

# Integrating AI Components for a Military Planning Application

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## Abstract

We integrated three mature AI reasoning systems and several legacy military systems in order to provide human planners with advanced capabilities in a military planning domain. The integration demonstrates the operation of a diverse set of AI applications that present a unified system to a human planner in a realistic and meaningful context. We began with an operational planning support system and integrated into it AI components that filled technology gaps. These components, drawn from AI research laboratories, were a generative planner, a temporal reasoner and plan visualizer, and a knowledge-based plan critiquer. The resulting system uses a shared representation to support plan authoring, consistency checking, feasibility analysis, replanning, and visibility into the plan. The support provided is flexible and user controlled. We describe lessons learned from the simultaneous application and integration of mature AI research software, and for individual system components, primarily as they relate to the representation of plans.

## Introduction

Military planning support systems demand end-to-end functionality that can be provided by the integration of separately developed components, including AI and legacy systems. Pursuing both application and integration requires tailoring tools to the requirements of a user while making the integration appear seamless through a combination of common interfaces and the use of shared representations and reasoning tasks. The challenges for integration multiply when we consider the need of the end-to-end system to augment rather than supplant human reasoning and to support an existing military work process.

The system described in this paper had, as its genesis, a manual plan authoring tool, the Air Campaign Planning Tool (ACPT), which the U.S. Air Force (USAF) developed after the air war in the Persian Gulf to capture their experiences in developing and executing the air campaign. ACPT was designed to support a new military planning paradigm called "strategy-to-task." Strategy-to-task planning involves articulating high-level military strategies down to specific actions or tasks. It is a complex human

endeavor, and the goal of the integrated system we describe was to combine technology into an end-to-end planning system to better support it. As a standalone application, ACPT lacks support for the time-consuming and complex tasks of generating consistent and complete plans. ACPT also lacks support for generating qualitatively different plans to address the same high-level campaign objectives and then estimating the feasibility of these plans. Additional system requirements were for military planners to be able to (1) achieve a coherent view of a plan that includes its structure, resources, and timeline, (2) understand the results of changes in the plan, (3) manage dependencies, and (4) perform "what-if" analyses.

The planning system we describe is called the IFD4 system because it resulted from a year-long effort called the Integrated Feasibility Demonstration 4 (IFD4). IFD4 was the fourth major demonstration effort of the [D]ARPA/Rome Laboratory (RL) Planning and Scheduling Initiative (ARPI). ARPI is a multiyear program, begun in 1990, for the development of the next generation of knowledge- and constraint-based planning and scheduling technology (Fowler, Cross, and Owens 1995). As is typical of a feasibility demonstration (see Bienkowski and Edwards, 1996), the IFD4 system as it was demonstrated in 1996 is not in current use. Instead, based on the favorable reviews it received from government sponsors and the military end users, parts of the system and system concept were transitioned to other programs within DARPA in early 1997. The IFD4 system concept and software modules were also used for a 1997 ARPI demonstration on planning and evaluation of multiple alternative plans using advice, visualization, and simulation. Also, some IFD4 concepts and code have been included in deployed versions of ACPT.

The IFD4 system development team<sup>1</sup> integrated several AI reasoning systems in order to meet the demands of the strategy-to-task planning application. The IFD4 system started with ACPT and a campaign analysis tool. ACPT provides an excellent user interface to a text-based plan editor and database, and provides a way for users to organize an air campaign hierarchically from high-level military

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