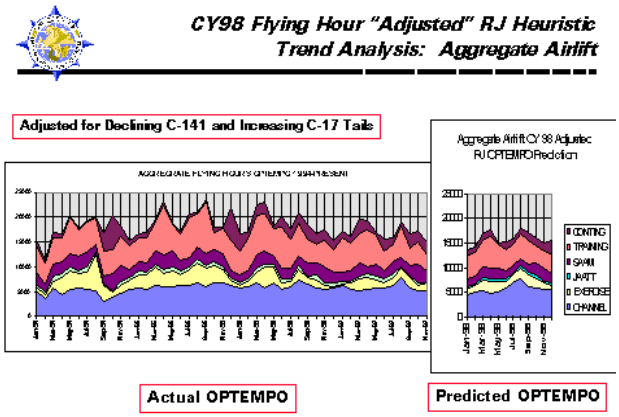
OPTEMPO Forecasting

For Air Mobility and Defense Transportation Operations



by

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Background. Presently, The United States Transportation Command (USTRANSCOM) nor any of its Transportation Component Commands (TCCs) have a system or established methodology that attempts to predict OPTEMPO for the Defense Transportation System (DTS). This paper attempts to lay out project OPTEMPO forecasting/trend analysis focus, concepts, and campaign plan to move project from concepts to implementation. The authors have previously been engaged to determine a practical, reasonably accurate methodology which attempts to provide a gauge of anticipated OPTEMPO trends based on actual historical data. Envisioned "process owners" of USTRANSCOM OPTEMPO forecasting/trend analysis efforts are USTRANSCOM Director of Operations and Logistics (TCJ3/J4) and eventually, TCC operations' leadership. It is envisioned there are both internal and external USTRANSCOM and TCC customers who would benefit from utilizing OPTEMPO forecasting/trend analysis as described in this paper.

To date, efforts have been focused on airlift trend analysis/forecasting, but eventual desired outcome is to have an "across the board" OPTEMPO trend analysis/forecasting tool available in an automated, widely accessible medium to provide information on DTS Operations. The reason for this effort has been to attempt to provide both DTS leadership and customers a practical tool which can be useful for planning and at least assist with supportability decision making. The following paragraphs describe OPTEMPO forecasting/trend analysis as currently developed, while concluding with concepts to define a recommended "way ahead:"

1. Provide a Medium to Obtain and View Historical OPTEMPO Information. To date, project has focused on illustrating Air Mobility Command strategic airlift fleet operations (C-5, C-17,

and C-141). Thus far, archive data has been obtained from Jan 92-present. An initial determination to utilize data from Jan 94 onward was reached by the project officers because they determined that pre-1994 data was operating at a considerably higher OPTEMPO rate than succeeding years (which was attributed to higher force structure. Excel data sheets have been obtained from AMC (from Global Decision Support System (GDSS)) providing number of hours flown per month broken down into 6 major categories (the category data was sorted using mission codes from GDSS archives). Note, a small number of varied missions flown that do not fit into these categories have not been considered to date, but if desired, could also be included in a viewable category such as "other missions." The six major categories are:

a. Contingency/Crisis
b. CJCS Exercises
c. Special Assignment Airlift Missions (SAAMs)
d. Joint Airdrop/Air Transportability Training (JA/ATT)
e. Channel Mission (both frequency and requirements based channels)
f. Unilateral training

Additionally, aggregate totals were illustrated (of the six major categories, plus by airframe category). The following figure illustrates the concept of providing a format to view historical OPTEMPO information:

