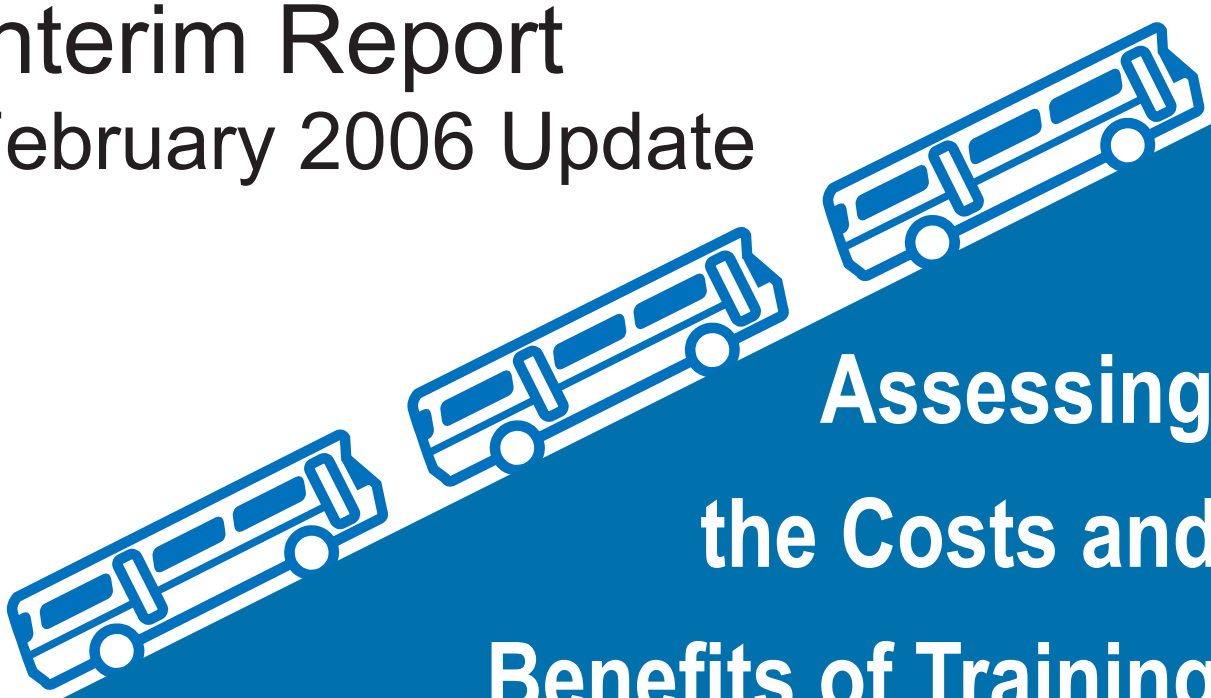
Measuring Up

Interim Report

February 2006 Update



Assessing the Costs and Benefits of Training in the Keystone Transit Career Ladder Partnership

COMMUNITY TRANSPORTATION CENTER

Preface

Measuring Up is the fruit of a long-term effort by the Community Transportation Center and its staff, particularly lead author Xinge Wang, the Center's Senior Research Associate, and her partner in this work, Jack Clark, Director of Workforce Development. The *Measuring Up* project goes beyond earlier research by showing that enhanced maintenance training through Pennsylvania's statewide Keystone Transit Career Ladder Partnership has (1) raised the knowledge and skill levels of transit maintenance employees, (2) led to improved effectiveness in diagnostics and repair and (3) yielded significantly reduced maintenance costs and improved vehicle reliability.

This *Interim Report* breaks new ground in comparing the value of savings in SEPTA's maintenance program with the costs of Pennsylvania's innovative Keystone Transit Career Ladder Partnership. This training program is uniquely based on an effective labor-management training partnership and a joint process driven by objective data identifying the training needs of transit systems and their workers and unions.

Research is continuing to isolate the contribution of the new training program from all the other factors that simultaneously impact transit maintenance and operations. The wide range of changing conditions surrounding any transit training program – changes in fleet composition and age, weather, management strategies, workplace practices, the labor-relations climate, and so forth – make this further analysis a challenge. But it is a challenge the Center is committed to pursuing.

Measuring Up has gone further than many studies in identifying the impacts of training for two reasons: the perseverance of the Center's research team and the thoughtful assistance provided by Pennsylvania's transit systems and unions, particularly at SEPTA and the Transport Workers Union, Local 234. Most importantly, however, this research was able to find and measure significant results because of the extraordinary effectiveness of the Keystone Transit Career Ladder Partnership and the training it has developed.

This *Interim Report* builds on research conducted by the Center over the past four years. In 2003 *Pennsylvania Transit on the High Road* examined the history of Pennsylvania's innovative Keystone Transit Career Ladder Partnership and reported leadership impressions. In 2004 *Making a Difference* showed that workers receiving Keystone training and their supervisors perceived the program to be extremely valuable. *Measuring Up* seeks to explore quantitative changes in the key components of transit operations and their linkages to the new Keystone maintenance training. Its first volume was completed in January 2005.

The Center is continuing its research on labor-management training partnerships in the transit industry. Subsequent volumes will examine the effects of new training in smaller transit properties as well as in Pittsburgh's Port Authority Transit and ATU Local 85. The Center is also working to quantitatively parse the contribution of training relative to the many other factors at play at any time. This type of research will lead us closer to a report on training's return on investment in the future.

Finally, we want to acknowledge the Pennsylvania Department of Labor and Industry and the Federal Transit Administration. Their support made this study possible.

Brian Turner, Director

Executive Summary

This *Interim Report* is part of the ongoing research work by the Community Transportation Center (the Center) to examine whether effective transit maintenance training is a smart investment. It is focused on the Keystone Transit Career Ladder Partnership (Keystone), a labor-management initiative to address critical skills shortages in the Pennsylvania transit industry on a unique partnership-based, data-driven basis. Begun in December 2001, the Keystone Partnership has provided training to more than 2,000 transit workers in some 34 transit properties.

With this *Interim Report*, the Center attempts to quantitatively examine both the benefits and costs of Keystone training in bus maintenance. It is based on data collected from the Vehicle Maintenance Information System (VMIS) at Southeastern Pennsylvania Transit Authority (SEPTA) and the Keystone program expense reports.

As reported in January 2005 in the Center's *Measuring Up* report, bus maintenance training provided through Keystone resulted in savings on preventive maintenance and maintenance replacement labor and part costs. Analysis of the most recent VMIS data indicates consistent cost savings in many more areas of vehicle maintenance at SEPTA since the start of Keystone. In addition to preventive maintenance, significant manpower efficiency improvement has been achieved in repairs for service failure and operator reported failure, overhaul, running repairs, repairs of vandalized vehicles, etc. The combined cost savings accounted so far are estimated to be over $26 million during Keystone's first four program years.

While the monetary costs remained relatively constant, the benefits continued to increase over time. In a few short years, the Keystone Transit Career Ladder Partnership at SEPTA has created measurable benefits that far outweigh the cost of the agency's investment. Even including the total cost of the increased investment in training systems (agency spending plus government grant funds) the value of the partial benefits that can be measured at this point outweighs the total investment substantially.

With only a fraction of measures included so far, the data indicates that Keystone's innovative partnership-based, data-driven training program is producing very positive benefits for SEPTA.

A full return on investment study is beyond the scope of this *Interim Report*. As is indicated by the conclusion, this type of study will require multi-variable analysis that attempts to identify the role of training, as distinct from other factors, in observed improvements. Additional measures on the benefit side will also need to be assessed to draw a complete picture of the rate of return.

Further research is underway to examine more complete data on the benefits side, including repeat and chronic mechanical failure, usage of parts, vehicle downtime, missed trips, spare bus ratio and vacancies in skilled positions. This research and the effort to identify the role of training specifically to observed improvements will form the basis of the Center's next report in this series.

Measuring Up Interim Report – February 2006 Update
Assessing the Costs and Benefits of Training in the Keystone Transit Career Ladder Partnership

I. Introduction

Is good transit maintenance training a smart investment? If transit systems spend scarce resources on highly effective maintenance training, does it cost them money overall? Or, conversely, could transit systems actually save money in other areas (or even "make money") by increasing their spending on high quality maintenance training?

These questions provide the background to ongoing research work by the Community Transportation Center. It is focused on the Keystone Transit Career Ladder Partnership, a labor-management initiative to address critical skills shortages in the Pennsylvania transit industry on a partnership-based, data-driven basis. The Keystone Transit Partnership was begun in December 2001 and has since provided training to more than 2,000 Pennsylvania transit workers in some 34 transit properties.[1] (See Figure 1 for a summary of number of workers trained in three areas of the state from Dec. 2001 to June 2005, and Figure 2 on the following page for Keystone bus promotions and wage gains in Philadelphia).

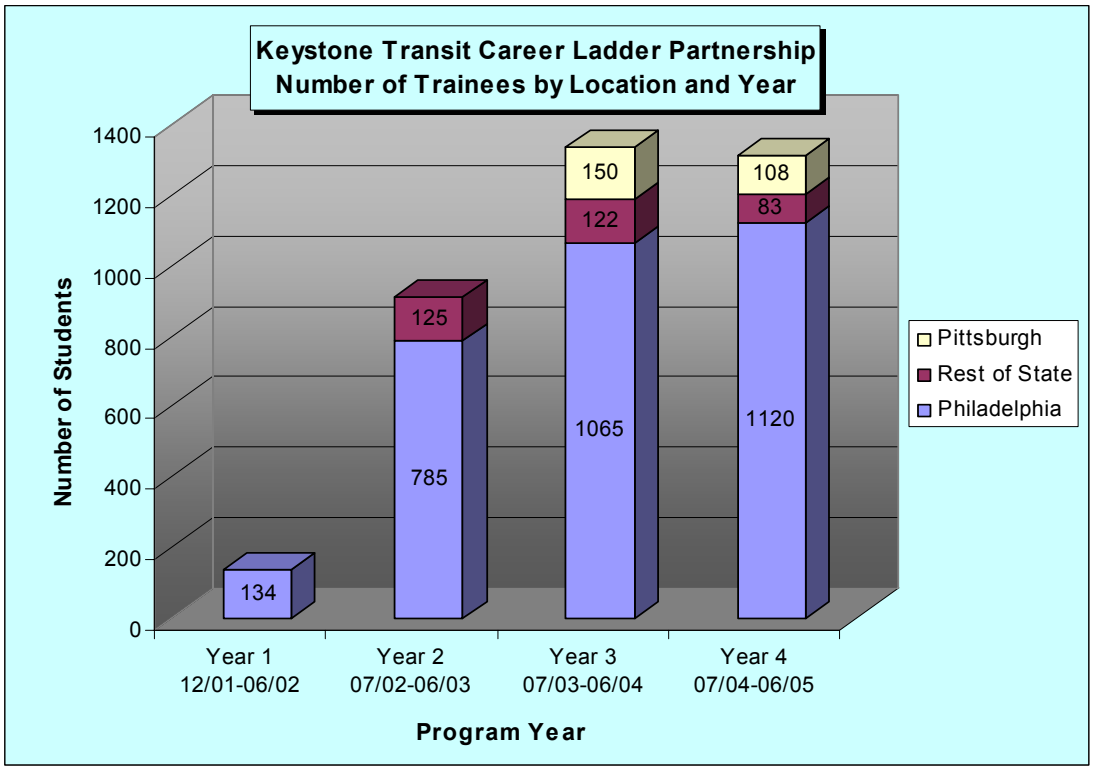


Figure 1. Number of Trainees by Location and Phase

[1] The Partnership is funded by the Pennsylvania Department of Labor and Industry and supported by the Pennsylvania AFL-CIO. Its principal members are SEPTA (Southeastern Pennsylvania Transit Authority), the Amalgamated Transit Union (ATU), the Transport Workers Union (TWU), Port Authority of Allegheny County, and smaller transit properties organized in the Pennsylvania Public Transportation Association (PPTA).

