group who received external feedback.

There was also evidence provided by Ivancevich (1980) regarding the use of behavioural expectation scales (BES) and better performance. Ivancevich found that when the subject company used BESs, engineers showed significant improvement in the task, scheduling performance, compared to when the traditional trait system was used. In a trait

evaluation system the manager rates the employee on a list of characteristics instead of on specific behaviours.

Self-Generated Feedback. The evidence supports the idea that self-generated feedback by engineers will lead to higher performance (Ivancevich & McMahon, 1982). If a scale is constructed with direct supervisor feedback at one end, self-generated feedback at the other end, and participative feedback in the middle, then the research would support using feedback that is more to the self-generated end of the spectrum when a manager is trying to achieve improved performance.

Performance improvements were found when feedback was given to an engineer in a participatory fashion or when the engineer was enabled to self-assess (Ivancevich & McMahon, 1982). The performance improvements included costs control, quality control, and scheduling. Ivancevich and McMahon also found associated attitudinal improvements with the performance improvements. The research in which self-generated feedback and participative feedback was used (Ivancevich & McMahon; Thompson & Dalton, 1970) showed improved performance by engineers.

Ivancevich and McMahon (1982) considered groups with no feedback, supervisor feedback, and self-generated feedback along with goal setting and their effects on performance and attitudinal outcomes. The groups that received feedback showed greater performance than the groups that did not received feedback. The groups that received some form of feedback showed increased performance on the performance outcomes of controlling costs and unexcused overtime and on the attitudinal outcome of organizational commitment. The group which received self-generated feedback and goal setting showed

more dramatic results with increased effects on five of the seven outcomes: control costs, quality control, unexcused overtime, intrinsic satisfaction, and organizational commitment (Ivancevich & McMahon). These results by Ivancevich and McMahon support the use of self-generated feedback to support performance improvements.

This evidence is further supported by two case studies by Hessami and Moore (2007), and McCuddy and Griggs (1984) who recommend the use of self-generated feedback or participative feedback, respectively. Hessami and Moore's opinion was presented in the context of a case study of how a performance appraisal system might be framed. Their system involved assessing an engineer's competence by having the engineer respond to a series of queries as to whether they are meeting a predetermined industry standard. The engineer would respond to indicate if they were meeting criteria set by an industry standard for their job, and they would provide evidence of how they felt the criteria were being met. The result was a list of criteria with an associated "achieve or did not achieve" indication with supporting evidence.

McCuddy and Griggs (2004) presented a case study in which engineers used participative feedback to achieve a reduction in errors and missed project completion dates. The case study was of an engineering firm that produces custom products such as truck bodies and vans. After a control period of several weeks, the managers began meeting with the project engineers to set goals and provide participatory feedback. The manager and engineer would meet to discuss the previous weeks work, set completion dates for new projects, and discuss any other issues that may have arisen during the week. After twenty weeks, they had achieved a reduction in weekly errors and a reduction in the number of

deadlines missed. The performance improvement was maintained for at least one year after the commencement of the study.

Future Orientated Feedback. The evidence supports a future orientated approach to feedback for improved performance (Ivancevich & McMahon, 1982; Thompson & Dalton, 1970). The nature of future orientated feedback involves goal setting with employees in reference to performance appraisal and not criticizing past work. Kluger and Denisi (1996) suggested that negative feedback (criticism) may cause the individual to shift attention to the meta process of the self and reduce performance. Feedback that has a future orientation or includes goal setting may lead to improved performance.

Thompson and Dalton (1970) warned performance appraisal managers to beware of the consequences of some evaluation and feedback procedures that produce discouragement, cynicism, and alienation. They were referring to peer comparison systems. In their studies of technology-based companies, they found that while each company has its own circumstances, there are three general guidelines that they recommend, one of which is to maintain a future-orientated performance appraisal approach. They warn that managers should not foreclose future possibilities for the growth of an employee. They refer to this as an objective-focused approach. Thompson and Dalton's warnings about performance appraisals and their guidelines to keep them future orientated are in line with the opinions and findings of other authors (i.e., (Ivancevich & McMahon, 1982)).

The research by Ivancevich and McMahon (1982) indirectly supports the position of keeping feedback future oriented. They found that when feedback was combined with goal

setting, there was an improvement in performance. That is, the addition of goal setting to a feedback or performance appraisal process orients the appraisal toward future performance. A goal cannot be set for past work, and can only be created for what is to come. The work by Ivancevich and McMahon therefore provides indirect support for future orientated feedback being more constructive for improved performance.

In the case study by McCuddy and Griggs (1984), managers met with engineers on a regular basis and set goals for future work. This program led to reduced errors and fewer missed deadlines. On a weekly basis, managers met with engineers, discussed their work, and set goals for the upcoming week. This worked to keep the feedback meetings future orientated. The results of this case study by McCuddy and Griggs are in line with the recommendations of Thompson and Dalton (1970); and the engineers' performance improved in this study.

The evidence in these articles either directly or indirectly lends support for future-orientated feedback being constructive for improved performance. Thompson and Dalton (1970) recommended as a guideline that feedback and evaluations be kept future orientated. The work by Ivancevich and McMahon (1982), and McCuddy and Griggs (1984) indirectly support this approach with the successful inclusion of goal setting with feedback to improve performance. Future orientated feedback is therefore an approach that when used may lead to increased performance in employees who are engineers.

Individual Feedback. There is no “one size fits all” when it comes to feedback that will improve performance. The evidence found in the systematic review supports the individualistic approach to performance appraisals (McCuddy & Griggs, 1984; Thompson

& Dalton, 1970). When engineers met with their supervisors for a participative appraisal, or when they self-assessed, the results were favourable for performance. A consistent theme that emerged in the relevant literature was that favourable results were observed when engineers met with their supervisors and discussed their performance and their goals.

In the article by Thompson and Dalton (1970), there were three guidelines recommended for engineering supervisors. One was to keep feedback future orientated and the other two were related to providing individualistic evaluations. The two guidelines related to providing individualistic evaluations were to resist the temptation to devise one grand performance appraisal system to serve all management needs, and in providing feedback to the individual to use many kinds of feedback, and avoid zero-sum comparisons (Thompson & Dalton). They argued that if two employees were doing different tasks, then a single rating system or a comparison of the two employees requires the manager to inappropriately rank one against the other. They may require different strengths for their positions, or one may serve a different purpose on the team. Engineers may also require different counselling depending on where they are in their careers. Based on their research, Thompson and Dalton recommended an individualistic approach to evaluations to avoid the possible negative consequences of discouragement, cynicism, and alienation.

