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Technology Assessment for Powertrain Components Final Report CRADA No. TC-1124-95

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Technology Assessment for Powertrain Components

Final Report
CRADA No. TC-1124-95
Date Technical Work Ended: November 6, 1999

Date: August 6, 2001 Revision: 3

A. Parties

This project was a relationship between Lawrence Livermore National Laboratory and General Motors Corporation (General Motors Powertrain Division).

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B. Project Scope

There were four tasks in this project:

1. Technology Selection
2. Gathering Information, Technology Familiarization
3. Scenario Construction
4. Reporting Format and Deliverables

LLNL utilized its defense technology assessment methodologies in combination with its capabilities in the energy, manufacturing, and transportation technologies to demonstrate a methodology that synthesized available but incomplete information on advanced automotive technologies into a comprehensive framework.

LLNL also organized this intelligence into a presentation format that provides easily grasped information visualization.

The assessment methodology employed for GMPT was similar to the methodology used by LLNL to make assessments of foreign weapons technology. The information used to make these assessments was derived mostly from open and public sources. The methodology was useful, but there was incomplete information from numerous sources spanning the full width of the reliability spectrum. Some of the information was contradictory and inconsistent with other data. Overall assessments of foreign technology trends made with an incomplete database would be open to multiple interpretations.

A technology assessment methodology that was productive with this type of database was to assemble elements of incomplete information into simple technology trend scenarios that would be used as working suppositions. These scenarios assumed use of the technology by the competitive manufacturers and were consistent with the known facts. As more information was obtained the scenarios were refined and those no longer compatible with the available information were discarded. Information indicators and data observables supporting the scenario were earmarked for more detailed search in the database.

The construction and analysis of technology scenarios focused attention on scenario weaknesses and narrowed the information search domain for observables that would either augment or diminish the scenario.

Sometimes a scenario led to predictions of additional observables that had not been previously noticed or recognized as significant. If this additional data were found together with other corroboratory information, then that scenario was strengthened. On the other hand, the finding of scenario contra-indicators and of observables negating corroboratory data weakened the scenario and led to its eventual discard.

This methodology allowed the construction of refined, if not perfect, scenarios that were inferred from information referenced in the database. An overall assessment of the scenario fidelity was then attributed to the reliability of the data elements and the coherence with which they fit together. Scenario dependent predictions about future technology trends were formulated.

Deliverables
The deliverable resulting from Task 1 was a selection of topic focus area and a work breakdown statement describing details of work performance. The Task 2 deliverables were the establishment of database search strategies, the exercise of it, the formation of an information ranking system, and the establishment of a database structure in which to deposit and rank information.

In Task 4, The Principal Investigator (PI) prepared a written status update report and delivered it to GMPT during the first phase. This report summarized progress made and resources spent. In addition, the PI prepared briefings for the GMPT assessment team that detailed report progress, defined methodology strategy, and refined presentation techniques. These briefings were delivered to GMPT.

C. Technical Accomplishments

There were four tasks in this project:

1. Technology Selection
2. Gathering Information, Technology Familiarization
3. Scenario Construction
4. Reporting Format and Deliverables

Task 1: Technology Selection
The first task requirement was to select specific technologies to be identified as targets for initial information gathering/assessment and to define progress milestones.

This approach introduced the assessment team members (LLNL and GMPT) to the automotive problem, allowed a narrowing of the initial search domain and directed the effort toward building a database of technology mini-assessments to be used as a reference library for broader technology evaluation. The GMPT assessment process was reviewed to formulate a methodology conformation or negation check.

A list of potential candidate technologies for initial study was:

- Combustion Charge Handling Lean-Burn Systems
- NO_x Catalysts
- Direct Fuel Injection And Stratified Charge Engines
- Light Weight Alloys and Composite Materials
- Ignition And Spark Delivery Systems Light Weight Alloys
- Composite, Metal-Matrix And Advanced Materials Coatings
- Friction Reducing Materials For Poston Rings And Bearings
- Assembly Techniques
- Sensors And Controls

- Piston Engine Hybrid Vehicles
- Electric Motor Packaging And Motor/Generator Cooling
- Fuel Cells
- Continuously Variable Transmissions

This list was initially narrowed to these primary areas: Direct Injection, Lean NO_x Catalysts, Continuously Variable Transmissions, and Light Weight Alloys and Composite Materials.

Initial task selection was made by the assessment team members, primarily according to GMPT interest and secondarily depending upon the richness of the available information about the technology and the ability to construct meaningful scenarios from it.

The deliverable resulting from Task 1 was a selection of topic focus area and a work breakdown statement describing details of work performance.

A list of task progress milestones was:

- Selection of Technologies For Assessment
- Set Up of Information Retrieval Hardware and Construction of Search Strategies
- Formation of Assessment Team Members
- Development of Simple Scenarios

Task 2: Gathering Information, Technology Familiarization

Information about specific advanced technologies, their potential application and usefulness to the worldwide automotive industry, public perceptions of these technologies, and the like were readily available through open and public sources. These sources included publications in scientific, engineering, commercial, and automotive professional journals, news articles, international conferences, and trade shows, discussions with automotive professionals, visits to manufacturers, the internet, etc.

Auto employees and executives who met and held discussions with their colleagues at professional meetings frequently gained impressions and insights into what the competition was doing.