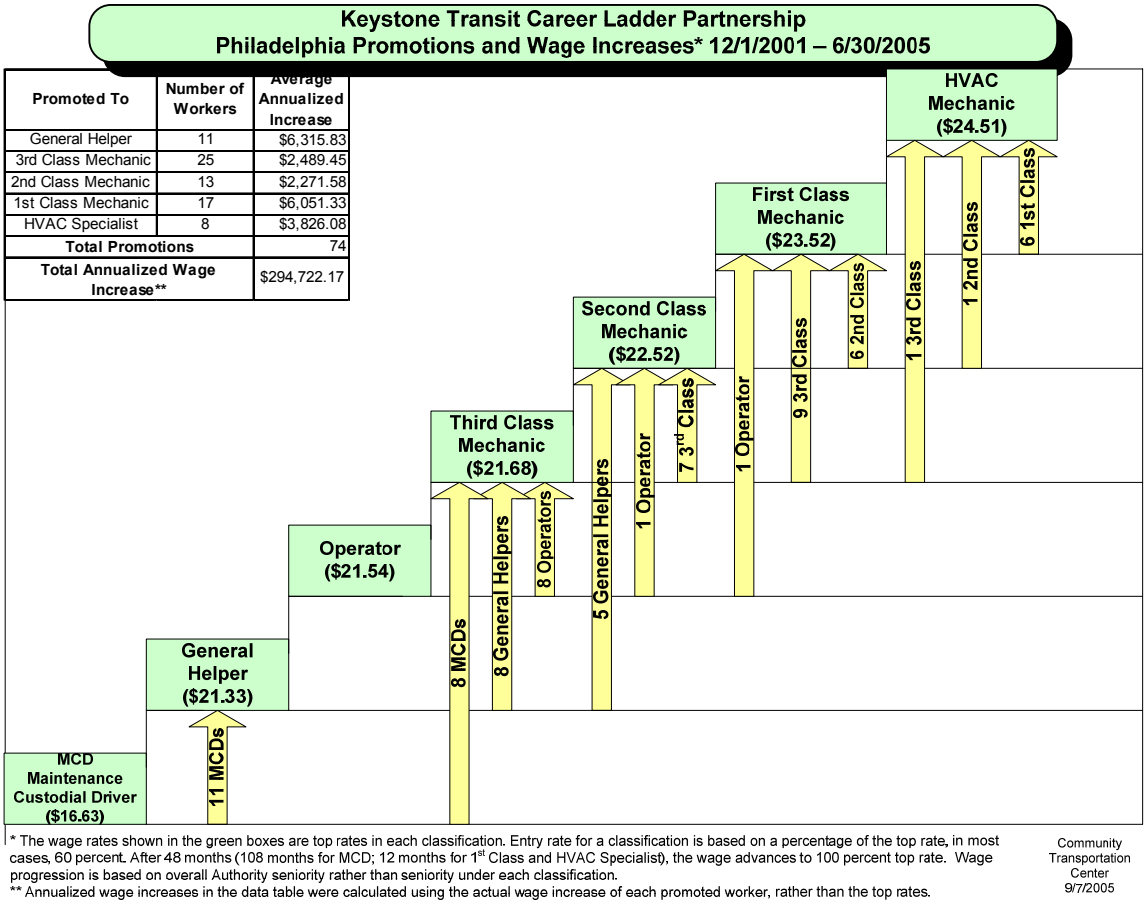


Figure 2. Keystone Philadelphia Bus Promotions and Wage Gains

The first two reports in this study series documented the founding of the program in a climate of labor-management hostility and the very positive perception of the program by trainees and their supervisors. The third study, the first volume of *Measuring Up*, developed an initial quantitative analysis of the benefits of Keystone Partnership training through improved skills, more efficient maintenance activities, and increased reliability.

The next question, posed by Keystone stakeholders and researchers alike, addresses the benefits and costs of Keystone training in financial terms. While, for technical reasons that will be discussed momentarily, this is not a formal return on investment study, the *Interim Report* borrows from the literature and methodology on rate of return to examine benefits.

Rate of return analysis applies both to the transit agencies and to government agencies that provide funding for training programs. In general, studies of returns on training investment across many industries indicate that firms recoup their investments in training many times over in raised productivity and organizational performance. Case studies on individual firms in different industries found that “returns to training investments are

nearly always positive and can be very high"[2]. Cost-benefit analysis has previously been done on transit mechanical training programs, with results showing significant cost savings and revenue increases related to training[3]. However, quantitative case studies are rather scarce in the transit training world.

With this *Interim Report*, the Center attempts to quantitatively examine the monetary benefits and costs of transit maintenance training investment utilizing extensive data collected from the Vehicle Maintenance Information System at SEPTA. The results reported here build on the quantitative foundation of the first volume of *Measuring Up* and provide a preview of more extensive results that will appear in the second *Measuring Up* volume within the next year in quantitatively evaluating the returns of partnership-based, data-driven transit maintenance training.

[2] Return on training investment can vary "between 30 percent and 7000 percent", according to the case studies cited in Smith, Andrew 2001, *Return on Investment in Training: An Introduction*, p. 13.

[3] Southern California Rapid Transit District 1975, *Advanced Mechanical Training Program / Southern California Rapid Transit District*. Washington: Urban Mass Transportation Administration. Southeastern Pennsylvania Transportation Authority 1986, *Southeastern Pennsylvania Transportation Authority's Automotive Training Demonstration Program*. Philadelphia, PA.

II. Research Framework

Figure 3 below shows the basic causal relationship model the Center follows in its continuing study on training metrics. It lists potential organizational and maintenance performance outcomes caused by enhanced maintenance training that can be used to come up with total training benefits in dollar terms. The yellow shaded boxes represent outcomes already measured in Volume 1 of *Measuring Up* and those that will be presented later in this *Interim Report*. They address the improved efficiency in vehicle maintenance and repair, or the *quantity* side of maintenance work. These partial results are used in this report to estimate fractional benefits of training. Further research is underway to examine whether the *quality* of the maintenance work has also been upgraded after the start of Keystone. The key measure in this category is the number and type of repetitive/chronic mechanical failures, generally considered the most direct indicator of maintenance workmanship. Other data such as part usage, number of road calls, downtime, bus spare ratio and number of vacancies in skilled positions will also be looked into.

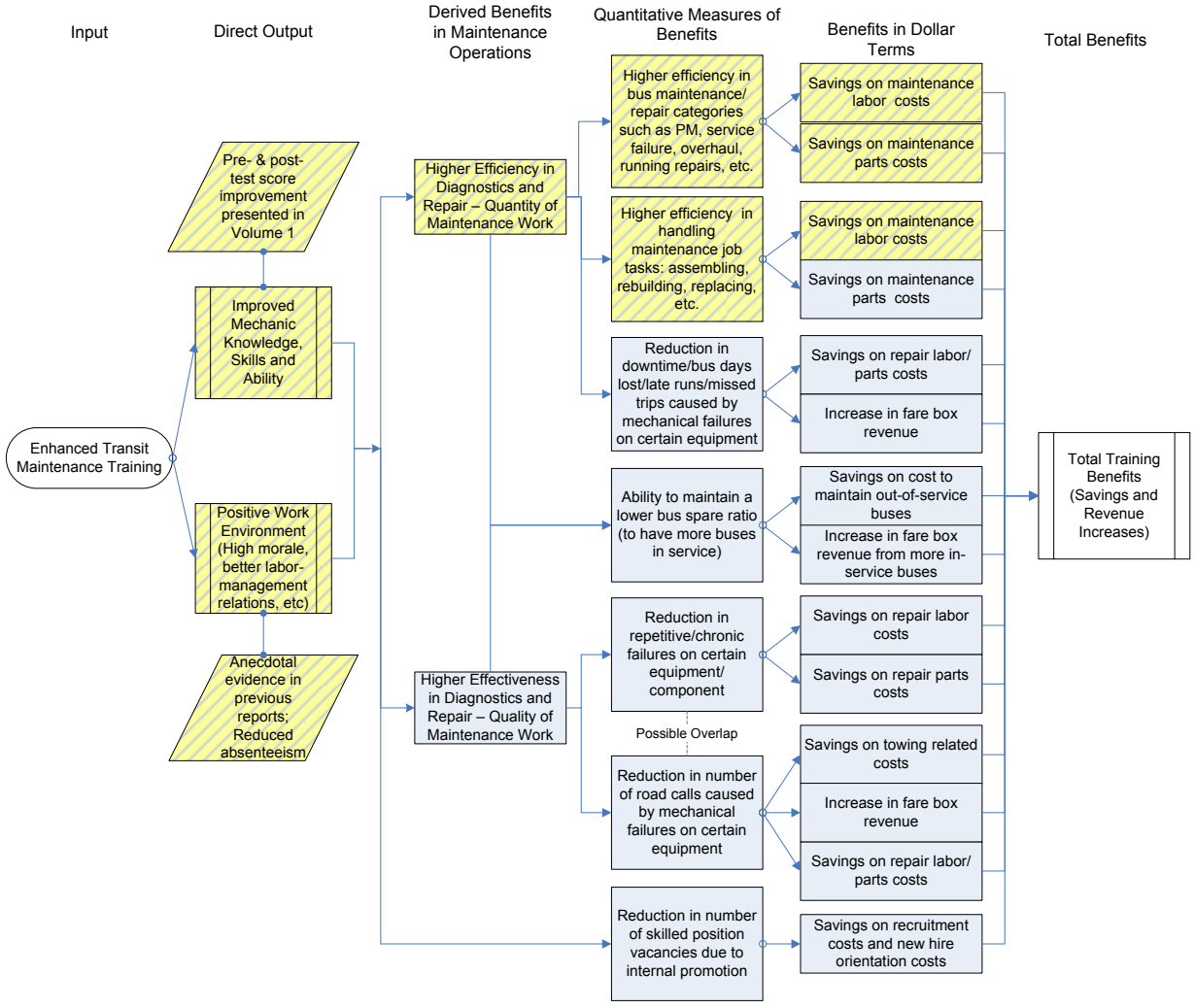


Figure 3. Transit Training Costs and Benefits: A Causal Relationship Model

A note of caution needs to be sounded about the results from this report. As stated in the first volume of *Measuring Up*, organizational performance is affected by a myriad of factors. The larger the organization, the greater the number of potential variables that can influence the performance measures. In the world of transit maintenance operations, these can include changing weather, aging vehicle fleets, increased vehicle complexity, vehicle procurement, changing fleet composition, changing levels of transit funding, internal management strategies and operational practices, and the broader labor-management environment and workplace culture. In practice, although training may influence the outcomes in vehicle maintenance, it is difficult to separate the impact of training from the impact of other factors.