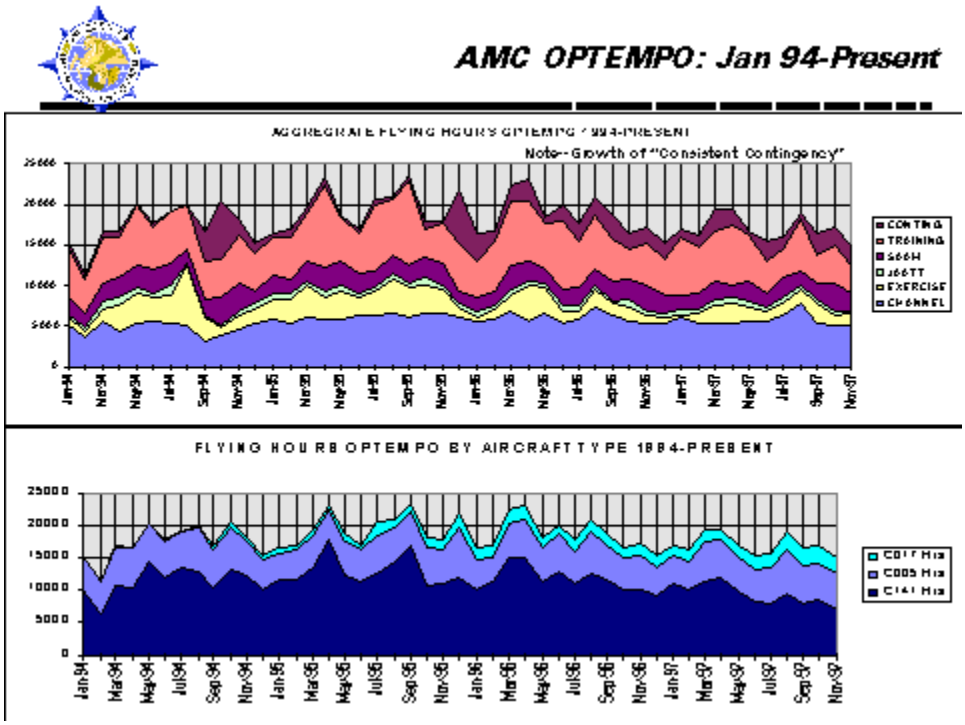

Figure 1: Aggregate Views of Historical OPTEMPO data

2. OPTEMPO Forecasts/Trend Analysis: "Forecasting" offers an initial value over simply providing a picture of what was actually flown. Simply stated, attempting to predict OPTEMPO

allows mobility leadership a force management tool which if tailored to specific needs could be effectively employed across the spectrum of DTS operations—from operations, maintenance and logistical support, to service support missions. This project has made predictions of future OPTEMPO by performing various simple manipulations of existing historical data. The simplest "forecasting" methodology that could be employed is that of "naïve forecasts." A naïve forecast uses most recent forecast period (such as a month) to use as the "forecast" of the next period's activity. The USTRANSCOM OPTEMPO forecast/trend analysis team actually employed three separate approaches of attempting to predict OPTEMPO: Trend lines, monthly moving averages, and a heuristic that averages three previous years of OPTEMPO by month as the predicted "years' forecast." All methods employed provide a "rough order of magnitude" level of accuracy, which could at least serve as a "goal post" for predicting future OPTEMPO. There are significantly more sophisticated forecast methodologies that could improve accuracy of forecasts. However, employing more sophisticated forecasting would require the dedication of considerably more statistical talent and time than the project officers possess. The three separate methodologies were employed in order to attempt to allow leadership to attempt to determine a "most probable position" of future OPTEMPO. Those methodologies are described below:

a. Predict OPTEMPO via Excel "Trend Analysis." This method provides a medium to predict/forecast future operations OPTEMPO, by the six defined categories, both by airframe type and aggregate totals as described above, using Microsoft Excel trend analysis. This is done by utilizing a grouping of determined number of months to serve as a data base, and going to the Excel "pull-down" menu on trend line. The project to date has utilized Jan 94-present, and 1997-present only data applying a 6-month linear and logarithmic trend analysis. Categories included airlift aircraft categories by mission categories as previously described. The intent of attaching Logarithmic analysis to the same data grouping as Linear data was simply to yield another "data point." Excel provides more trend line possibilities, such as exponential trend analysis that could yield yet more data points. All forecasts are presented in terms of airlift hours to enable a baseline commonality among potential OPTEMPO forecasting users. The following figure simply illustrates historical data by month as "data bars," and to the right of the most recent monthly data bar extends the excel "trend lines" for the desired period of trend analysis. Although the project to date has used 6 months as the baseline for future trend period, any range from 1 month onward as the next period of trend analysis is capable. Currently, the data point under the trend line is manually extracted to obtain the trend analysis number of category airlift hours per mission type. The figure illustrates the concept:

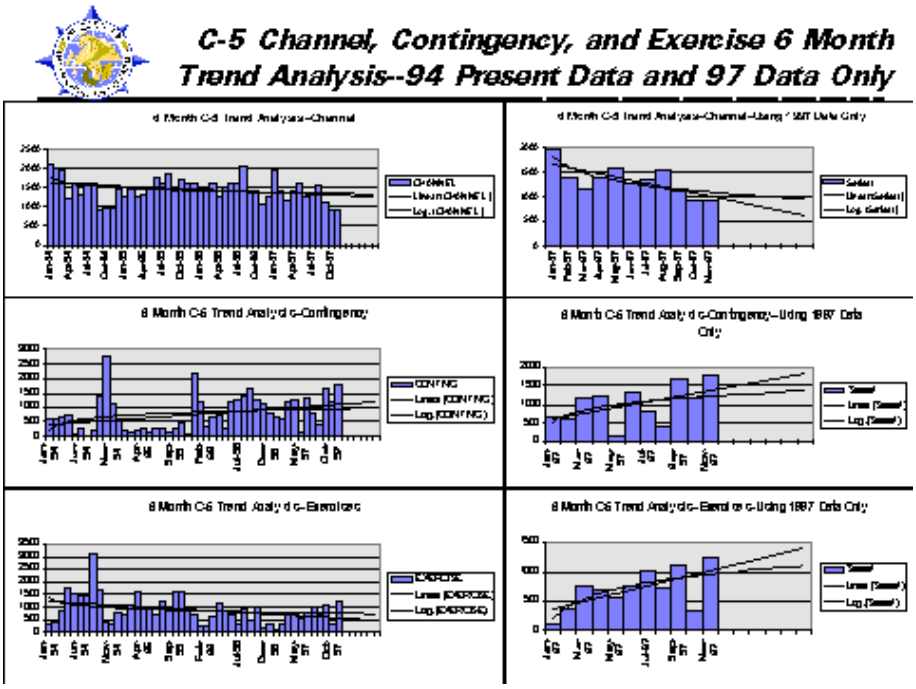

Figure 2: Example of Trend Analysis, using Excel Trend Lines

b. Predict OPTEMPO via Established "Monthly Moving Averages." The project utilized Excel spreadsheets to establish "monthly moving averages for the six defined categories, airframe type, and aggregate totals. The trend analysis was conducted and illustrated for 3, 6 and 12- month categories. Data base was from 1994-present. Project team realized that further forecasting data becomes very "smoothed"—essentially "averaging the averages." This "smoothing" reduces forecasting responsiveness which impacts forecasting accuracy the further the forecast is carried from the last actual known data month. All forecasts are presented in terms of airlift hours to enable a baseline commonality among potential OPTEMPO forecasting users. The following figure illustrates:

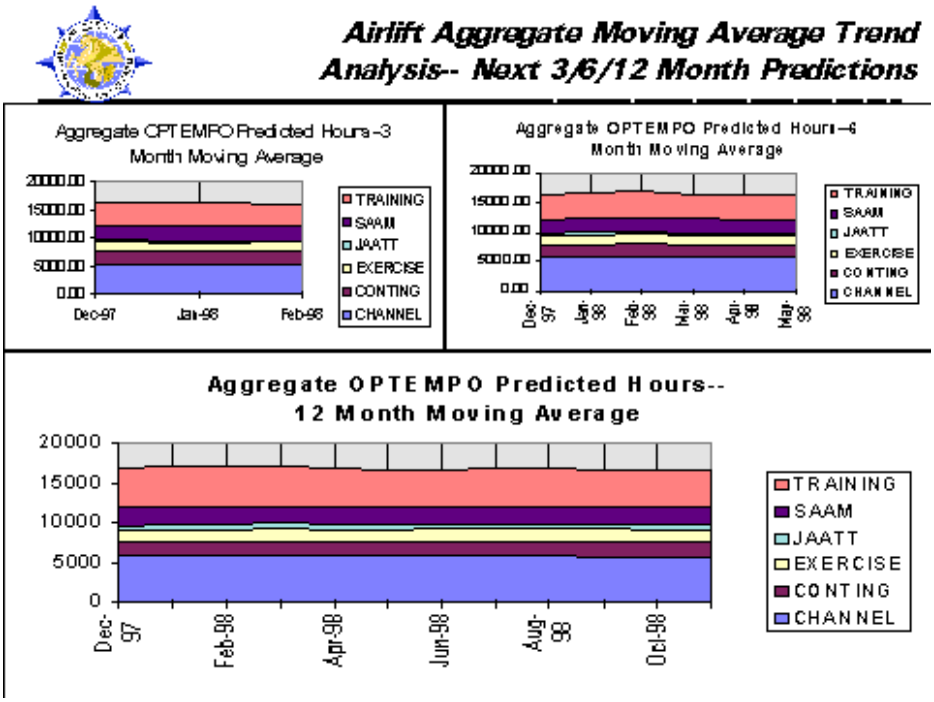

Figure 3: Example of Moving Trend Analysis

c. Predict OPTEMPO via the "RJ Heuristic." This heuristic or rule of thumb was essentially established using a "90 degree different approach" to traditional trend analysis (such as employed when using monthly moving averages techniques). The RJ (standing for first name of team project officers) averages the category of data by month over a period of years. The averaged months by category are then combined to provide up to a year's worth of predicted OPTEMPO. The project to date uses the past 3 years averaged by month via the six categories, airframe type and aggregate totals. A "lesson learned," however, was the RJ method could not adequately account for a dynamic fleet size, such as being experienced in both the C-141 and C-17 inventory. As a result, the modified RJ Heuristic simply multiplies the monthly averages against a change of aircraft inventory factor. To illustrate, the 3-year average of aircraft tails (which is the same period of time used to establish the RJ "by month" Heuristic) are factored against the "forecast" year's planned aircraft inventory. The derived factor is then multiplied against the forecast to arrive at an adjusted forecast. All forecasts are presented in terms of airlift hours to enable a baseline commonality among potential OPTEMPO forecasting users.