The evaluation method that McCuddy and Griggs (1984) used, which achieved their performance outcomes, also involved an individualistic approach. Managers met on a weekly basis to discuss the projects that each project manager had in his portfolio. The projects managers were given goals based on their discussions with the manager. This

approach is consistent with Thompson and Dalton's (1970) recommendation to avoid a one-size-fits-all appraisal system.

Rating Scales. The systematic literature review also uncovered an article by Ivancevich (1980) that investigated the effects of a behavioural expectation scale performance evaluation system on ratee attitudes and performances compared to performance appraisals done based on traits. The subjects were 249 engineers, half of whom were evaluated using the BES system and the other half were evaluated with the traditional trait system. There were five attitude outcome measures: attitudes about selected performance evaluation characteristics, job related tension, job satisfaction, organizational commitment, and internal motivation. There were also three objective performance measures: cost over-runs, scheduling, and grievance rate. Over a period of 20 months, the engineers evaluated with the BES system showed more improvements in attitude and performance than those evaluated with the trait system (Ivancevich). The engineers showed significant performance improvements in scheduling but not on the other two dimensions of cost over-runs and grievance rate although they were no worse on those dimensions. They also showed improvement in attitudes about equity, meaningful feedback and clarity, and a significant reduction in job related tension.

Summary. The primary interest behind this literature review was to study the psychological and performance effects of providing feedback to Professional Engineers. Although there were only three articles found in the systematic literature review related directly to feedback's effects on performance, some insights were identified in that regard. The use of non-threatening or constructive feedback is the most salient finding. When

engineers are able to engage in their own assessments, receive future-orientated feedback, and receive personalized feedback, performance benefits are reported. Ivancevich and McMahon (1982) found a dramatic improvement in the performance of engineers who were involved in goal setting and self-generated feedback on the dimensions of control costs, quality control, and unexcused overtime. Based on their research, Thompson and Dalton (1970) have recommended avoiding the temptation to make one grand performance appraisal system for all, avoiding zero-sum peer comparisons, and keeping the company's approach open and future oriented. Both of these findings are supported by the opinions of McCuddy and Griggs (1984), and Hessami and Moore (2007) in their case studies.

It is somewhat disappointing that only three of the twenty-four articles related directly to effects of feedback on engineers' performance. Well over half of the articles related to reliability and validity, or perceptions of reliability and validity of performance appraisals. Research in those domains is discussed below.

Perceptions

The systematic literature review identified two articles that investigated the perceptions of engineers in the feedback process. The two distinct articles informed on perceptions of fairness and accuracy, subordinate feedback perceptions, and peer mentoring perceptions. The two articles were:

- Trust-in-supervisor and perceived fairness and accuracy of performance evaluations (Fulk, Brief, & Barr, 1985)
- Impact of peer mentor training on creating and sharing organizational knowledge (Bryant & Terborg, 2008)

Path Model of Perceived Fairness and Accuracy. Fulk, Brief, and Barr (1985) developed a path model of three correlates to explain perceived fairness and accuracy of performance evaluations. In a study of 198 research and development engineers, they found that supervisor's knowledge of the subordinate's work, development of action plans related to performance weakness, and subordinate trust in supervisor explained 42% of the variance in perceived fairness and accuracy.

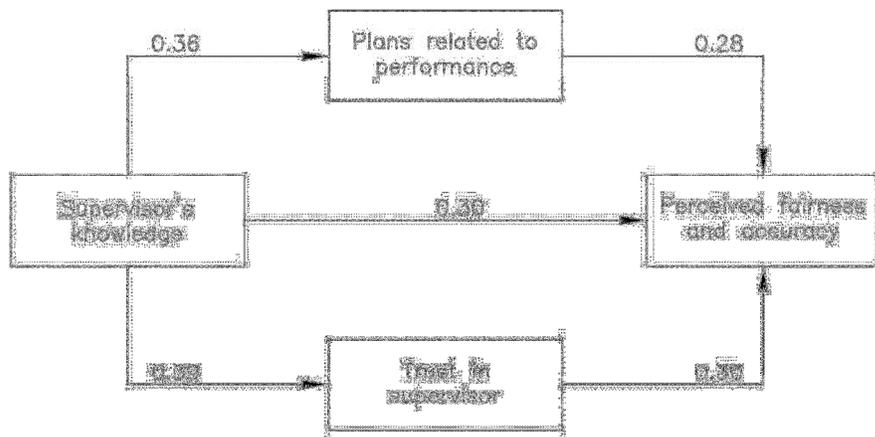


Figure 1. Fulk, Brief, and Barr's (1985) Path Model of Perceived Fairness and Accuracy

As shown in Figure 1, plans related to performance and trust in the supervisor are part of paths from supervisor's knowledge to perceived fairness and accuracy. Fulk et al. suggested that these three correlates might be viewed as representing a sincere and constructive orientation to the performance evaluation process. They appear to tap the processes which characterize the actual dyadic interaction in the appraisal (Fulk, et al.). The path model helps to explain the engineer's perceived fairness and accuracy of their appraisal.

Peer Mentoring. Bryant and Terborg (2008) found that higher perceived levels of peer mentoring competence contributed to higher perceived levels of knowledge creation and sharing, and peer mentor training increased perceptions of the individuals' peer mentoring competence. The study was completed with 502 employees in a software engineering firm. All of the participants were employed in knowledge-intensive jobs, but they were not all engineers. The proportion of engineers in this study is unknown. This research implies that engineers who provide feedback through peer mentoring will contribute to a perceived increase in knowledge creation and sharing and that peer mentor training will enhance this perception.

Summary. The two distinct articles provided information on ratee perceptions of fairness and accuracy, subordinate feedback perceptions, and peer mentoring perceptions. Supervisors' knowledge of a subordinate's work, development and action plans related to performance weakness, and subordinate trust in supervisor explained 42% of the variance in an engineering employees perception of fairness and accuracy of performance appraisals (Fulk, Brief, and Barr, 1985). Peer mentoring competence contributes to a higher perceived level of knowledge creation and sharing (Bryant & Terborg, 2008).