In the specific case of SEPTA, the beginning of Keystone training coincided with a shift in maintenance management practice that placed new emphasis on preventive maintenance (PM). PM received greater attention in part because SEPTA was purchasing many new buses[4]. These two factors are independent of the start of the training program, and both may have contributed significantly to the cost savings detailed in this report. Within SEPTA management, there is broad consensus that the Keystone training program has had a substantial positive impact. Among other benefits, improved training helped support the new emphasis on PM and other changes in workplace practices.

How much of the benefits observed can be assigned specifically to training? That question needs to be answered in order to develop a full rate of return study. The Center is working with SEPTA and the Transport Workers Union to look at the many variables that affect bus maintenance and to make an effort to define quantitatively the specific contribution of training. This *Interim Report* will look at costs and benefits from training. In subsequent research, the Center attempts to isolate the specific contribution of training while looking at a broader range of the data laid out in Figure 3.

[4] The average age of the SEPTA bus fleet dropped from 10.8 years in 2001 to 6.1 years in May 2005, according to SEPTA and the National Transit Database.

III. Savings / Training Benefits

Over the past four program years, workers at SEPTA have filled about 2,000 training slots in bus maintenance. Training ranged from one-day refresher courses to five weeks of intensive classroom instruction. Participating maintenance employees included all job classifications, from general helper to first-class mechanic. As documented in Volume 1 of *Measuring Up*, average test scores from these classroom training sessions were improved by 40.6 percent, indicating significant learning gains. Furthermore, 84 percent of the participating trainees passed the "hands-on" performance test and earned promotions after Keystone, compared to only 53 percent prior to Keystone. On-the-job learning was enhanced by assignment of mentors who coached trainees on the shop floor. As detailed in the section on training investments, the total cost of this bus maintenance training equaled close to $3 million.

1. Average Parts and Labor Costs and Annual Cost Savings for Major Bus Maintenance/Repair Categories

The time and effort spent on bus maintenance training at all skill levels has produced impressive improvements in parts and labor cost reduction in many categories of major maintenance/repair categories as detailed in the following sections using VMIS data. While reviewing these findings, readers should be aware that the hourly labor rate that SEPTA applied to each maintenance category only slightly fluctuated over the past four years. Therefore, most of the changes in mean labor costs can be attributed to changing average length of time workers spent completing work orders in each maintenance/repair category.

A. Preventive Maintenance

Preventive maintenance is the regular inspection and repair cycles for a transit fleet, including midlife overhaul. A transit maintenance department's ability to perform preventive maintenance inspections on time is a critical factor to ensure vehicle reliability. Preventive maintenance cuts down substantially on the number of buses that require costly unplanned service. Training equips mechanics with the knowledge and skills required for performing PM work and maintaining PM schedules.

Prior to Keystone, PM training was very limited at SEPTA's bus maintenance facilities. Early on in Keystone, the PM program was identified as a top priority subject area of training. In the first three program years, 66 mechanics attended the three-day PM training sessions. They showed an 87 percent improvement in PM knowledge after completing the class. In addition, through the initiative of the working group on bus maintenance, a new program specifically geared to hands-on PM training was launched in late 2003. This one-day course involved a staff trainer and a very highly skilled mechanic traveling to garages to conduct practical training on PM.

From fiscal year (FY) 01 to 04, the share of PM jobs among all types of major bus maintenance categories[5] was on a steady increase, from 27 percent to 38 percent. The

[5] Buses are brought into maintenance garages for a variety of reasons. These reasons include but are not limited to: accident, service failures, overhaul, inspection repairs, operator reports, preventive maintenance, running repairs, etc.

rise in PM jobs appears to be associated with SEPTA's strategic adjustment in vehicle maintenance related to changes in fleet composition in recent years.[6] This initiative could not have been successfully implemented without the support of enhanced training in preventive maintenance procedures.

Not only did training help to keep worker skills up to the speed of the PM program improvement, it may have also contributed to higher efficiency in workers' performance of each work order. A preventive maintenance job that used to take workers 2.74 hours to complete four years ago took only 2.05 hours in FY05. In turn, the average labor cost for PM jobs dropped from $85.89 to $62.50 per work order, a difference of 27 percent. Taking $85.89 as the baseline and the actual number of annual PM jobs as the multipliers[7], SEPTA has achieved increasingly larger annual cost savings in PM since Keystone was initiated in December 2001 (See data table in Figure 4 – Annual Labor Cost Savings – PM Jobs).

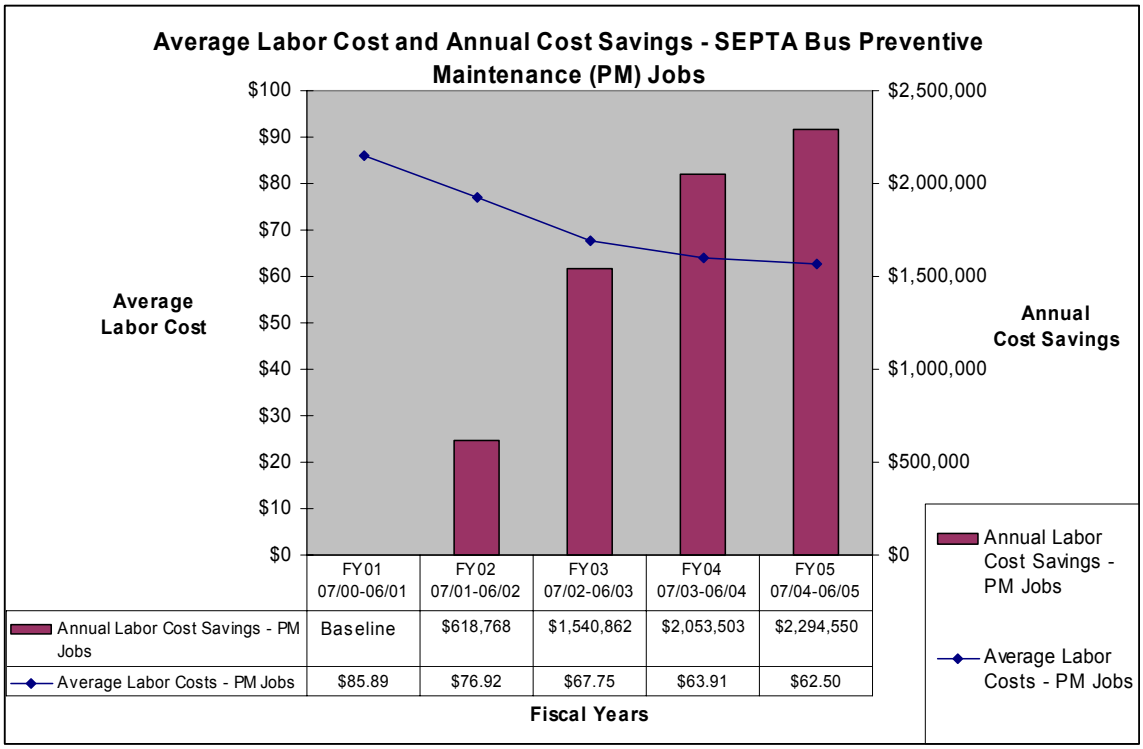


Figure 4. Average Labor Cost and Annual Cost Savings – SEPTA Bus Preventive Maintenance (PM) Jobs

The efficiency of preventive maintenance job performance is also demonstrated in the reduction of the mean PM parts cost. On average, a PM job required the use of $28.27 worth of parts and materials in FY01, whereas in FY05 it only cost $19.97. The exact

[6] SEPTA acquired several new fleets in the recent years. With a younger average-aged fleet, the need for more PM's will rise and corrective maintenance tasks will tend to drop.

[7] For example, FY02 Annual Cost Savings in PM = [(FY01 Average Labor Cost) – FY02 Average Labor Cost)] * FY02 Actual Number of PM Jobs = ($85.89 - $76.92) * 68,945 = $618,768;
FY05 Annual Cost Savings in PM = [(FY01 Average Labor Cost) – FY05 Average Labor Cost)] * FY05 Actual Number of PM Jobs = ($85.89 - $62.50) * 98,092 = $2,294,550

causes behind this cost saving are still under examination[8], but the value of savings on parts in preventive maintenance alone came to $1,690,380 for the four year period. The following chart (Figure 5) shows the trend of average combined cost of labor and parts for PM work orders. Over a period of four years, SEPTA has saved $8,198,057 from FY02 to FY05 on vehicle preventive maintenance jobs.

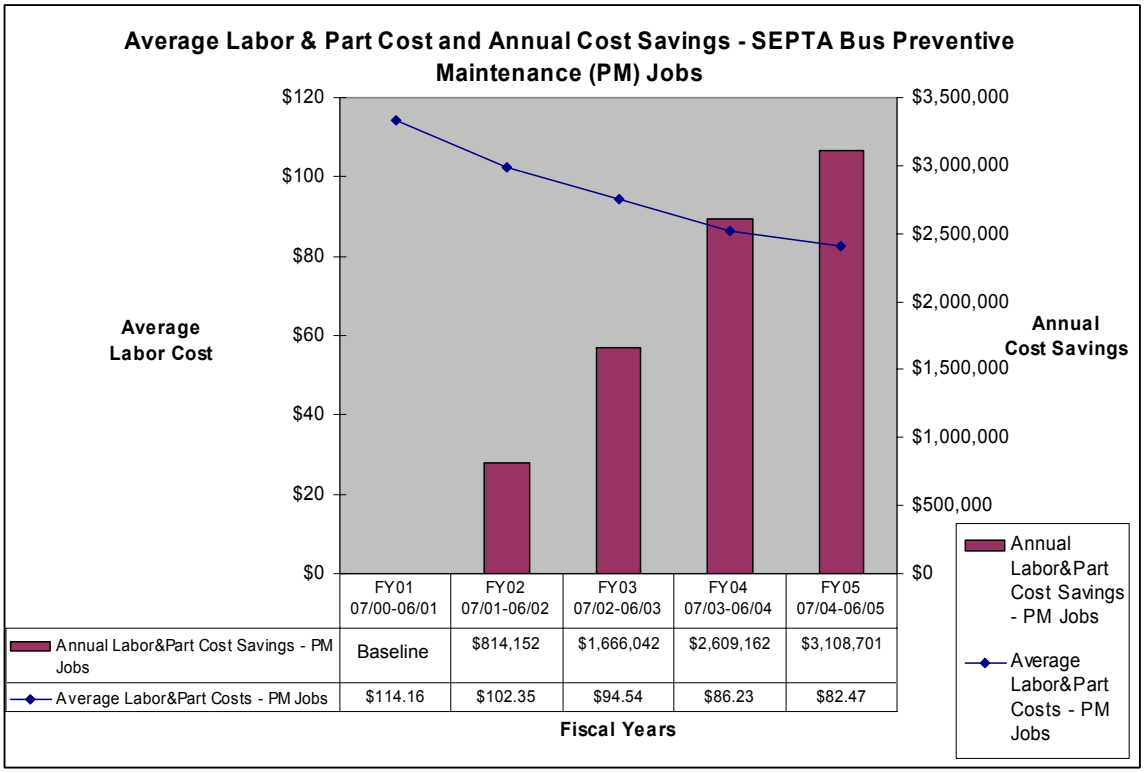


Figure 5. Average Labor & Part Cost and Annual Cost Savings – SEPTA Bus Preventive Maintenance (PM) Jobs

