O-Plan

Information Package

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Acknowledgements

The O-Plan project began in 1984. Since that time the following people have participated: Colin Bell, Ken Currie, Jeff Dalton, Roberto Desimone, Brian Drabble, Mark Drummond, Anja Haman, Ken Johnson, Richard Kirby, Glen Reece, Arthur Seaton, Judith Secker, Austin Tate and Richard Tobin.

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From 1989 to 1993, research on scheduling applications of the O-Plan architecture was funded by Hitachi Europe Ltd. From 1989 to 1992, the UK Science and Engineering Research Council (grant number GR/F36545 – UK Information Engineering Directorate project number IED 4/1/1320) funded a collaborative project with ICL, Imperial College and other partners in which the O-Plan architecture was used to guide the design and development of a planner with a flexible temporal logic representation of the plan state. A number of other research and development contracts placed with AIAI have led to research progress on the O-Plan prototype.

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Contents

1 Introduction

This Information Package on the O-Plan system introduces papers which describe some aspects of the O-Plan system. They generally are published papers which reflect the rationale behind the O-Plan system or some component of it.

Information on licencing O-Plan for use for authorised purposes and for licencing software that can be used to support O-Plan is included at the end of the Information Package.

The papers themselves are not included directly in the Information Package but may be provided as optional appendices which are available on request from the O-Plan Team at AIAI.

Figure 1 shows how the attached papers relate to the main themes of the O-Plan research.

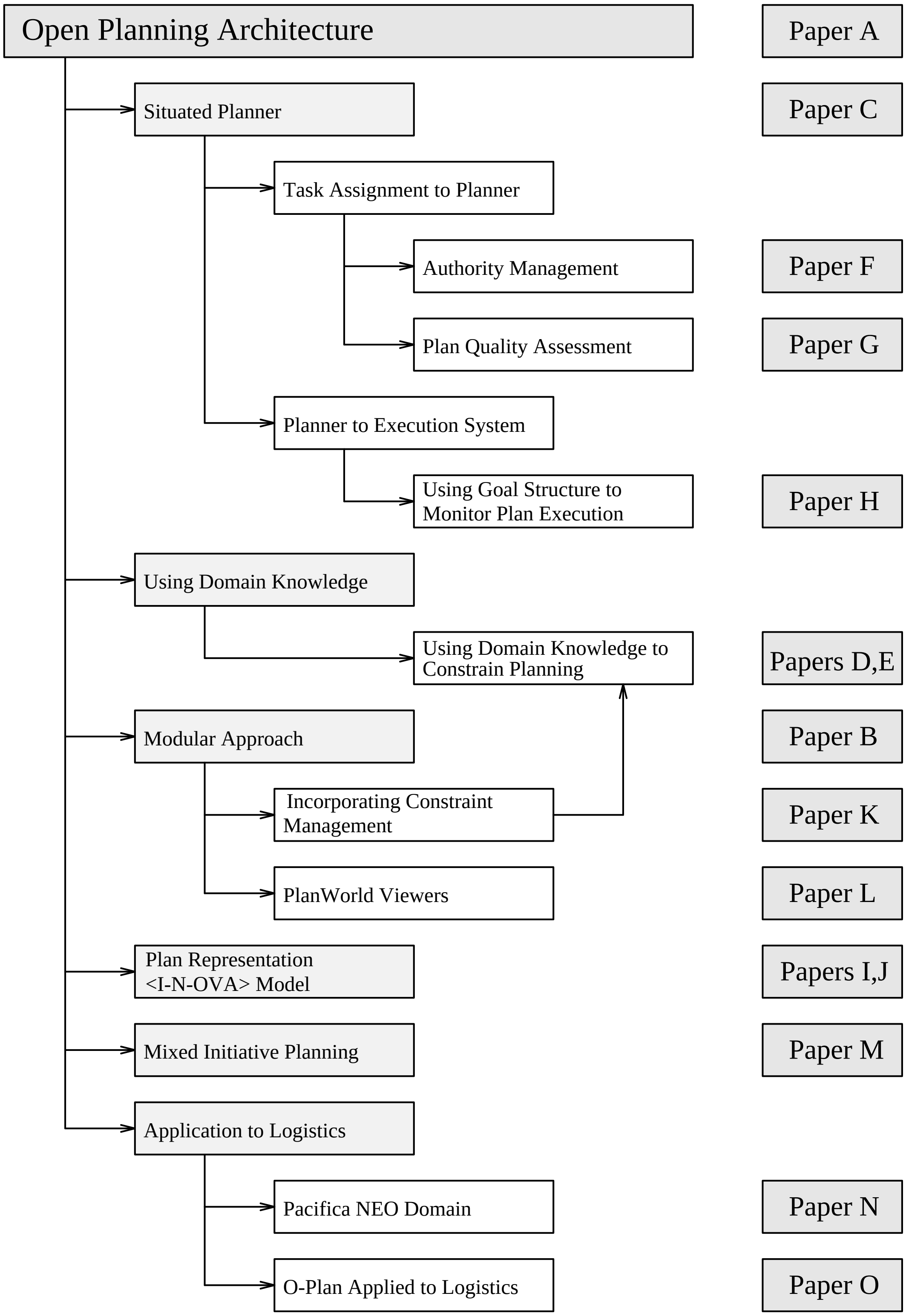

Figure 1: Road Map to the Attached Papers

PAPER A: Tate, A., Drabble, B. and Kirby, R.B., O-Plan2: an Open Architecture for Command, Planning and Control, in *Intelligent Scheduling* (eds. M.Fox and M.Zweben), Morgan Kaufmann, 1994.