Validity

Whereas perceptions are the employee's opinion of the feedback, validity is grounded in the pursuit of accurate measurement. Nine articles provided information on the topic of validity or related measurement issues (e.g., reliability; rater errors or biases). Validity was divided into the following themes with the number of articles for each: forced

choice rating scales (2), management practices (2), two-tailed ratings (2), and inequality (3).

The titles of the articles found were:

- Development of a forced-choice rating scale for engineer evaluation (Lepkowski, 1963)
- Longitudinal study of the effects of rater training on psychometric error in ratings (Ivancevich, 1979)
- Fakability and the engineer performance description form (South, 1980)
- Contrast effects in performance evaluation and reward practices (Ivancevich, 1983)
- Why do employers only reward extreme performance? Examining the relationships among performance, pay, and turnover (Zenger, 1992)
- The moderating effect of raters' opportunities to observe ratees' job performance on the validity of an assessment centre (Moser, Schuler, & Funke, 1999)
- Favoritism, bias, and error in performance ratings of scientists and engineers: The effects of power, status, and numbers (Smith, DiTomaso, Farris, & Cordero, 2001)
- Effects of structural position on allocation and evaluation decisions for scientists and engineers in industrial R&D (DiTomaso, Post, Smith, Farris, & Cordero, 2007)
- Sources of differences between Chinese, Indian, and Caucasian scientists and engineers: Evaluations of managerial potential (Post, DiTomaso, Farris, & Cordero, 2009)

Forced-Choice Rating Scales. Forced-choice rating scales (FCRS) were found to be both reliable and somewhat fake-able in the literature that was available. Two studies

were found that informed on FCRS. Lepkowski (1963) studied 33 electronic engineers to test the reliability of the FCRS. South (1980) looked at the ability of engineering managers to give fake scores on the engineer performance description form (EPDF) which was a FCRS. Neither of the two studies provided the evaluative devices that were used.

Lepkowski (1963) had 33 supervisors of electronic engineers' rate them using two evaluative devices. One device was a FCRS and the other was the Merit Appraisal Scale (MAS). Each was tested with the split-half method and the scores from the FCRS were correlated with the scores from the MAS. The FCRS that was developed proved to be reliable ($r=0.9$) (Lepkowski).

South (1980) provided his subjects with the EPDF and the subjects were given instructions to score as highly as they could ($n=43$) or as poorly as they could ($n=54$). The subjects who were asked to rate highly were able to provide scores 6.85 points higher than the mean of 17.5 on a 35-point scale. The subjects who were asked to rate poorly were able to provide scores 6.39 points lower than the expected mean of 17.5 on a 35 point scale (South). They were not, however, able to predict how high or low they were able to fake the scores. Therefore, they were able to fake the EPDF forced-choice rating scale, but not to the extent they thought they could.

Management Practices. Two management practices that can improve the validity of performance appraisals are present in the literature. From two articles, we are informed that continuous training of raters can reduce halo and leniency error, and an increased opportunity to observe raters also increased validity. These two management practices were offered by Ivancevich (1979), and Moser, Schuler, and Funke (1999).

In Ivancevich (1979), sixty-six supervisory engineers were found to have less halo and leniency error for a period after training. Ivancevich assigned his subjects to three groups: 1) an intense training group, 2) a discussion group, and 3) a control group. The three groups were tested before training, six months after training, and twelve months after training. Ivancevich found that the group that received intense training showed reduced halo and leniency error six months after training but that the improvements in halo error diminished after twelve months. The discussion group showed improved halo error only after six months, and it diminished after twelve months. The control group showed no change. These results imply that adequate training and yearly refresher courses are required to reduce halo and leniency error in performance appraisals by supervisors.

It is important to note here that it is now believed that halo and leniency error are poor surrogates for direct measures of rating accuracy. Murphy and Cleveland (1995) gave two reasons: 1) the true distribution of performance is almost never known, and 2) empirical research has shown ratings with more favourable “error” indices are not necessarily most accurate.

Managers must be aware that raters’ opportunity to observe ratees’ performance is a moderator to validity. Moser, Schuler, and Funke (1999) compared ratings of 155 engineers and applied scientists in a research and development department to an assessment center of trained psychologists. They found that opportunity for a supervisor to observe a ratee’s performance was a moderator to validity. For example, when a supervisor had less than two years to observe a ratee’s performance, the validity was $r = 0.09$, and for two

years, the validity was $r = 0.50$. The supervisors were not able to assess an employee's performance well within the first two years of their role as the employee's supervisor.

Two-Tailed Ratings. Two articles dealt with performance appraisal validity of employees whose performance was in the top percentile or bottom percentile of employees. The first study, by Ivancevich (1983) looked at evaluations of 104 supervisors of 624 engineers in a research and development division. He found that when, in the opinion of the supervisor, the supervisor managed a prevalence of poor performers, he or she would rate the other employees more favourably. The attitudes and the ineptness of the poor performers were most responsible for creating this favouritism (Ivancevich). The few employees that were rated as the poorest employees in the areas of attitude and ineptness had effects on the rating of the other satisfactory employees. It is also notable that Ivancevich conducted the same analysis for scientists in the same company and found no such effect.

Zenger (1992) found that employees who were rated at the extremes of either higher performers or lower performers were compensated at rates higher or lower than the majority of employees. Two large technology companies with a combined total of 984 engineering employees were the subjects in this study. For the majority of employees, there was little distinction made among rates. The employees that were not rated at the extremes were lumped together with little distinction between them. Zenger called for the need for finer rating distinctions among the employees who are not in the extremely high or extremely low tails.

This focus on the extremes also had implications on turnover rates (Zenger, 1992). Employees who rated as extremely high or moderately low had lower turnover rates. The employees in the extremely low or moderately high groups had higher turnover rates. The moderately low employees were those that were rated within the majority of average performers, but who were below the average and the moderately high were those that were slightly above average. The focus on extremely high performing employees was at the expense of many moderately high performing employees. Zenger claims that moderately high performing employees are unhappy because the upper echelon seems unattainable to them, and they feel undervalued as compared to the moderately low performers who receive similar compensation. Zenger does not directly tie this occurrence to the need for finer distinctions amongst the moderate employees. However, we can speculate that finer distinctions may reduce turnover rates among the moderately high performers.