The clear trend of significant part savings over all four years has been found so far only in the PM job category. This may be explained by the difference in nature between PM and other types of repairs. PM involves mostly standard parts or materials, such as engine oil, lubricants, filters, brake pads, etc., whereas other types of repairs may also involve special parts made only for the type of vehicle. As SEPTA procures new fleet and phase out old vehicles, the fleet model composition varies yearly. Cost for special parts is largely determined by the model of buses and the type of onboard equipment, and is normally beyond the control of mechanics performing the job. For instance, certain buses with advanced electronics or ADA equipment may have much more expensive parts than others.

Determining the exact cost of special parts is beyond the scope of this *Interim Report*. However, strong anecdotal evidence from SEPTA managers and supervisors suggests that there has been significant improvement in part usage in many areas of bus maintenance as a result of more effective diagnosis of mechanical problems. Part 4 on page 17 will elaborate on this point.

[8] Adoption of better technologies or more cost-effective materials is a possible cause other than training.

B. Service Failure Repairs

As Figure 6 illustrates, the average labor cost for bus service failures went from $66.66 to $51.56 per work order between FY01 to FY05, even though the hourly rate of mechanics for this type of job went up slightly during the same time period. Work efficiency has apparently been improved with only 1.6 hours spent on each service failure job now compared to 2.08 hours before Keystone.

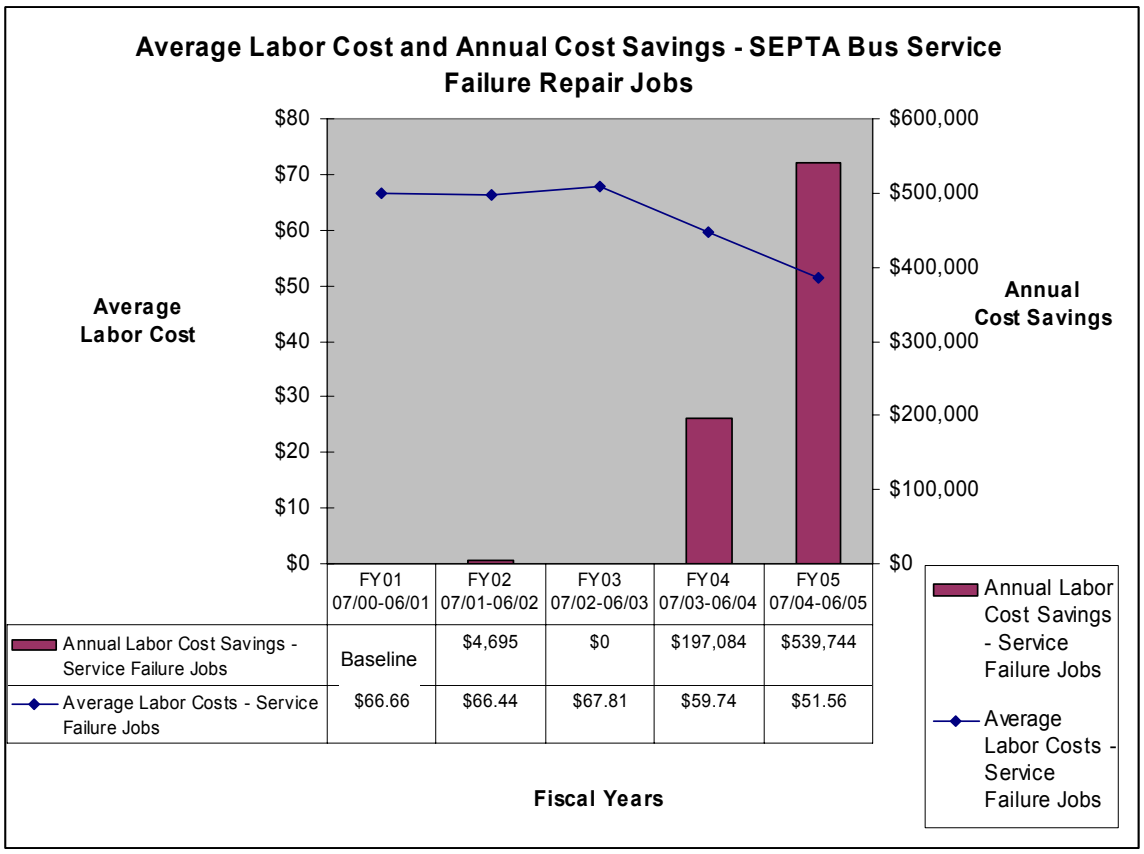


Figure 6. Average Labor Cost and Annual Cost Savings – SEPTA Bus Service Failure Repair Jobs

C. Component Overhaul

Average labor cost for bus component overhaul work orders has been on a steady decline from $406.64 in FY02[9] to $262.27, a drop of 35.5%. This has resulted in significant savings for SEPTA even though the number of overhaul jobs only accounted for 1% of all types of maintenance jobs. This cost reduction is particularly meaningful for SEPTA since it demonstrates that mechanics have an enhanced ability to tackle extremely complicated maintenance jobs that may have otherwise been outsourced.

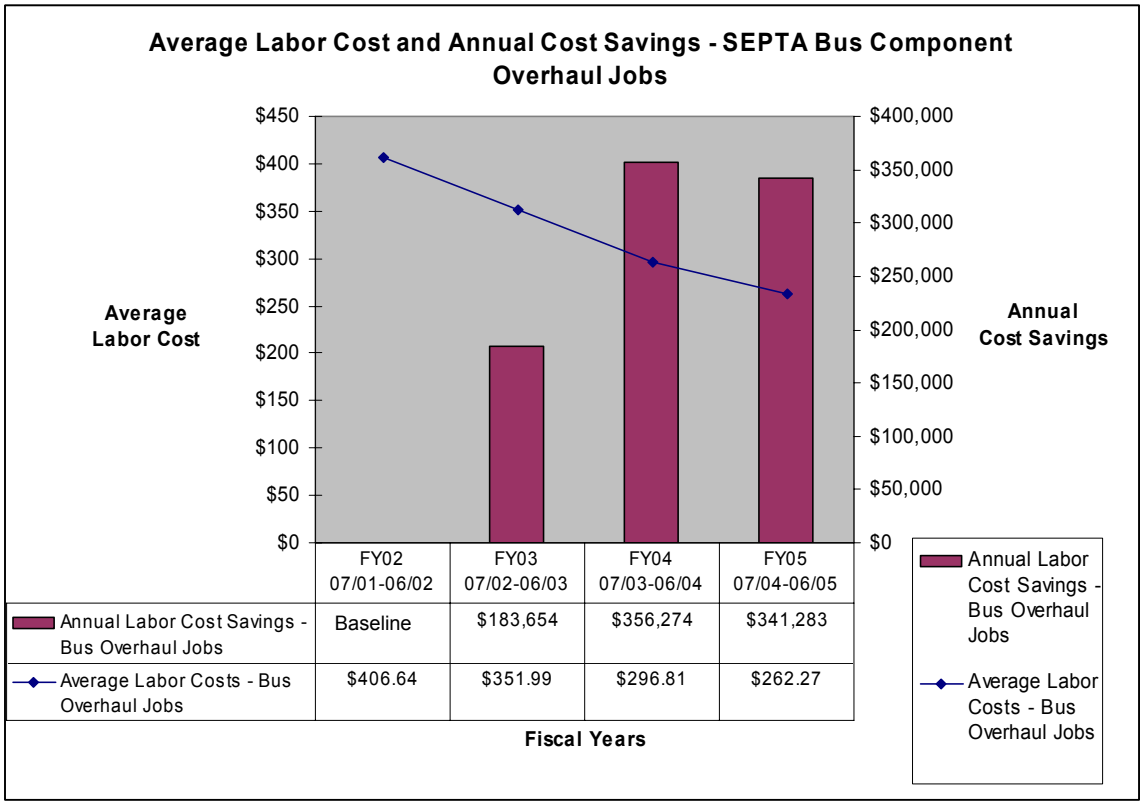
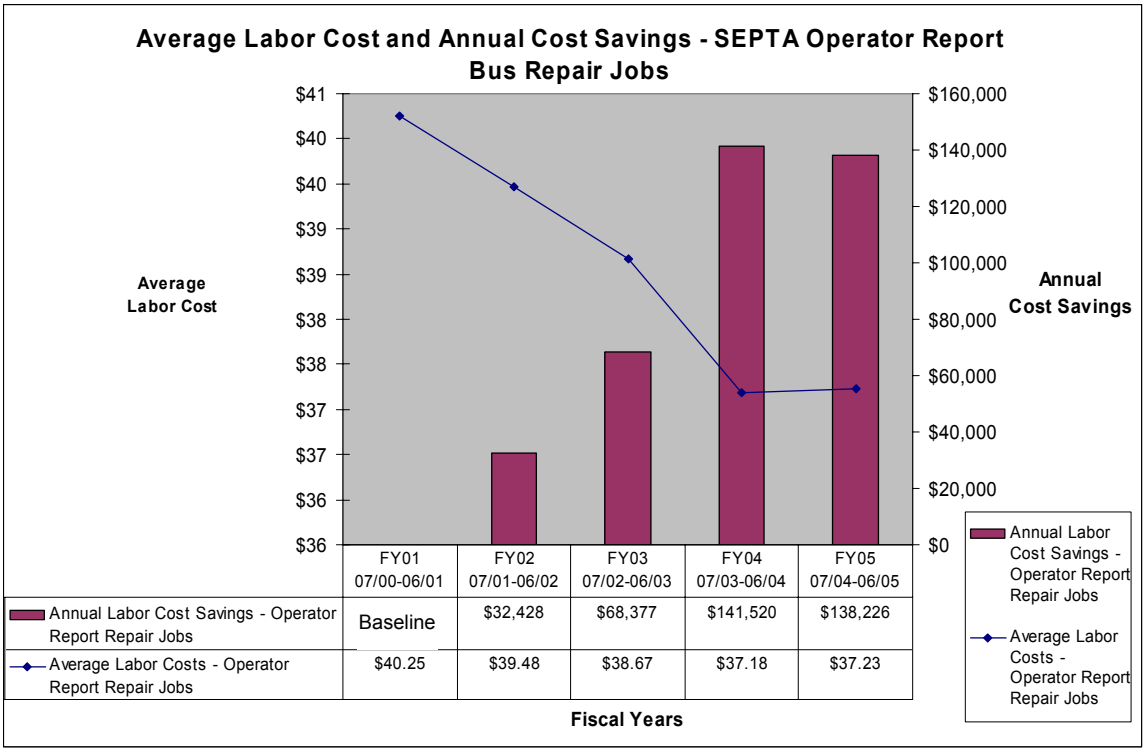


Figure 7. Average Labor Cost and Annual Cost Savings – SEPTA Bus Component Overhaul Jobs

[9] Component overhaul data was first available in the VMIS system in fiscal year 2002.