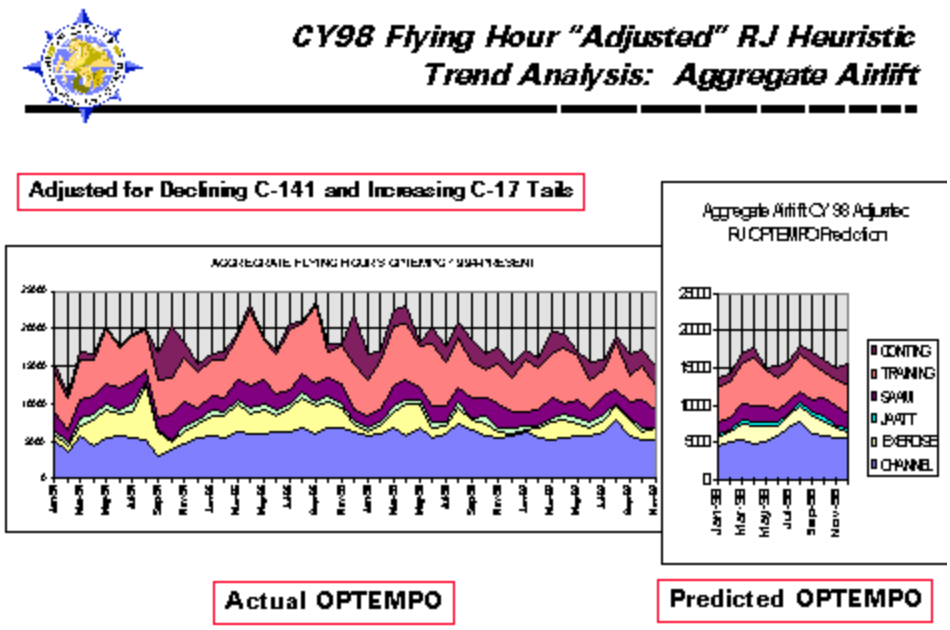

Figure 4: Example of RJ Heuristic Trend Analysis

3. Automating the Methodologies. Once a practical set or series of forecasting tools can be refined/developed, the next step is to determine/develop a suitable series of algorithms needed which would enable automation of forecasts methodologies from the supporting data base. As it is understood, a COGNOS system which enables queried data retrievals direct from AMC's Global Decision Data Support System (GDSS), is being acquired by TCJ4. A similar style of data query would be needed to automatically retrieve GDSS data, to then be fed into the OPTEMPO forecasting/trend analysis algorithms. Regardless of the specific retrieval mechanism, data needs to be retrieved from GDSS to then feed the forecasting tools automatically, to enable the update of the forecast for the next applicable period.

4. Determining a Host Site for the OPTEMPO Forecasting. Once the appropriate forecasting tool/methodology, data retrieval, and automation algorithms can be established, next step in the process is to determine a host site for presenting OPTEMPO forecasting/trend analysis information. It has been suggested that Global Transportation Network (GTN) may provide the appropriate medium to serve as a host site to present OPTEMPO forecasting/trend analysis information, plus historical OPTEMPO. GTN does provide the opportunity of ready access by a wide range of potential customers, and gains the same type of GDSS data feed as is necessary to support OPTEMPO forecasts/trend analysis. Project officers understand that GTN is under a managed improvement and upgrade plan, that would force OPTEMPO forecasting efforts to be compared and prioritized against competing upgrade/improvement programs. A presentation goal for establishing OPTEMPO forecasting would be to establish a user driven menu page that could provide a summary view of potential forecasts which employ the combination of "data points" forecasts, plus snapshots of actual historical data. The following illustration provides a concept view of how such a page could be constructed:

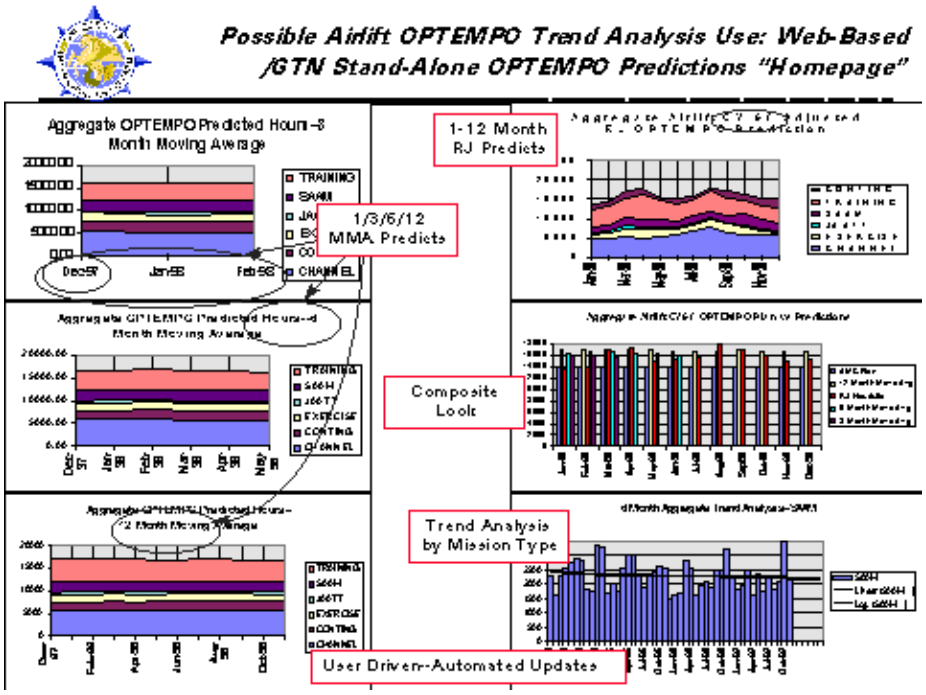

Figure 4: Possible OPTEMPO Homepage View As Envisioned Within GTN

5. "Blending" OPTEMPO Forecasts/Trend Analysis Against Known Requirements. Preceding paragraphs illustrate OPTEMPO Forecasting/Trend Analysis as a "stand alone" methodology. However, it would be desirable to have a data feed which would enable known/scheduled requirements to flow into a table which would allow a cross comparison against "forecast" requirements. This simply allows a look at "what's scheduled on the books" to be compared against what is anticipated in the applicable forecast period. Observation is that the closer the forecast period is to execution, the closer the comparison should be to that of forecast OPTEMPO (and/or actual historical data) . The following slide illustrates the concept:

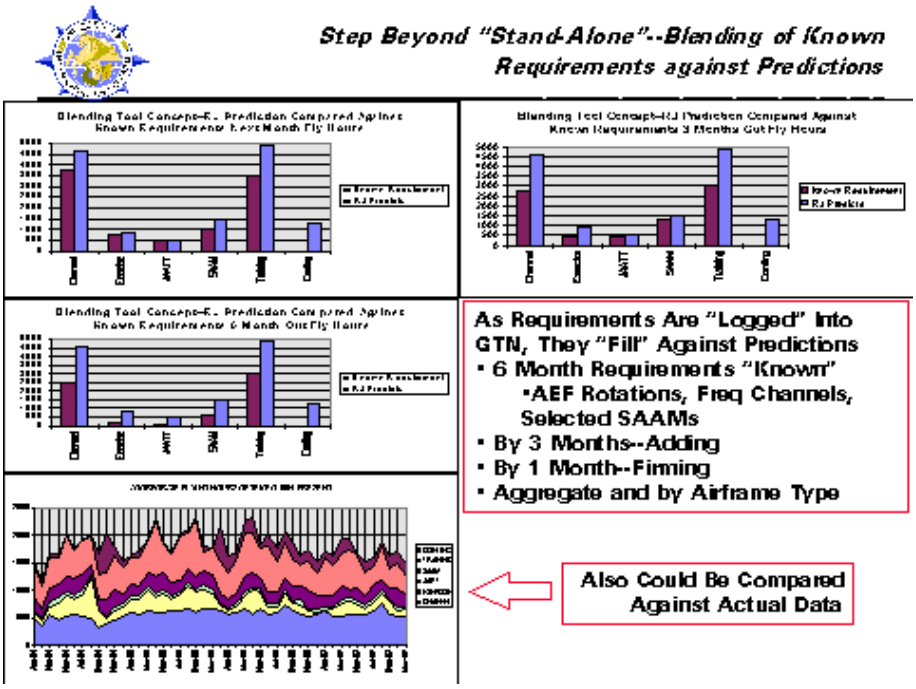

Figure 5: Concept of Forecast OPTEMPO "Blended" Against Known Requirements

6. Continuing the OPTEMPO Forecasting/Trend Analysis Campaign "Plan of Action." The following paragraphs attempt to describe the needed steps to take the OPTEMPO forecasting/trend analysis project beyond the concept stage into at least an initial implementation phase. The envisioned stages of project completion are: define the requirement, design/refine the prototype, automate and implement the prototype into an access medium; once established, refine/upgrade forecasts/automation and access capabilities as refinements are developed and funded. To initiate the campaign, the following list describes the initial steps that should be taken to achieve at least a working prototype within a suitable access medium (such as GTN): a. Needs statement. b. Design and/or refine OPTEMPO forecast/trend analysis methodologies. c. Establish a priority for automation and implementation of OPTEMPO forecasts/trend analysis within a suitable medium (such as GTN). d. Funding of project.

a. Statement of Need. The first consideration which needs to be mapped out is to define a requirement/statement of need to establish OPTEMPO forecasting/trend analysis as a desired tool. The "needs statement" should focus on what OPTEMPO forecasting/trend analysis does and associated benefits. A "rough order-of-magnitude" statement of need is that OPTEMPO forecasting/trend analysis is defined by following remarks. OPTEMPO forecasting is "needed to provide USTRANSCOM leadership and customers a historical view definable by mission type of mobility missions executed plus a practical gauge of expected mobility fleet operations tempo (OPTEMPO) as attainable utilizing statistical forecasting methodologies." Adding thoughts such as "OPTEMPO forecasting/trend analysis tools should be automated and linked in a forum that can provide a supporting historical data base which is necessary for obtaining future forecasts/trends as well as providing a medium accessible to a wide variety

of USTRANSCOM customers is vital for application usefulness." OPTEMPO forecasting/ trend analysis information value is enhanced when it is compared against actual data. Thus the needs statement should also include the remark the OPTEMPO forecasting/trend analysis project should have the ability to "automatically update and present actual historical information." As discussed throughout many OPTEMPO forecasting progress reviews, establishing an automated Forecasting Page via GTN as the OPTEMPO forecasting home site appears to provide an avenue to establish a supporting data base, automation, and wide ranging access for leadership and customer use/information. It is believed by the project officers that OPTEMPO forecasts themselves need to stay in a format that enables wide ranging commonality—for example, flying hours appears to be the best "common base" for air mobility OPTEMPO forecasts.

b. Design and/or Refine OPTEMPO Forecast Methodologies. "Duty experts" who are well grounded in operations research disciplines need to review efforts to date and determine if the forecasting/trend analysis concepts presented could be used initially as a "prototype" to automate and integrate into a medium such as GTN while refining efforts to achieve statistically improved methodologies. The project officers believe that concepts as presented to USCINCTRANS have the potential to serve as a reasonable "point of departure" on forecast methodologies and could serve usefully in a prototype fashion, while better tools are designed. It appears that significant improvements to the OPTEMPO forecasts/trend analysis concepts as described in this paper would have to be borrowed from another source (such as commercial industry) or designed with contractor assistance.

1. Commercial Transportation OPTEMPO Forecasts. Determine commercial transportation industry has available, applicable, automated forecasting tools of OPTEMPO. USTRANSCOM has conducted industry visits with more planned. If possible, need to have industry visits attempt to determine if there are any applicable commercial OPTEMPO forecast methodologies that could be utilized by USTRANSCOM which could supplant the OPTEMPO forecast methodologies as described in this paper in either a prototype or initial operations capability program.