The evidence found in the present systematic literature review informs that there is reason to pay closer attention to ratings of extremely high and extremely low rated employees. When a supervisor has a prevalence of poor performers, he or she will rate the other employee more favourably. In organizations that offer performance pay, managers reward top performers at higher rates, and low performers at lower rates than the majority of employees, while the mid-performers were rewarded with little distinction made among them. Managers of organizations who have two tails of employees require careful consideration to avoid overly favourable ratings and the loss of moderately highly-rated employees.

Inequality. The most recent research found during the systematic literature review investigated potential inequalities in appraisals of engineers who are of Caucasian, Indian, Chinese, and African-American descent. The studies were by a common group of authors: (Smith, DiTomaso, Farris, & Cordero, 2001), (DiTomaso, Post, Smith, Farris, & Cordero, 2007), and (Post, DiTomaso, Farris, & Cordero, 2009). (Note: these authors used the term whites and blacks, where I have used Caucasian and African-American). The articles had similar outcomes and it is relatively easy to synthesise the results.

Inequality means that one or more group is not receiving valid ratings in comparison to another. Groups may be rated as more favourable or less favourable by raters. Generally, the authors found that in the US, where these studies were conducted, Caucasians were given more favourable ratings than the other groups. They occupied a prototypical role as the image of how an employee should be. With the exception of African-American women and Indians who received inordinately low evaluations, minority groups received indifferent evaluations, meaning they received average ratings.

Smith, DiTomaso, Farris, and Cordero (2001) and DiTomaso, Post, Smith, Farris, and Cordero, (2007), used the variable of innovativeness and promotability into management, and Post, DiTomaso, Farris, and Cordero, (2009) used promotability into management only. Table 2 provides a summary of whether the groups in each investigation receive favourable (+), unfavourable (-), or indifferent (l) ratings on the variables technical (t) and management promotability (p).

In both the technical dimension of innovativeness and promotability into management, Caucasians generally received favourable ratings. They were considered the

prototypical competent employee and were rewarded as such, with the exception of Caucasian women who may be rated unfavourably or indifferently on innovativeness. If the Caucasian person was not US-born however, they tended to be rated indifferently.

The results for Asians were not consistent, but themes did emerge that inform on their position. Chinese-Asians have a high proportion of Ph.D.'s, and are seen as having technical competence, but they are not considered to have high social competence. It might be expected that Asians would be rated more favourably on technical competence and lower on management promotability. This was the case in Smith, DiTomaso, Farris, and Cordero (2001), but in DiTomaso, Post, Smith, Farris, and Cordero, (2007), Asians were treated with indifference on both dimensions. This may be due in part because Chinese and Indians were considered Asians and not considered separately in Smith, et al., and DiTomaso, et al.,. In Post, DiTomaso, Farris, and Cordero (2009), Indians and Chinese were considered separately. In Post, et al., Chinese were rated indifferently on promotability and Indians were rated unfavourably.

For African-Americans, employee rating varied by sex. In Smith, DiTomaso, Farris, and Cordero (2001), African-Americans were rated unfavourably on the technical dimension and indifferently on management promotability. In DiTomaso, Post, Smith, Farris, and Cordero, (2007), however, when ratings of African-American men and African-American women were investigated separately, the African-American men were rated with indifference, but the African-American women were rated unfavourably on the technical and management promotability dimensions.

The findings of Smith, DiTomaso, Farris, and Cordero (2001) also indicated that minority groups overshot in their ratings of others. They were likely to rate Caucasians more favourably and other minorities unfavourably. Asians were found to give African-Americans less favourable ratings on management promotability, and likewise African-Americans were found to give Asians less favourable ratings.

Table 2. Summary of groups for technical ratings and managerial promotability

(Smith, et al., 2001)		(DiTomaso, et al., 2007)		(Post, et al., 2009)	
Group	Rating	Group	Rating	Group	Rating
Caucasians	+t +p	US born Caucasian men	+t +p	Caucasians	lp
Asians	+t -p	non-US born Asian men	lt lp	Chinese	lp
African-Americans	-t lp	US born African-American men	lt lp	Indian	-p
Women	-t lp	US born Caucasian women	lt +p		
		US born African-American women	-t -p		
		Other non-US born	lt lp		
		non-US born Caucasian men	lt lp		

Note: favourable (+), unfavourable (-), indifferent (l), technical (t), management promotability (p)

In summary, these three studies inform on the inequalities of performance appraisals between groups. Caucasian groups enjoyed favouritism as they are seen as prototypical employees. In most cases, minorities were treated with indifference except for Indians who seem to be rated more critically than Chinese. African-American women are the most

disadvantaged, being rated unfavourably on both technical proficiency and management promotability.

Summary. The topic of validity was the most widely covered in the literature. Nine articles were found and synthesised into the themes of forced-choice rating scales, management practices, two-tailed ratings, and inequality. The researchers provided information on some management practices that are beneficial to improving validity and some of the validity errors that can arise.

Information and Opinions

As discussed previously, the opinions provided support for the idea of keeping feedback future orientated and to include goal setting. Three of the authors recommended making use of goals to align an engineer's future work with the company's objectives (Boyes, 2000; McCuddy & Griggs, 1984; Varhol, 2000). In a case study of an engineering department where managers were struggling with scheduling and quality errors, McCuddy and Griggs showed how having weekly meetings with project managers to provide feedback and set future goals reduced errors. Boyes, through an interview with a HR consultant, recommended that employers discuss company objectives with the engineer and ensure that the employee's goals align with those of the company. The consultant argues that aligning the employee's goals with those of the company provides a frame of reference for the employee and also lets the employee know that it is not about who the manager likes or dislikes but what is best for the company. Varhol looked at performance appraisal from a different perspective, but ultimately offered a similar recommendation. Varhol looked at the appraisal from the perspective of the employee preparing for an appraisal. He

recommended that the engineer think about the goals that would be most appropriate for himself or herself and be prepared to discuss them with the employer. The three opinions stress the importance of the engineer and the employee engaging in an objective focused, or future orientated approach.

Three of the articles also recommended an approach that involves self-assessment or a participatory approach, which is consistent with the evidence. McCuddy and Griggs (1984), Hessami and Moore (2007), and Varhol (2000) included a form of engagement between the engineer and supervisor. McCuddy and Griggs used weekly meetings between the engineer and the supervisor to discuss the engineer's performance in an open manner and, as a result, they realised a performance improvement. Varhol urges engineers to prepare a self-assessment of what they have accomplished since their last performance review in advance of meeting with their supervisor, and Hessami and Moore proposed an evaluation system where the engineer self-assesses against a set of predetermined occupational standards. These recommendations are aligned with the evidence that suggest that when engineers are able to self-assess or participate in their feedback, there is a performance benefit.