D. Repairs for Operator Reported Defects

The percent of repairs for operator reported defects (mechanical failures reported daily by bus operators) among all types of major bus maintenance categories was on a decline from 22% before the start of Keystone to 15% after four years of Keystone. This indicates that defects are being repaired during the PM inspections and, as a result, buses break down less on the road due to mechanical failures. At the same time, the average maintenance labor costs for repairs of operator reported mechanical failures dropped gradually from $40.25 per job in FY01 to $37.18 in FY04, and then held steady for FY05, resulting in $380,551 in total savings.



	FY01 07/00-06/01	FY02 07/01-06/02	FY03 07/02-06/03	FY04 07/03-06/04	FY05 07/04-06/05
Annual Labor Cost Savings - Operator Report Repair Jobs	Baseline	$32,428	$68,377	$141,520	$138,226
Average Labor Costs - Operator Report Repair Jobs	$40.25	$39.48	$38.67	$37.18	$37.23

Figure 8. Average Labor Cost and Annual Cost Savings – SEPTA Operator Report Bus Repair jobs

E. Running Repairs

Mean labor cost for bus running repairs (ordinary maintenance required to maintain fleet) went slightly up in FY02 and fell consecutively over the next three years, resulting in savings of nearly $2 million. The efficiencies gained from using manpower in scheduled maintenance activities such as PM inspections, instead of using that manpower chasing unscheduled repairs, which, although can never be fully eliminated, results in savings and more proficient manpower allocation.

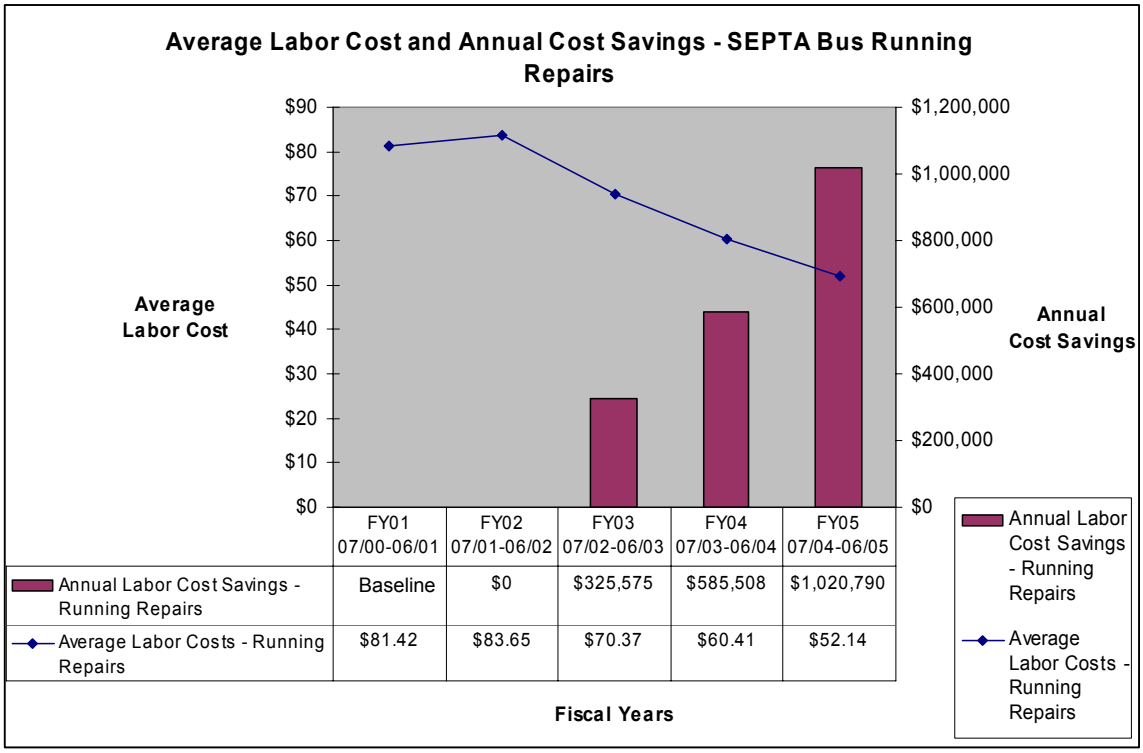


Figure 9. Average Labor Cost and Annual Cost Savings – SEPTA Bus Running Repairs

F. Repairs for Vandalized Vehicles

Savings have also been achieved on repairs for vandalized vehicles over the past four years, as the following chart indicates.

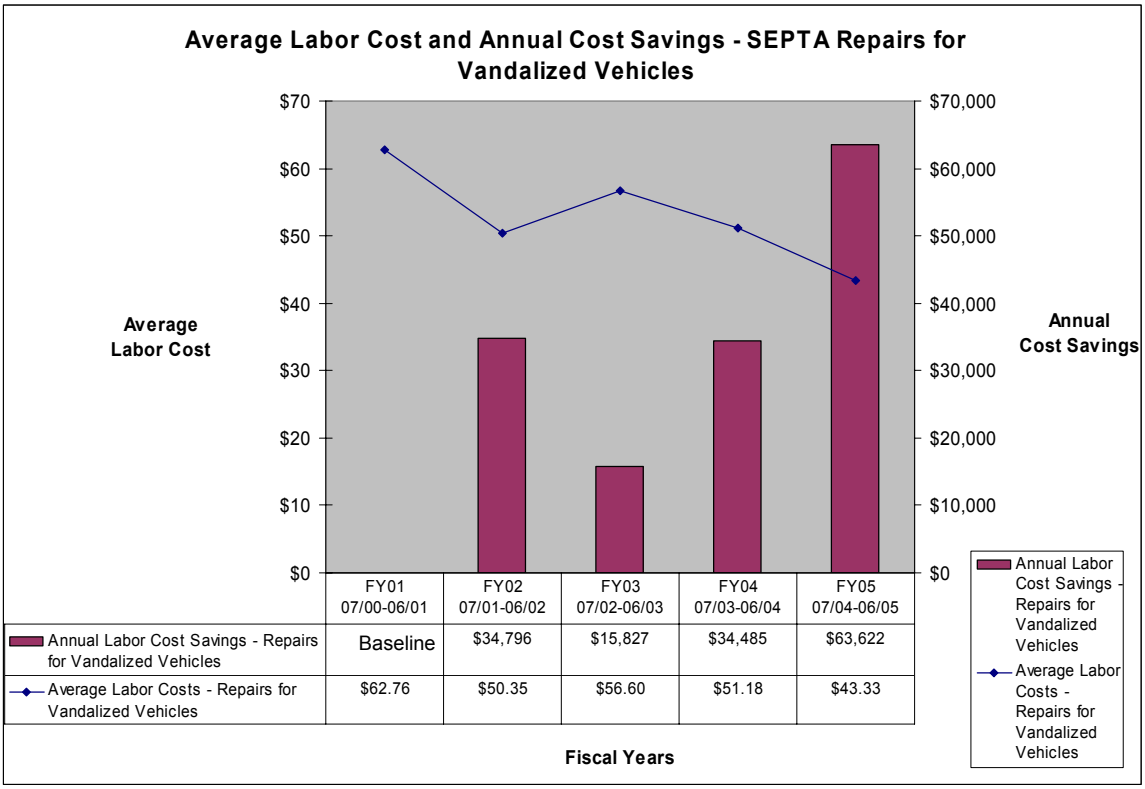
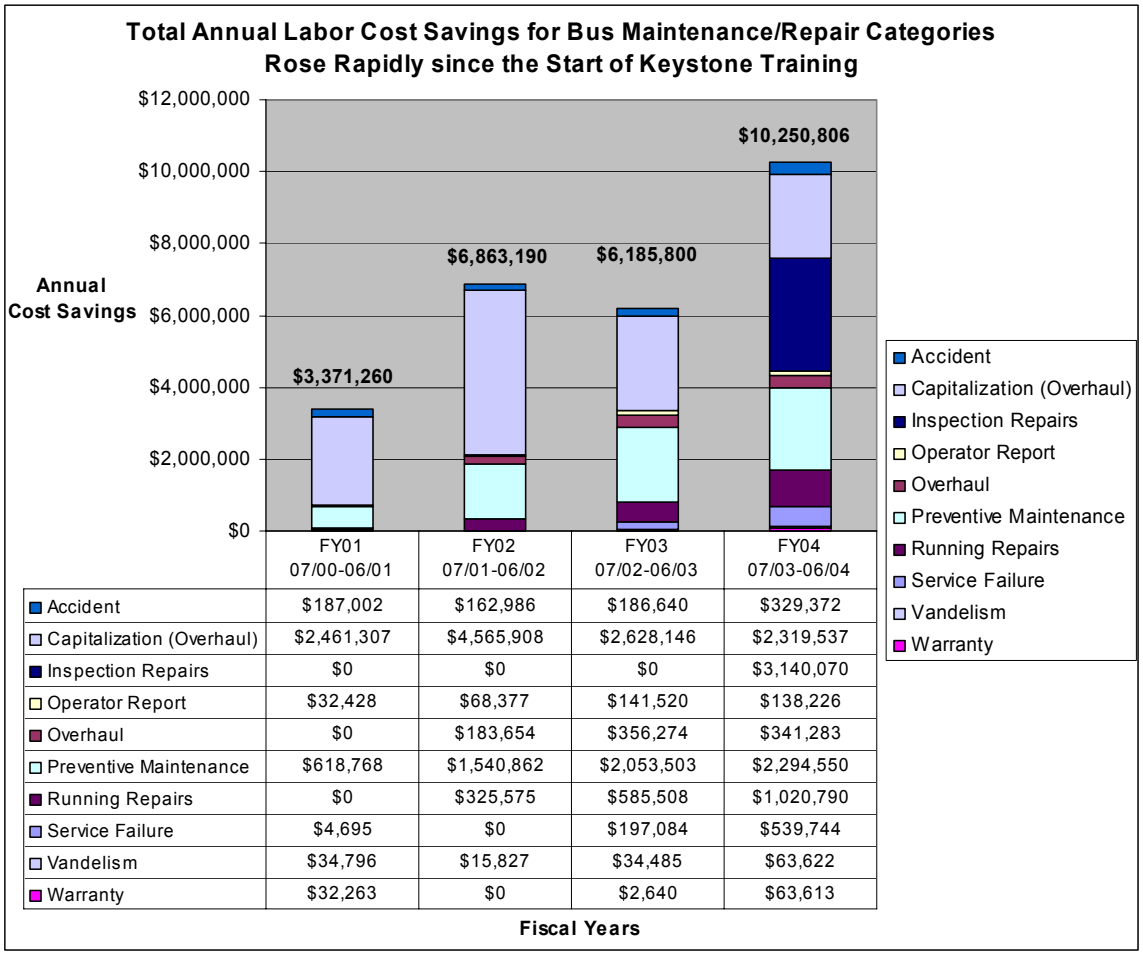