(2.) Contract Development of OPTEMPO Forecasts. Determine if a suitable contractor could be utilized to develop a statistically improved forecast/OPTEMPO methodology. Any developed tool would have to be automated and capable of providing better forecast accuracy than currently designed within the project. At present, the concepts provide an approximately 80% average accuracy "goal post" of predicted OPTEMPO—significant deviations above and below that level have been noted on individual forecasts. This level of accuracy has been discussed as too inaccurate from other than a concept or prototype standpoint. If contractor support was requested to refine/design better forecasting

tools an "acceptable" level of accuracy would need to be levied in the request for proposal.

c. Establish a Priority for Automation and Implementation of OPTEMPO Forecasts/Trend Analysis Within a Suitable Medium (Such as GTN). If it is determined that GTN is the suitable site to establish OPTEMPO forecasts/trend analysis (plus display historical), then an implementation priority needs to be established against other GTN improvement priorities. At this point, it appears that GTN is a suitable host site; however, leadership needs to make a determination that GTN is going to be the home site plus when should it be incorporated within the hierarchy of GTN improvement projects. Automation of OPTEMPO methodologies needs to be accomplished before information can be adequately presented within GTN (or any other potential host site).

d. Funding. OPTEMPO forecasts/trend analysis efforts will most probably need to receive funding support to refine/design, automate, and implement efforts within a suitable access/presentation medium. Contracting support for all the above will probably be necessary to move the program from beyond the concept stage to implementation. Again, "duty smart" personnel would need to be relied upon to assist in drafting a cost proposal to submit for contract bids. As for funding, it has been suggested USCINCTRANS could apply for CJCS CINC's Initiative Funds (CIF) as a potential source to support contracting costs of getting the project launched into the implementation stage. It has been learned, however, that use of CIF to fund contracting support for further OPTEMPO development/implementation is potentially a very difficult endeavor. As stated in the CJCS instruction report for CIF, the primary focus of the fund is to "support unforeseen contingency requirements critical to CINC joint warfighting readiness and national security interests.

Summary. Developing a forum and methodology for presenting OPTEMPO historical and forecasts/trend analysis data has the potential to provide USTRANSCOM and the TCCs a tremendous force management tool. A common concern among those who lead and work the DTS is the axiom of "what will we be doing tomorrow, next week, month, and year?" Developing and presenting historical

and future predictions using historical data provides at least a starting point to gauge "what may come next." The simple tools developed thus far by the project officers are not accurate enough to base critical supportability decisions upon. However, the project officers believe some kind of forecast methodology even of only an 80% or so approximate prediction accuracy would at least provide the people who lead and operate the DTS some visibility of potential OPTEMPO as a point of departure.

As we look to a desired "endstate" the concept of OPTEMPO forecasting has the potential to lead into many other significantly important avenues of interest to the DTS, such as as port workloads and cargo throughput or other useful metrics that could provide benefit to DTS customers and operators alike. If forecasting DTS operations could be refined to an acceptable

level of accuracy, those forecasts could at least provide some level of assistance to a significant variety of force management decisions.

As OPTEMPO forecasting/trend analysis evolves, it should grow towards becoming a cornerstone of DTS database and information management. Trend analysis and forecasting are useful ways to work with the data but, in itself, it is only a partial answer to our information needs. Also, while linear models, moving averages, and other time series modeling/forecasting techniques could be proposed, as we look beyond air mobility OPTEMPO forecasting, research would have to determine if different forecasting models would be required for other areas of the DTS where forecasting would be desirable.

GTN provides a medium across the DTS that enables access for both operators and customers. GTN appears to be the most logical choice as a host site for OPTEMPO forecasting and other related information management applications. Because GTN has such tremendous information management possibilities, applications need to phased and orchestrated to enhance the utility of its tremendous potential. Considerably more value to the efforts expressed in this paper could be realized if known requirements could be compared against predictions in a "blended" format. Again, GTN appears to offer the opportunity to provide both a "stand alone" forecast and a "blended" forecast/known requirements model in a "one stop shop" for quality DTS operations information management. As a starting point however, implementing a refined version of the basic concepts while more statistically accurate tools are developed could provide value now to DTS operators, approaching the efforts from an evolutionary perspective. The authors believe the inherent value of this paper and project to date has been to highlight a potential area of "process improvement" within USTRANSCOM that could positively impact both DTS customers and operators alike—both near and long term.