Rating Systems. Two rating systems were found in the literature that measured an engineer's overall rating and motivation to work. The overall rating system was developed by Radu, Pitariu, and Czitrom (1972) and was developed for Romanian engineers. The motivation to work scale was developed by Landy and Guion (1979). It is worth noting here that motivation to work is not necessarily the same thing as job performance.

Williams and Seiler (1973) found support for discriminant validity between an engineer's motivation to work and job performance, however the evidence was not conclusive.

Table 3. Radu et al.'s six weighted variables for performance appraisals of engineers

No.	Variable	Weight
1	Quantitative efficiency	16%
2	Quality of work	18%
3	Professional competence	
	a) Information	9%
	b) Experience	9%
	Special traits	
	c1) Analytical and critical sense	6%
	c2) Methodical sense	5%
	c3) Thoroughness and self-control	5%
	c4) Originality	5%
	c5) Self-exigence in work	2%
4	Relation with his group	5%
5	Leadership and organizing ability	10%
6	Social professional attitude	10%
		100%

The motivation to work scale was based on seven dimensions that used behavioural scales, and it was designed to be used by peers. The rating tool had inter-rater reliability that was considered adequate to use. The seven dimensions were: 1) team attitude, 2) task

concentration, 3) independence/self-starter, 4) organizational identification, 5) job curiosity, 6) persistence, and 7) professional identification. The behavioural scales were provided in the article and may be of use to supervisors who do not already have such a scale.

Radu, Pitariu, and Czitrom (1972) developed a performance appraisal rating system for Romanian engineers. The system was developed in response to a law that required all socialists working for industrial units and institutions of Romania to be evaluated annually. The objective of the rating system was to control systematic error as much as possible and to provide an overall judgement about the employee and an analytic profile with ratings for different dimensions (Radu, et al.). The appraisal system included six weighted variables (shown in Table 3) that were best able to explain the engineer's performance.

Discussion and Advice

There is plenty of evidence available to managers providing feedback. This systematic review looked at the evidence that was available on providing feedback to engineers specifically. The body of literature is reduced significantly when the subjects are limited to engineers. While much of the general literature might apply to engineers, there are differences. Ivancevich (1983) found that the greater the pervasiveness of poorer performers in an organization, the more favourable was the ratings for satisfactory engineers, but he did not find the same effect for scientists. Even though scientists and engineers both work in highly technical professions, both groups may not behave equally. Engineers also have perceptions of how they feel about their performance. Zenger (1992) reports that among 714 engineers surveyed, 32 percent in company A and 42 percent in company B placed their performance in the top five percent relative to their peers

(engineers) in Company A or B (Zenger). The evidence found in the systematic literature review is useful in explaining any differences that exist in providing feedback to engineers.

The literature provides some insight into providing feedback in terms of performance, validity, and perceptions. Evaluations should be done with an objective focused approach. Feedback should be kept future orientated through participative goal setting with the engineer. To assess an engineer's past performance, they can be allowed to self-assess their performance against past goals. If the goals were quantitative this may be easy, but if the goals were subjective it may be harder, especially if the supervisor needs to make pay adjustment decisions based on the evaluation. While the research does not provide evidence on the validity of engineers self-assessing their performance, forced-choice rating scales and behaviour expectation scales may be useful in conjunction with occupational standards to set up rating scales that the engineer can be given to assess their own performance. This practice of allowing engineers to self-assess their performance may be new for managers. While a survey of civil engineering companies was silent on self-assessments, it determined that 91% of engineers were receiving feedback from their direct supervisors (Shah & Murphy, 1995).

If engineers are not self-assessing, then supervisors can benefit from a few management practices to keep their evaluations higher on validity. When a supervisor-employee relationship is new, the research shows that in the first two years it is more difficult for a supervisor to rate an employee. The evidence points to validity increasing with the supervisor's opportunity to observe, and as such, validity may be suspect in the first two years. There is therefore a need for concerted efforts on behalf of the supervisors

to observe performance, understand performance standards, and develop as performance managers during that initial period.

Supervisors must exert an effort to eliminate the gap between Caucasians and minority groups. The evidence implies that minority groups are rated indifferently while Caucasians are rated more favourably. This is with the exception of African-American women who are disadvantaged in both technical and management promotability ratings. Whenever possible, supervisors should review objective data to ensure that ratings given to different groups are fair.

Table 4. Number of men and women subjects (for studies that reported)

Study	# Subjects	# Men	# Women
(Ivancevich & McMahon, 1982)	209	192	17
(Ivancevich, 1983)	104	89	15
(Fulk, et al., 1985)	198	196	2
(Moser, et al., 1999)	155	150	5
(Smith, et al., 2001)	3,163	2,776	387
(Herold & Fields, 2004)	136	128	8
(DiTomaso, et al., 2007)	2,202	1,696	506
(Bryant & Terborg, 2008)	502	320	182
Total	6,669	5,547	1,122

Gender

It is important to note that men dominate the engineering profession. The research presented here would have been completed predominately on men. Many of the studies in the earlier years refer to the subjects as “the men”. Table 4 lists the studies that reported the gender of the participants and the number of each gender. Of the studies that reported the gender of their subjects, (8 studies of 24), 83% were men. Before these results can inform decisions in a company, the manager should consider the gender of the workforce. While women did represent approximately 1/5 of the participants, it may not be valid to generalise the findings to a more modern workforce that has a larger percentage of women engineers.

Limitations and Cautions

A reader who is developing a performance appraisal program must be cautioned that this systematic review considered evidence that related to feedback given to engineers and included only cursory discussions of the broader topic of feedback (i.e., Kluger & DeNisi, 1996). There is a much larger body of evidence available on feedback, or more specifically performance appraisals, that is applicable to different subjects. A search of the subject term feedback (psychology) in the database PsycINFO resulted in 6,452 hits, and limiting the same search with the text engineer reduced the results to 10 hits. The evidence compiled in this review is a smaller population of what is available. It is not meant to provide sufficient information to develop a performance appraisal program.