Figure 10. Average Labor Cost and Annual Cost Savings – SEPTA Repairs for Vandalized Vehicles

G. Total Annual Labor Cost Savings for Bus Maintenance/Repair Categories

In addition to savings presented in the earlier sections, partial maintenance labor cost savings have been found in categories such as repairs of vehicles involved in accidents, capitalization (scheduled vehicle overhaul programs), inspection repairs, and repair jobs covered under manufacturers' warranties. Figure 11 on the following page summarizes the labor cost savings revealed so far. The annual savings for all bus maintenance/repair categories rose rapidly from $3,371,260 in the first year of Keystone to $10,250,806 in the fourth year. The gross savings for all four years add up to $26,671,057. The savings represent greater effectiveness in use of resources by SEPTA. Increasing the effectiveness of resources allowed SEPTA to take on other bus maintenance tasks that might otherwise have been deferred. That, in turn, should lead to better fleet performance in coming years. If all works well, the contributions of training and decisions to increase preventive maintenance lead to a virtuous cycle of improvements that lead to a better transit system. For a fuller discussion of savings leading to better customer service see, "Toward a More Complete Measure of Benefits from Effective Training," beginning on page 17.

Extensive research is needed to parse out all possible variables causing this saving. Yet strong anecdotal evidence shows that Keystone training has played a significant role in upgrading worker skills and advancing both the quality of the work and productivity of the maintenance workforce. Furthermore, by utilizing *average* labor cost per work order to calculate the savings, variables such as total vehicle hub mileage (that may impact the number of annual maintenance work orders) would have a lesser effect on the results.



	FY01 07/00-06/01	FY02 07/01-06/02	FY03 07/02-06/03	FY04 07/03-06/04
Accident	$187,002	$162,986	$186,640	$329,372
Capitalization (Overhaul)	$2,461,307	$4,565,908	$2,628,146	$2,319,537
Inspection Repairs	$0	$0	$0	$3,140,070
Operator Report	$32,428	$68,377	$141,520	$138,226
Overhaul	$0	$183,654	$356,274	$341,283
Preventive Maintenance	$618,768	$1,540,862	$2,053,503	$2,294,550
Running Repairs	$0	$325,575	$585,508	$1,020,790
Service Failure	$4,695	$0	$197,084	$539,744
Vandelism	$34,796	$15,827	$34,485	$63,622
Warranty	$32,263	$0	$2,640	$63,613

Figure 11. Total Labor Cost Savings for Bus Maintenance/Repair Categories Rose Rapidly since the Start of Keystone Training

2. Increases in Scheduled Maintenance and Decreases in Unscheduled Maintenance

Between FY01 and 05, there has been a general trend of increasing percentage of scheduled maintenance (repair jobs accomplished within a planned service interval) and decreasing percentage of unscheduled maintenance (falling between scheduled service intervals) at SEPTA (See Figure 12 below). Scheduled or planned maintenance, including activities such as PM inspections, planned component overhaul programs, retrofits and inspection repairs, accounted for 46 percent of all bus repair jobs in 2001, and increased to 56 percent in 2005. Correspondingly, unscheduled maintenance activities[10] resulting from mechanical failures reported by bus operators, running repairs and unforeseen defects covered under vendor warranties dropped from 51 percent to 42 percent. The reduction of unscheduled maintenance is a strong indicator of improved equipment performance as a result of better and more frequent preventive and predictive maintenance. Moving maintenance into the scheduled category gives the maintenance department greater control, improves the structure of the operations, and generates cost savings from the reduction of costly breakdowns. As explained earlier in the report, this shift in maintenance scheduling accompanied several rounds of large-scale bus fleet procurement at SEPTA. However, training has undoubtedly contributed to making this shift possible in feeding SEPTA with more adequate and capable maintenance manpower to perform the scheduled jobs in a timely fashion.

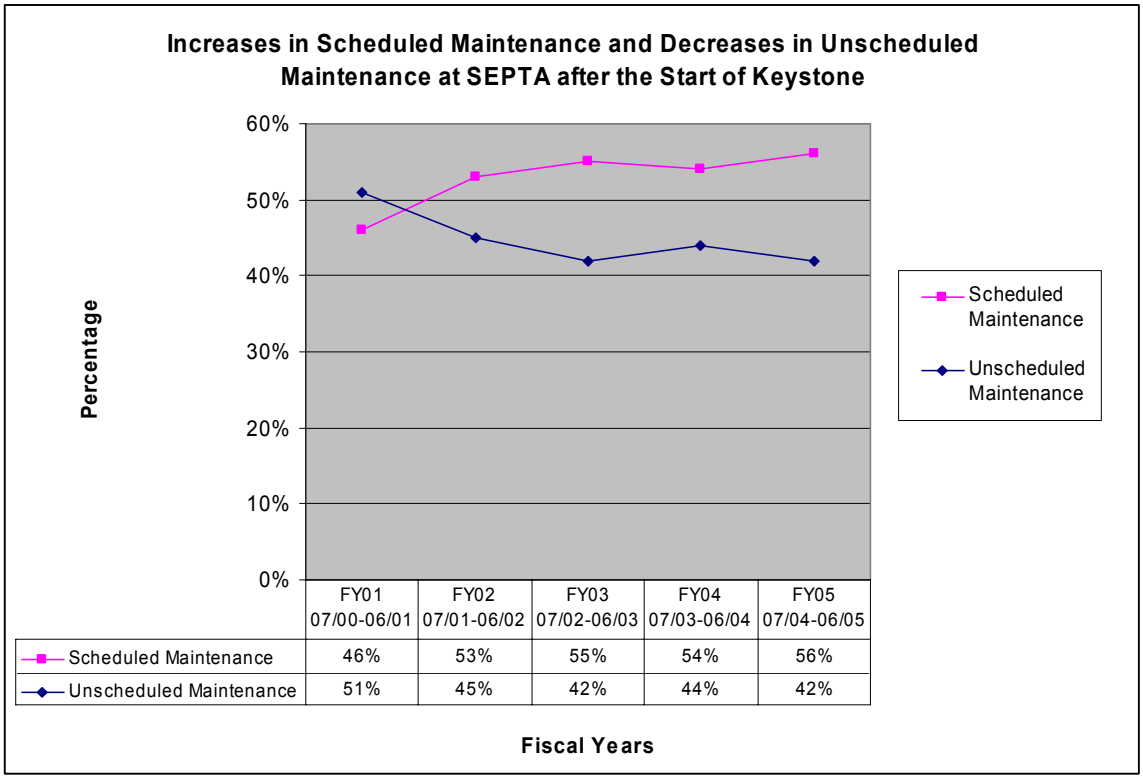


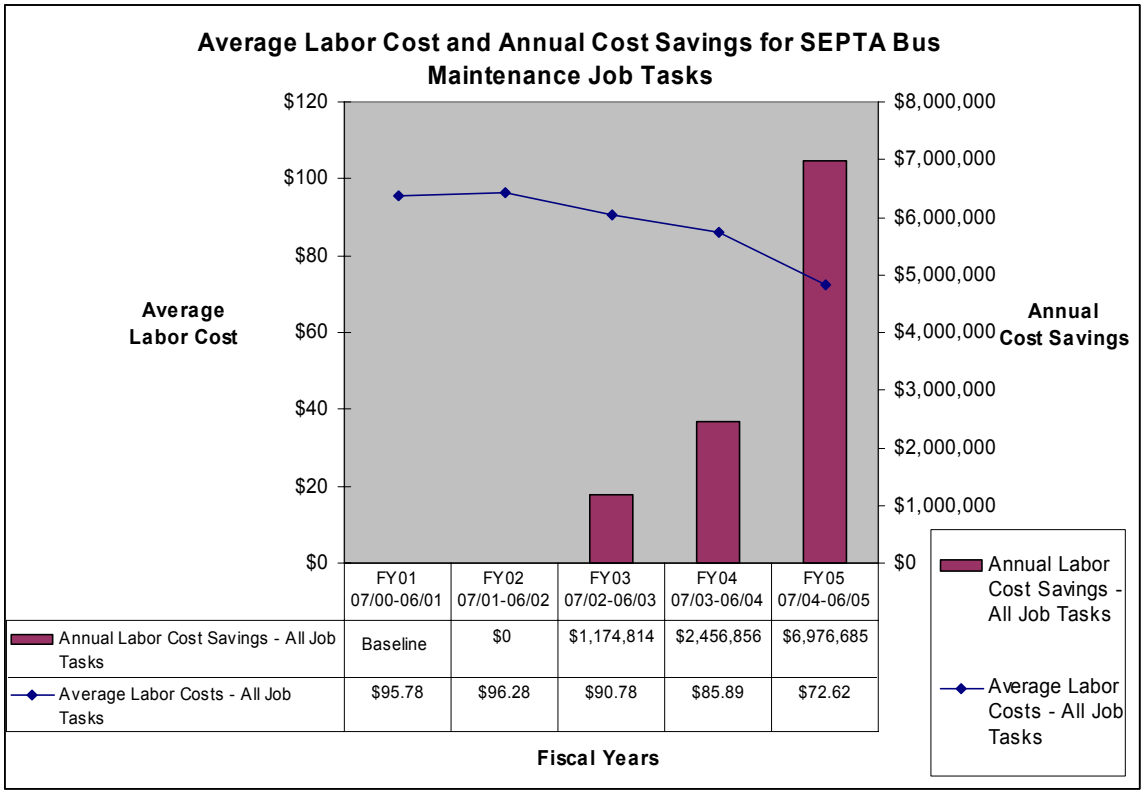
Figure 12. Increases in Scheduled Maintenance and Decreases in Unscheduled Maintenance at SEPTA after the Start of Keystone

[10] Even though repairs resulting from accidents, fire and vandalism are also unplanned activities, they are not included in the calculation of the percentage due to the fact that they are largely beyond the control of transit maintenance planning.