A major effort for the assessment team during the first task-year was to identify and familiarize themselves with these sources of information and to exercise them for informational content. Networking and interacting with the professional automotive technical community and by performing database searches to retrieve and digest technical information accomplished this effort.

The Principal Investigator (PI) developed databases of automotive technology information sources and techniques on how to access them. This task was initiated within Energy, Manufacturing and Transportation Technologies (EMATT) program office using program reference material found in the Technical Information Department (TID) library at LLNL. Information search and retrieval expertise, available from TID, provided support in locating databases of automotive information, developing search strategies, and setting up the appropriate computer hardware.

Information retrieval was initially oriented toward technologies considered as candidates for selection and further study. Articles and references were procured and reviewed to develop an understanding of the technology, its principles of operation, and its proposed benefit to the industry.

Answers were sought to questions about the technology such as:

1. What is the current status of the technology?
2. What are its problems?
3. What are the required supporting technologies?
4. Are additional factors needed to utilize the technology?
5. Which manufacturers are interested in the technology?
6. How far is the technology from the marketplace?
7. What are the costs and requirements to develop, implement and mass produce the technology?
8. Are alternative technologies available that provide a similar benefit?

An information structure was defined enabling answers to the above and other relevant questions to be categorized and compared. It was then possible to construct a meaningful ranking system to evaluate specific technologies with regard to implementation costs and consequences.

The Task 2 deliverables were the establishment of database search strategies, the exercise of it, the formation of an information ranking system, and the establishment of a database structure in which to deposit and rank information.

Task 3: Scenario Construction

Information about technologies selected for assessment was assembled and scenarios constructed for which the technologies come into mass use by competitive manufacturers. The assessment team attempted to validate or discard these scenarios by searching the available database for technology indicators, observables and their supporting infrastructures and to determine the existence or nonexistence of technology contra-indicators and show stoppers.

The construction of technology scenarios from incomplete data elements represented the innovative aspect of this assessment assignment. It was the first year goal of the assessment team to have some elementary scenarios under construction that are of technological interest to GMPT. This construction could not occur until a critical mass of information had been obtained and digested by the assessment team.

Task 4: Reporting Format and Deliverables

The Principal Investigator (PI) prepared a written status update report and delivered it to GMPT during the first phase. This report summarized progress made and resources spent. In addition, the PI prepared briefings for the GMPT assessment team that detailed report progress, defined methodology strategy, and refined presentation technique. These briefings were delivered to GMPT.

D. Expected Economic Impact

This effort provided the GMPT assessment team with assessment methodology consisting of informational search strategies and proposed methods for handling relevant data.

This task enhanced and expanded the LLNL capability to utilize NAI methodologies for assessing technical programs. It complemented the Energy Manufacturing, and Transportation Technologies (EMATT) programmatic thrust areas within EMATT and assisted the lab in augmenting its materials science and computer technology establishment.

E. Partner Contribution

LLNL provided the leadership and expertise for assembling an automotive technology assessment team to perform these tasks and constructed a suitable assessment methodology based upon its experience with foreign weapons technology assessments.

LLNL also formulated informational search strategies, developed databases of relevant data, and reported to GMPT as specified in Task 4.

F. Documents/Reference List

A progress report and presentation materials have been cited in the body of this report.

CRADA reports and other topic/periodic reports

A final technical report was written at the end of the CRADA.

Patent/copyright activity

No patents or copyrights were generated by this project.

Subject inventions

No subject inventions were created during this CRADA.

Background Intellectual Property (BIP)

There was no formal BIP involved in this CRADA.

G. Acknowledgement

Participant's signature of the final report indicates the following:

1) The Participant has reviewed the final report and concurs with the statements made therein.
2) The Participant agrees that any modifications or changes from the initial proposal were discussed and agreed to during the term of the project.
3) The Participant certifies that all reports either completed or in process are listed and all subject inventions and the associated intellectual property protection measures generated by his/her respective company and attributable to the project have been disclosed and included in Section E or are included on a list attached to this report.
4) The Participant certifies that if tangible personal property was exchanged during the agreement, all has either been returned to the initial custodian or transferred permanently.
5) The Participant certifies that proprietary information has been returned or destroyed by LLNL.

Charles Gough 11-13-01

Charles Gough, Contract Administrator — Date
General Motors

Frank Tokarz 1-15-02

Frank Tokarz, Principal Investigator — Date
Lawrence Livermore National Laboratory

Karena McKinley 2/12/02

Karena McKinley, Director — Date
Industrial Partnerships & Commercialization
Lawrence Livermore National Laboratory

Attachment I – Final Abstract

Technology Assessment for Powertrain Components

Final Abstract (Attachment I)
CRADA No. TC-1124-95
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C. Benefit to Industry

This effort provided the GMPT assessment team assessment methodology consisting of informational search strategies and proposed methods for handling relevant data.

D. Benefit to DOE

This task enhanced and expanded the LLNL capability to utilize NAI methodologies for assessing technical programs. It complemented the Energy Manufacturing and Transportation Technologies (EMATT) programmatic thrust areas within EMATT and assisted the lab in augmenting its materials science and computer technology establishment.

E. Project Dates

November 6, 1998 – November 6, 1999