The studies on inequality may not be generalizable due to cultural differences. The three studies on inequality were conducted in American companies. Cultures are different

across different countries. The culture of Americans is different from the culture of Canadians. For example, according to Geert Hofstede, Americans have one of the highest individualistic ratings in the world with a 91 while Canadians have an individualistic rating of 80 (ITIM, 2011). With a higher individualistic culture, the American groups in the study may behave differently than groups in Canada would. Therefore a caution should be made when using the results of the studies on inequality in a Canadian organization.

Future Work

Ivancevich and McMahon (1982) found dramatic results with the combination of self-generated feedback and goal setting. A case study presented a method for engineers to self-assess their performance; however there was no work of an empirical nature to investigate the validity of self-assessments by engineers. It is necessary to review literature to determine what evidence is available for the topic of self-assessments. Once a better understanding of self-assessments and validity is in hand, one can apply the information to engineers.

Key Recommendations for Practice

- Use goal setting with feedback and make feedback objective-oriented.
- Provide an opportunity for engineers to participate in their own assessment of past performance. One possible way to do this is against established standards.
- Managers should use comparison ratings with caution. Distinctions among employees may be necessary so higher-performing employees feel their performance is valued in comparison to employees who do not perform as well. However,

comparisons that create winners and losers can demoralize an employee and have negative impacts on performance.

- In the first two years of an employee's employment, the supervisor responsible for appraisal needs to make a concerted effort to observe performance, understand performance standards, and develop as a performance manager.
- Supervisors must exert efforts to eliminate the gap between Caucasians and minority groups and thereby make assessments on performance-relevant factors.

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Appendix A. Table of Systematic Literature Review Results

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Abstracts in Anthropology	15-Dec-10	Feedback	1	0
Academic Collection Complete (ebrary)	15-Dec-10	Feedback, rating of, job evaluation	19	0
Academic Search Premier	16-Dec-10	Feedback (psychology), performance evaluation, employees -- rating of, Job evaluation, job performance, professional employees -- rating of, peer review	381	5
ACS Web Editions (American Chemical Society)	24-Dec-10	Feedback, performance appraisal	2	0
Agricola (via National Agricultural Library) [Public Access]	24-Dec-10	Feedback, performance appraisal	0	0
Agricola via CSA (1970-)	24-Dec-10	Feedback, performance appraisal	16	0
ALPSP Learned Journals Collection - See Learned Journals Collection	24-Dec-10	Feedback, performance appraisal	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
America: History and Life (Canada and US history)	24-Dec-10	Feedback, performance appraisal	0	0
Annual Review of Anthropology	24-Dec-10	Feedback, appraisal, performance, review	10	0
Annual Review of Political Science	24-Dec-10	Feedback, appraisal, performance, review	10	0
Annual Review of Psychology	24-Dec-10	Feedback, appraisal, performance, review	10	0
Annual Review of Sociology	24-Dec-10	Feedback, appraisal, performance, review	10	0
Annual Reviews	24-Dec-10	Feedback, appraisal, performance, review	10	0
Anthropological Index Online	24-Dec-10	Feedback, appraisal, performance	0	0
Aquatic Sciences & Fisheries Abstracts - Pt. 1 (ASFA-1)	24-Dec-10	Feedback	1	0
arXiv.org	24-Dec-10	Feedback	0	0
ATLA Religion Database with ATLASerials	24-Dec-10	Feedback (psychology), performance evaluation, job evaluation	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Atomic Learning	24-Dec-10	Dead Link	0	0
BioOne	24-Dec-10	-	0	0
BioOne Abstracts and Indexes (via CSA)	24-Dec-10	-	0	0
BIOSIS Previews	24-Dec-10	Feedback, behavioral sciences	3	0
Blackwell Synergy -- See Wiley InterScience	24-Dec-10	Dead Link	0	0
Books in Print (Bowker's Global Books in Print)	24-Dec-10	-	0	0
Business Source Premier	24,26,29,30D EC-10	Feedback (psychology), EMPLOYEES -- Rating of, EMPLOYEES --Coaching of, job evaluation	493	9
CAB Abstracts	2-Jan-10	Performance appraisal, job performance	3	0
Cairn	2-Jan-10	-	0	0
CAIRSS for Music	2-Jan-10	Dead Link	0	0
Canadian Census (via CHASS)	2-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Canadian Institute for Historical Microreproductions (CIHM)	2-Jan-10	-	0	0
Canadian Labour History Bibliography	2-Jan-10	-	0	0
Canadian Music Periodical Index	2-Jan-10	-	0	0
Canadian Patents Database	2-Jan-10	-	0	0
Canadian Poetry Archive	2-Jan-10	-	0	0
Canadian Publishers Collection	2-Jan-10	Feedback (psychology), job evaluation, executives --training of, employees --rating of, leadership evaluation, executive coaching, employee --coaching of	29	0
CANSIM - Canadian Socio-Economic Information (via CHASS)	2-Jan-10	-	0	0
CANSIM - Canadian Socio-Economic Information (via E-STAT)	2-Jan-10	-	0	0
CBCA Business, Current Events, and Reference	2-Jan-10	Feedback, performance appraisal, management reviews	30	1