3. Labor Cost Savings for SEPTA Bus Maintenance Job Tasks

The first volume of *Measuring Up* reported declining number of replacement jobs and the associated labor costs with improved diagnostic and preventive maintenance skills in the mechanics. Further analysis of the repair data shows that the average labor cost has in fact fallen on almost all accounts of maintenance job tasks, from $95.78 per job task in FY01 to $72.62 in FY05[11]. A total saving of over $10 million was achieved over time.

Readers should be aware that savings presented in this section largely overlap with those in Figure 11, given that maintenance/repair work orders are normally broken down into more detailed job tasks that specifies the associated parts and actions. For this reason, savings in this section will be excluded from the benefits and costs comparison later in this report.



	FY01 07/00-06/01	FY02 07/01-06/02	FY03 07/02-06/03	FY04 07/03-06/04	FY05 07/04-06/05
Annual Labor Cost Savings - All Job Tasks	Baseline	$0	$1,174,814	$2,456,856	$6,976,685
Average Labor Costs - All Job Tasks	$95.78	$96.28	$90.78	$85.89	$72.62

Figure 13. Average Labor Cost and Annual Cost Savings for SEPTA Bus Maintenance Job Tasks

[11] Fiscal year 2002 saw the average labor cost go up slightly for about $0.5.

4. Toward More Complete Measures of Benefits from Effective Training

The savings presented here largely reflect savings in labor costs. Since labor costs represent a very high proportion of maintenance costs and training directly influences the skills and knowledge a mechanic brings back to the job, it is logical that labor costs would represent a significant portion of savings that might be influenced by training. If training works well, other benefits should accrue to a transit agency. This report has already cited some cost savings in parts in preventive maintenance. In the data examined so far at SEPTA, there is no evidence of savings in parts overall in maintenance.

Substantial evidence does exist that training can produce savings on parts. In Volume 1 of *Measuring Up*, the Center presented a chart from AMTRAN, a smaller transit property in Altoona, Pennsylvania showing savings on battery replacements. Gary Williams, the maintenance manager at AMTRAN, traced the savings on battery replacement after sending five of his mechanics to a basic electric course. Because the workers could understand the whole system and perform some basic maintenance tasks such as fixing the wiring, the need for jobs requiring replacement of two batteries dropped sharply. The Chart is presented below.

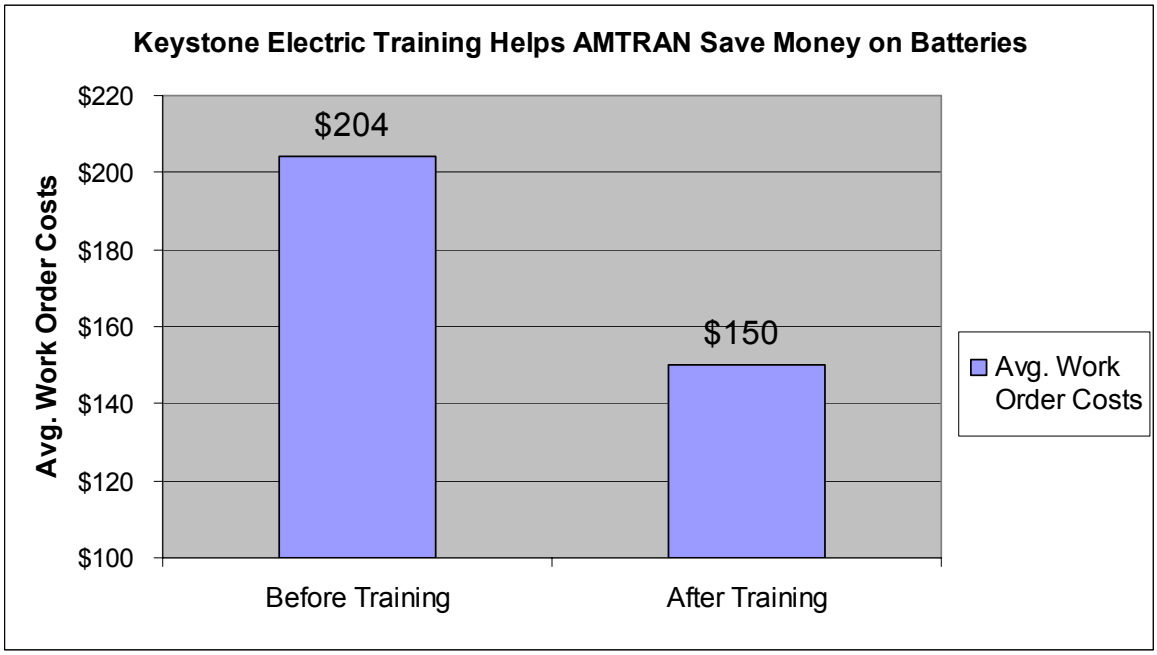


Figure 14. Keystone Electric Training Helps AMTRAN Save Money on Batteries

In a 2002 study on training for on-board electronics by John J. Schiavone for the Transit Cooperative Research Program (TCRP), even more dramatic evidence emerges:

"One agency participating in this study admitted that a trainer decided to test a stack of expensive relays marked 'defective' only to find that more than 90% were in good

working order. According to leading manufacturers of bus electrical charging systems, nearly 50% of all alternators sent in for repairs are in perfect working order." [12]

Knowledgeable mechanics and supervisors speak often of a pattern of "rip and repair" jobs that are characterized by poorly trained maintenance crews replacing one part then another until the bus runs again. This practice could have devastating consequences as the number of advanced – and expensive – electronic intelligent vehicle systems (IVS) are added to buses.

Well-trained mechanics will understand and diagnose engines and electronic systems effectively and only do needed parts replacements and repairs. Labor costs may decrease if unnecessary jobs aren't done. There could also be very significant savings in parts costs and inventory. Tracking a reduction in unneeded replacements is difficult. No data base at SEPTA or any place will have a baseline of how many unnecessary replacements were done in a given year. The Center will attempt to track parts use and costs over time as a partial measure for these savings.

More fundamentally, the Center will look at broader trends such as decline in repeat failures and improved mean distance between failures (MDBF). Identifying positive trends in these broad reliability measures and relating them to training represents the gold standard of defining improvements.

A transit system with a well trained maintenance work force could reduce costs on parts and inventory and even on capital equipment (with more reliable buses, the ratio of spare buses can go down). A more reliable system and a system capable of adapting to new rider-friendly technologies should be able to increase ridership. The improvement in the system also shows the taxpayers who support transit that their tax dollars are being spent wisely. Ultimately, the effects of training lead to significant cost savings, improved reliability and a transit system with a larger share of the regional market for daily trips taken by residents to work, shopping or leisure.

[12] Schiavone, John J. 2002, *TCRP Synthesis 44: Training for On-Board Bus Electronics.* Transportation Research Board – National Research Council. National Academy Press: Washington, DC. p. 6.

IV. Training Investment / Costs

In the 43 months between December 2001 and June 2005 (Keystone Year 1, 2, 3 and 4), the statewide Keystone Partnership has received $4,528,000 from the Pennsylvania Department of Labor and Industry, with nearly $3 million coming to SEPTA/TWU in Philadelphia. Bus maintenance related training activities[13] accounted for a large share of the total training investment in Philadelphia – $436,644, $257,643, $332,207, $427,001 from program years one to four respectively.

For purposes of this study, it is estimated that SEPTA's internal investment matched the government funding. In fact, SEPTA and TWU Local 234 certainly spent more than the required match. Substantial investments of time, from front-line supervisors through trainers up to the top-level executives, were required to build and sustain the Keystone partnership. Improving the process of training (e.g. implementing the system of mentors) and creating new curriculum across the range of maintenance occupations required major investments, only partially covered by grant funds.

Quantifying how much SEPTA did spend is the subject of future research. Estimating an exact match serves the immediate purposes of this analysis. As the subsequent pages will demonstrate, the benefits from training result in such dramatic savings that even an increased SEPTA investment would still yield very positive returns.

V. Benefits and Costs Comparison on Keystone Training

Figures 15 and 16 on the following page illustrate the bus training costs and partial benefits for the first four years. The top lines on the chart represent the benefits summed up in Figure 11 on page 14. The bottom lines are the internal and total costs of the bus maintenance training activities. In both charts, the benefits demonstrated a steady upward trend over time, while the costs remained relatively constant and very low compared to the benefits.

The earlier note of caution must be applied here. In looking at these very robust benefits, this report specifically avoids calculating a rate of return on the investment in training. The benefits observed here derive from multiple sources. A remaining research challenge will involve quantifying training's contribution to these dramatic savings.

[13] Costs presented include trainee wage reimbursement, instructor/SME wage, mentor wage premium reimbursement, vendor training, train the trainer, training equipment/aids, third party assessment and curriculum development, coordinator wages and expenses, union steering committee reimbursement, process training, tech prep training, and program technical assistance.

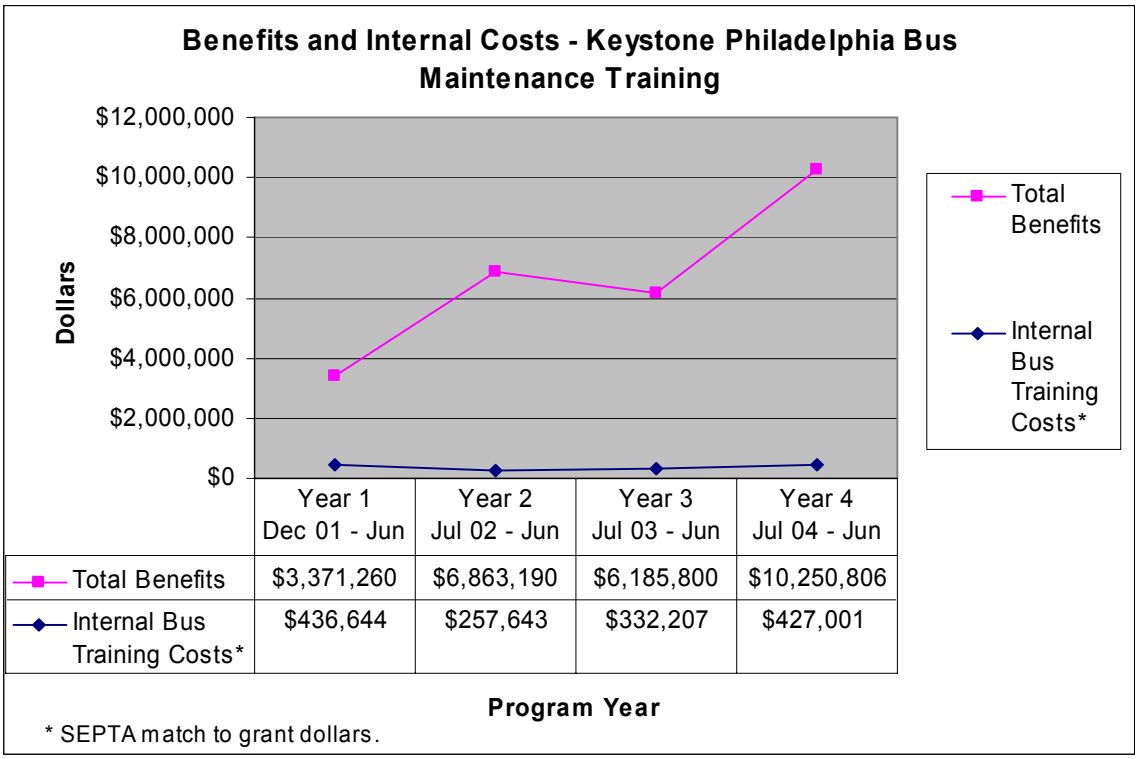


Figure 15. Total Benefits and Internal Training Costs Keystone Philadelphia Bus Maintenance Training