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
CBCA Education	2-Jan-10	Feedback, performance appraisal, management reviews	1	0
Center for the History of Music Theory and Literature	2-Jan-10	-	0	0
CERIS	2-Jan-10	-	0	0
Chaucer Bibliography Online	2-Jan-10	-	0	0
Chicago Manual of Style	2-Jan-10	-	0	0
Child Welfare Information Gateway	2-Jan-10	-	0	0
China: Trade, Politics and Culture, 1793-1980 (Adam Matthew Digital)	2-Jan-10	-	0	0
CICA Standards and Guidance Collection	2-Jan-10	-	0	0
CINAHL	2-Jan-10	Employee performance appraisal, employee discipline	0	0
Classical Net	2-Jan-10	-	0	0
Classical Scores Library	2-Jan-10	-	0	0
Cochrane Library	2-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Conference Board of Canada e-Library	2-Jan-10	-	0	0
Contemporary Authors	2-Jan-10	-	0	0
Contemporary Literary Criticism Select	2-Jan-10	-	0	0
Current Veterinary Serials	2-Jan-10	Dead Link	0	0
Defining Gender, 1450-1910, Online (Adam Matthew Digital)	2-Jan-10	-	0	0
Dissertations & Theses @ University of Prince Edward Island	2-Jan-10	-	0	0
DOAJ : Directory of Open Access Journals	2-Jan-10	-	0	0
E-STAT (Statistics Canada)	2-Jan-10	-	0	0
Early Canadiana Online	2-Jan-10	-	0	0
ebrary	2-Jan-10	Feedback (psychology), job evaluation, executives --training of, employees --rating of, leadership evaluation, executive coaching, employee --coaching of	29	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
EBSCOHost Mobile Edition (Regional Business News)	2-Jan-10	Feedback (psychology, employees --rating of, performance evaluation, job evaluation	18	0
EBSCOHost Standard Edition (all databases)	2-Jan-10	REDUNDANT	0	0
EconLit (EBSCOhost)	3-Jan-10	Feedback (psychology), performance appraisal	3	0
EconPapers	3-Jan-10	Performance appraisal, performance evaluation	15	0
Education Research Complete	3-Jan-10	Feedback (psychology), performance evaluation, peer counselling, job performance, peer review (professional performance), professional employee --rating of	140	0
Education-Line	3-Jan-10	Dead	0	0
Eighteenth Century Collections Online (ECCO)	3-Jan-10	Dead	0	0
Eighteenth Century Journals I & II (Adam Matthew Digital)	3-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Empire Online (Adam Matthew Digital)	3-Jan-10	-	0	0
Equinox Data Delivery System	3-Jan-10	-	0	0
ERIC (EBSCOhost)	3-Jan-10	Feedback	13	0
ERIC via the U.S. Dept of Education	3-Jan-10	REDUNDANT	0	0
Erudit	3-Jan-10	-	0	0
Explorations in Learning & Instruction: The Theory Into Practice Database	3-Jan-10	-	0	0
Federal Publication Locator	3-Jan-10	-	0	0
Feminae: Medieval Women and Gender Index	3-Jan-10	-	0	0
First Nations Periodical Index	3-Jan-10	-	0	0
Gales Literary Index	3-Jan-10	-	0	0
Gender Inn	3-Jan-10	-	0	0
Globe and Mail: Canada's Heritage from 1844	3-Jan-10	-	0	0
Google Scholar				

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
GreenFile	3-Jan-10	-	0	0
Grove Music Online - See Oxford Music Online	3-Jan-10	-	0	0
Handbook of Latin American Studies - HLAS Online	3-Jan-10	-	0	0
Historical Abstracts (European and World history)	3-Jan-10	-	0	0
IDLS Internet Data Library Service - see Equinox	3-Jan-10	-	0	0
Index to Federal Royal Commissions	3-Jan-10	-	0	0
Ingenta	3-Jan-10	-	0	0
Integrated Database in Canadian Environmental History	4-Jan-10	-	0	0
InteLex Past Masters	4-Jan-10	-	0	0
International Children's Digital Library	4-Jan-10	-	0	0
intute (science, engineering and technology)	4-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
IOP Electronic Journals (Institute of Physics)	4-Jan-10	-	0	0
IslandScholar	4-Jan-10	-	0	0
Iter: Gateway to the Middle Ages and Renaissance	4-Jan-10	-	0	0
JSTOR Arts & Sciences I - VI and Complement Collections and Life Sciences	4-Jan-10	Feedback, performance appraisal, job evaluation	111	1
Keesings World News Archive	4-Jan-10	-	0	0
Learned Journals Collection	4-Jan-10	-	0	0
Library, Information Science & Technology Abstracts (LISTA)	4-Jan-10	Feedback (psychology), performance evaluation, peer review (professional performance), professional employee --rating of	2	1
Management & Organization Studies: A SAGE Full-Text Collection	4-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
MAS Ultra - School Edition	4-Jan-10	Feedback (psychology), peer review (professional performance, professional employee --rating of	5	0
Mass Observation Online (Adam Matthew Digital)	4-Jan-10	-	0	0
MathSciNet	4-Jan-10	-	0	0
Medieval Travel Writing (Adam Matthew Digital)	4-Jan-10	-	0	0
MEDLINE	4-Jan-10	REDUNDANT	0	0
MEDLINE (via Ebscohost)	4-Jan-10	Feedback, peer review (professional performance)	0	0
Military & Government Collection	4-Jan-10	Feedback (psychology), employees --coaching of, performance appraisals, performance evaluation, employees --rating of	71	0
MLA Directory of Periodicals	5-Jan-10	-	0	0
MLA International Bibliography	5-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
MLA International Bibliography - Ebscohost	5-Jan-10	REDUNDANT	0	0
Music Education Resource Base	5-Jan-10	-	0	0
MyiLibrary	5-Jan-10	-	0	0
National Geographic Society Publications Index	5-Jan-10	-	0	0
National Sea Grant Depository	5-Jan-10	-	0	0
Naxos Music Library	5-Jan-10	-	0	0
NCJRS (National Criminal Justice Reference Service)	5-Jan-10	-	0	0
New York Times	5-Jan-10	-	0	0
NewsScan	5-Jan-10	-	0	0
Online Medieval and Classical Library (OMACL)	5-Jan-10	-	0	0
Open Access Journals in the Field of Education	5-Jan-10	-	0	0
OriginsOnline - CNS	5-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Oxford English Dictionary Online	5-Jan-10	-	0	0
Oxford Music Online	5-Jan-10	-	0	0
Oxford Reference Online	5-Jan-10	-	0	0
Oxford University Press Journals	5-Jan-10	-	0	0
PAIS International	5-Jan-10	-	0	0
PARLIT	5-Jan-10	-	0	0
PEI Articles Database (PEI PAD): for all users	5-Jan-10	-	0	0
PEI Articles Database (PEI PAD): for UPEI users	5-Jan-10	-	0	0
PEI Daily Newspapers	5-Jan-10	-	0	0
Periodicals Archive Online	5-Jan-10	-	0	0
Philosopher's Index	5-Jan-10	-	0	0
PIKA : Canadian Childrens Literature Database	5-Jan-10	-	0	0
Primary Search	5-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Project MUSE	5-Jan-10	-	0	0
PROLA Physical Review Online Archive	5-Jan-10	-	0	0
PsycARTICLES	5-Jan-10	Feedback, performance appraisal, job performance, personnel evaluation	104	3
PsycINFO	5-Jan-10	Feedback, personnel evaluation, peer evaluation	91	3
PubMed	6-Jan-10	-	0	0
Royal Society of Chemistry	6-Jan-10	-	0	0
S-PAC Searchable Proceedings of Animal Conferences	6-Jan-10	-	0	0
Safari Tech Books Online	6-Jan-10	-	0	0
SAGE Premier Collection	6-Dec-10	Feedback, performance appraisal	42	1
Science Direct	6-Dec-10	Performance evaluation, feedback	36	0
Science.gov	6-Dec-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Scirus	6-Jan-10	-	0	0
Shakespeare Collection	6-Jan-10	-	0	0
Ship Information Database	6-Jan-10	-	0	0
Slavery, Abolition and Social Justice, 1490-2007 (Adam Matthew Digital)	6-Jan-10	-	0	0
Social Services Abstracts	6-Jan-10	Feedback, job performance, performance appraisal	0	0
Sociological Abstracts	6-Jan-10	Feedback, job performance, performance appraisal	0	0
Sociology [List of databases]	6-Jan-10	-	0	0
Sociology-related databases	6-Jan-10	-	0	0
SORA	6-Jan-10	-	0	0
Springer LINK	6-Jan-10	Peer evaluation, performance appraisal	12	0
Theatre in Video	6-Jan-10	-	0	0
Theses Canada Portal	6-Jan-10	-	0	0

Database	Date Searched	Keywords	# in Review List	# of Relevant & Unique Articles
Times Digital Archive 1785-1985	6-Jan-10	-	0	0
Times Online	6-Jan-10	-	0	0
Toronto Stock Exchange Monthly Review (eReview)	6-Jan-10	-	0	0
United States Patent and Trademark Office	6-Jan-10	-	0	0
ViVa: A Bibliography of Womens History in Historical and Womens Studies Journals	6-Jan-10	-	0	0
WAVES	6-Jan-10	-	0	0
Web of Science	6-Jan-10	-	0	0
What Works Clearinghouse (US Dept of Education)	6-Jan-10	-	0	0
Wiley InterScience	6-Jan-10	-	0	0
Women in Politics: Bibliographic Database	6-Jan-10	-	0	0
WorldCat	6-Jan-10	-	0	0

Appendix B. List of Relevant Articles Accepted From the Review Lists

- 1) Boyes, S. (2000). Face to face: the necessity of doing performance reviews. *Canadian Consulting Engineer*, 41(5), 76.
- 2) Bryant, S. E., & Terborg, J. R. (2008). Impact of peer mentor training on creating and sharing organizational knowledge. *Journal of Managerial Issues*, 20(1), 11-29.
- 3) Busby, J. S., & Williamson, A. (2000). The appropriate use of performance measurement in non-production activity. *International Journal of Operations & Production Management*, 20(3), 336-358.
- 4) DiTomaso, N., Post, C., Smith, D. R., Farris, G. F., & Cordero, R. (2007). Effects of structural position on allocation and evaluation decisions for scientists and engineers in industrial R&D. *Administrative Science Quarterly*, 52(2), 175-207.
- 5) Fulk, J., Brief, A. P., & Barr, S. H. (1985). Trust-in-supervisor and perceived fairness and accuracy of performance evaluations. *Journal of Business Research*, 13(4), 301-313.
- 6) Herold, D. M., & Fields, D. L. (2004). Making sense of subordinate feedback for leadership development: confounding effects of job role and organizational rewards. *Group & Organization Management*, 29(6), 686-703.
- 7) Hessami, A. G., & Moore, M. (2007). Competence matters more than knowledge. *Electronic Journal of Knowledge Management*, 5(4), 387-397.
- 8) Ivancevich, J. M. (1979). Longitudinal study of the effects of rater training on psychometric error in ratings. *Journal of Applied Psychology*, 64(5), 502-508.

9) Ivancevich, J. M. (1980). A longitudinal study of behavioral expectation scales: Attitudes and performance. *Journal of Applied Psychology*, 65(2), 139-146.

10) Ivancevich, J. M. (1983). Contrast effects in performance evaluation and reward practices. *Academy of Management Journal*, 26(3), 465-476.

11) Ivancevich, J. M., & McMahon, J. T. (1982). The effects of goal setting, external feedback, and self-generated feedback on outcome variables: A field experiment. *The Academy of Management Journal*, 25(2), 359-372.

12) Landy, F. J., & Guion, R. M. (1970). Development of scales for the measurement of work motivation. *Organizational Behavior & Human Performance*, 5(1), 93-103.

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14) McCuddy, M. K., & Griggs, M. H. (1984). Goal setting and feedback in the management of a professional department: A case study. *Journal of Organizational Behavior Management*, 6(1), 53-64.

15) Moser, K., Schuler, H., & Funke, U. (1999). The moderating effect of raters' opportunities to observe ratees' job performance on the validity of an assessment centre. *International Journal of Selection & Assessment*, 7(3), 133.

16) Post, C., DiTomaso, N., Farris, G. F., & Cordero, R. (2009). Sources of differences between Chinese, Indian, and Caucasian scientists and engineers: Evaluations of managerial potential. *Journal of Engineering and Technology Management*, 26(4), 225-246.

- 17) Radu, I., Pitariu, H., Czitrom, I., & Langa, T. (1972). An experience in designers' performance appraisal. *Revue Roumaine des Sciences Sociales - Série de Psychologie*, 16(2), 141-152.
- 18) Shah, J. B., & Murphy, J. (1995). Performance appraisals for improved productivity. *Journal of Management in Engineering*, 11(2), 26.
- 19) Smith, D. R., DiTomaso, N., Farris, G. F., & Cordero, R. (2001). Favoritism, bias, and error in performance ratings of scientists and engineers: The effects of power, status, and numbers. *Sex Roles*, 45(5), 337-358.
- 20) South, J. C. (1980). Fakability and the engineer performance description form. *Personnel Psychology*, 33(2), 371-376.
- 21) Thompson, P. H., & Dalton, G. W. (1970). Performance appraisal: managers beware. *Harvard Business Review*, 48(1), 149.
- 22) Varhol, P. (2000). Preparing for your performance review. *Electronic Design*, 48(13), 183.
- 23) Williams, W. E., & Seiler, D. A. (1973). Relationship between measures of effort and job performance. *Journal of Applied Psychology*, 57(1), 49-54.
- 24) Zenger, T. R. (1992). Why do employers only reward extreme performance? Examining the relationships among performance, pay, and turnover. *Administrative Science Quarterly*, 37(2), 198-219.