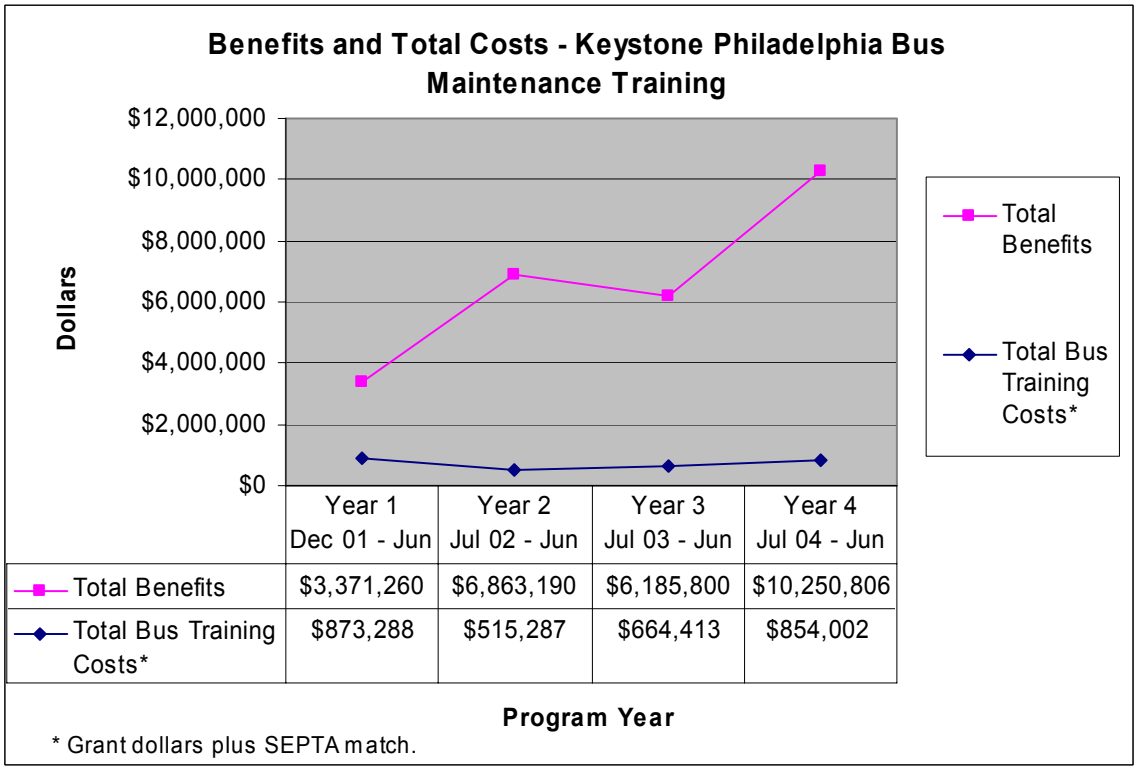


Figure 16. Total Benefits and Total Keystone Training Costs Keystone Philadelphia Bus Maintenance Training

It is worth repeating that only part of the training benefit measures proposed in this research framework has been included in the calculations above. In subsequent research, the Center will examine data in those other areas while developing a formula to define the specific role of training in these savings. With information on changes in repeat failure, parts usage, vehicle downtime, etc., the observed benefits should be even more dramatic.

VI. Conclusion

The data analysis in this *Interim Report* indicates that the unique partnership-based, data-driven training program is producing very positive results for SEPTA and the state of Pennsylvania. An investment of $2,906,990 in training the bus maintenance workforce, in conjunction with other factors such as the emphasis on improved preventive maintenance and other factors, has produced a combined cost saving of $26,671,057 in vehicle maintenance and repair over a four year period, with accelerating savings in each year since the beginning of the Keystone partnership training program.

With even a fraction of such large, quantified benefits deriving from this kind of training, transit systems would be justified in substantially increasing their investment in high-quality training programs - especially ones that mobilize the participation of employees and their unions and front-line maintenance supervisors in a data-driven training partnership. In a few short years, Keystone at SEPTA has created measurable benefits in many major areas that far outweigh the cost of the agency's investment. Even including the total cost of the increased investment in training systems (agency spending plus government grant funds) the value of the partial benefits that can be measured at this point substantially outweighs the total investment. The results of the Center's continuing analysis of more complete data on the benefits side showing more on the quality of work, including repeat mechanical failure and parts usage, will help complete this picture.

Based on just this interim analysis, transit systems would be well advised to invest their scarce budget resources in creating this kind of high quality partnership-based, data-driven expansion of training capacity. If other agencies can produce results similar to those achieved in Philadelphia, their investments in this kind of training will more than pay for themselves, and rather quickly. By acting strategically, the transit industry has an opportunity to save money, or "make money," by investing in this kind of highly effective enhancement of maintenance training.

In conducting research for *Measuring Up*, Center staff focused on quantitative findings. The first volume in the series of Keystone case studies, *Pennsylvania Transit on the High Road,* provided strong anecdotal evidence that a joint labor-management, data-driven training program was providing considerable value to stakeholders in Philadelphia and across the state. The subsequent study, *Making a Difference,* presented impressively consistent positive judgments from people who had been trained and from their immediate supervisors on the value of Keystone training. Those familiar with training, particularly at SEPTA, knew that both shop-floor workers and front-line supervisors had been skeptical of prior training efforts. The dramatic success of the Keystone effort was highlighted by findings that both trainees and their supervisors favored more training by ratios of 9:1. *Measuring Up* and this *Interim Report* were

designed to look at data that measured the benefits of training without relying on good stories or people's perceptions.

In both this *Interim Report* and in *Measuring Up,* the Center did succeed in quantifying results. VMIS and several related data bases maintained by SEPTA provided primary sources for the numbers used, as noted repeatedly. Interviews with managers, both in Philadelphia and in the smaller properties, supplemented the quantitative work.

Asking managers for evidence that training worked often produced a response along the lines of: "I know this training worked because I see better results." Smaller systems tend not to have the data collection capacities of very large transit organizations, so backing up their impressions with hard numbers was more difficult. See Appendix A for some of the quotations from smaller transit agency managers on the benefits of training.

Those impressions, though, provide data, too. Inevitably the managers interviewed would expand on their impressions of improvements resulting from training. All the managers interviewed, without any prompting from the interviewers, spoke about a specific difference training made on the shop floor. Mechanics that had experienced Keystone training, managers reported, had a larger view. They showed improved diagnostic abilities and understood the workings of whole systems within transit vehicles.

The data in this *Interim Report* already demonstrate impressive benefits from training done by Keystone in Philadelphia. The results underscore the need for further research to define more precisely the contribution of training to these results and to examine factors (e.g. on time performance, declining number of unnecessary parts replacement, reduced rate of repeat failures, reduced road calls) for which data so far has been unavailable. These interim findings already demonstrate positive results that can be measured in dollars and cents.

In understanding the success of the Keystone effort—and in trying to replicate its impressive results—it should be emphasized that good numbers flow from the hard work and discipline of dozens of people, from the shop floor working groups to the high level policy steering committee, working together to develop this partnership-based, data-driven model for quality transit training. The challenge offered by these initial results is for other transit systems and their unions to replicate and then build upon this level of demonstrated success.

* * * * * *

Further Research

As presented in the first volume of *Measuring Up*, a higher MDBF has been found at bus garages that received special preventive maintenance training in late 2003 and early 2004, indicating improved vehicle reliability associated with partnership training. Cost savings and revenue gains from this improvement have not yet been fully analyzed and thus are not incorporated in this report. Further research is also needed to examine training benefits that are demonstrated in other area of maintenance and operations, including repeat/chronic mechanical failures, parts usage, road calls, downtime, bus spare ratio and vacancies of skilled positions. Specific work on quantifying the contribution of training to the observed benefits will be a major theme of future research.

Appendix A

Quotes from around the Commonwealth on the Impact of Keystone Transit Career Ladder Partnership

With tight budget restraints for maintenance when it comes to training dollars for the mechanics, training is almost considered a luxury item at rural transit properties. That's why Keystone Career Partnership has been a God sent program to the smaller Class 4 and Class 5 properties across the Commonwealth. . . . All of our mechanics have successfully attended A/C certification classes. Most have attended the A/C preventive maintenance classes and the Lead Techs have attended the advanced A/C classes. *The Authority is experiencing fewer A/C failures and our repairs are lasting longer through multiple cooling seasons. A side bar to fewer A/C failures is fewer customer complaints.* . . . The mechanics that have attended classes come back to the Authority with their "batteries charged" and ready to go. They feel good about themselves, their jobs and bring back a wealth of knowledge garnered from the training session they attended. Just as important is the positive attitude and appreciation toward the Authority for allowing them to attend this training. The entire Keystone program has been a "win-win" program for ATA.

- Charlie Shilk, Director of Maintenance
Area Transportation Authority, Johnsonburg

Everyone we sent has come back home showing results. Even our Rural Division guys have gained from the classes. *Our electrical problems are fewer with faster repairs because they now know what to look for. Our A/C's have become more reliable* (Urban and Rural types). Our top people got training in multiplexing which has helped them. All in all, this program is a plus.

- Doug Greenwood, Director of Maintenance
Cambria County Transit Authority, Johnstown

The A/C training was probably the best. Our mechanics came back with a whole new outlook on PM and servicing of the A/C units. *We have experienced a whole lot less down time with A/C this summer than in the past.*

- Terry Smith, Maintenance Manager
COLT, Lebanon

All our employees have returned with a better understanding of the material. This also *decreases the downtime of our vehicles. They also serve to boost morale and confidence which relates to better job performance.*

- Denny Hahn, Director of Maintenance
Williamsport Bureau of Transportation, Williamsport

The changes we have seen [since Keystone training] include *the reduction of batteries being replaced, better troubleshooting of our electrical problems with a small decrease in down time*, which I think will get better with time and experience. Also, we have more people to troubleshoot/analyze HVAC problems, (everyone has had HVAC training) just have to wait until we have a problem to check out!

- Gary Williams, Director of Maintenance
AMTRAN, Altoona

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