Provides an overview of the O-Plan architecture with its task assignment, planning and execution agents, giving information about the aims of the work and its applications.

PAPER B: Tate, A., The Emergence of "Standard" Planning and Scheduling System Components, in *Current Trends in AI Planning*, (eds. Backström, C. & Sandewall, E.), IOS Press, 1993.

Provides an overview of the module specifications, interfaces and protocols used within the O-Plan architecture.

PAPER C: Drabble, B. and Tate, A., O-Plan: A Situated Planning Agent, Proceedings of the Third European Workshop on Planning (EWSP'95), Assisi, Italy, September, 1995.

Explains the importance of exploiting the task assignment and execution framework within which a planner is situated. The benefits of being able to use a rich model of the environment of the planner is explained.

PAPER D: Tate, A., Drabble, B. and Dalton, J., "The Use of Condition Types to Restrict Search in an AI Planner" Proceedings of the Twelfth National Conference on Artificial Intelligence (AAAI-94), Seattle, USA, August 1994.

O-Plan can make use of domain knowledge of various kinds to restrict its search for plans. It can thus be applied to larger problems than would otherwise be the case. This paper describes one strong contribution of the O-Plan research to finding ways to encode domain knowledge in forms which can be utilised by a planner.

PAPER E: Drabble, B. and Tate, A., The Use of Optimistic and Pessimistic Resource Profiles to Inform Search in an Activity Based Planner, Proceedings of the Second International Conference on AI Planning Systems (AIPS-94), AAAI Press, Chicago, USA, June 1994.

Accounting for resource availability is an important requirement when planning. This paper describes the novel mechanisms used within O-Plan for managing resources using incremental algorithms. The generic interface to such constraint managers within O-Plan is also described in this paper.

PAPER F: Tate, A., Authority Management - Coordination between Planning, Scheduling and Control, Workshop on Knowledge-based Production Planning, Scheduling and Control at the International Joint Conference on Artificial Intelligence (IJCAI-93), Chambery, France, 1993.

In a cooperative planning environment, a planner should be considered to work in isolation simply producing plans. This paper describes early work on modelling the role of authority and delegation within a command, planning and control environment in such a way that it can be used to effectively coordinate planning activities.

PAPER G: Gil, Y., Tate, A. and Hoffman, M., Domain-Specific Criteria to Direct and Evaluate Planning Systems, Proceedings of the ARPA/Rome Laboratory Planning Initiative Workshop, (ed. M.Burstein), Morgan-Kaufmann, 1994.

To be able to produce useful, effective plans, improved information about the quality of plans and the features of plans on which quality can be determined are required. This paper explores the general factors that may be used to analyse differences between plans and examines a specific domain of military Non-combatant Evacuation Operations (NEOs) to provide examples of domain criteria used to assess plan quality.

PAPER H: Reece, G.A. and Tate, A., Synthesizing Protection Monitors from Causal Structure, Proceedings of the Second International Conference on AI Planning Systems (AIPS-94), AAAI Press, Chicago, USA, 1994.

Plans are produced such that after being selected they can be executed. Work in the O-Plan project on a Reactive Execution Agent was performed on a linked Ph.D. This paper describes the use for plan execution support of the knowledge embedded in O-Plan plans which captures the rationale or Goal Structure of the plan steps. It is shown that reactive plan change support can be provided using such knowledge.

PAPER I: Tate, A., Putting Knowledge Rich Process Representations to Use, IOPener - The Journal of the IOPT Club for the Introduction of Process Technology, Vol. 2 No. 3 pp 12-14, March 1994, UK Introduction of Process Technology (IOPT) Club, c/o Praxis Ltd, UK.

The knowledge rich plan structures used within O-Plan are themselves of value in other contexts. This paper describes how the O-Plan plan model can support improved process modelling, analysis and workflow in organisations.

PAPER J: Tate, A. Characterising Plans as a Set of Constraints - the <I-N-OVA> Model - a Framework for Comparative Analysis, to appear in Special Issue on "Evaluation of Plans, Planners, and Planning Agents", ACM SIGART Bulletin Vol. 6 No. 1, January 1995.

In order to promote convergence of work in software engineering, process management, AI planning and formal mathematical work on planning, a model of plans as a set of constraints on behaviour or activity is being explored by the O-Plan project. This paper describes the <I-N-OVA> constraint model employed and relates it to other work.

PAPER K: Tate, A., Reasoning with Constraints in O-Plan2, Extended version containing a number of additional appendices of paper in the Proceedings of the ARPA/Rome Laboratory Planning Initiative Workshop, (M.Burstein, ed.), Tucson, Arizona, USA, Morgan Kaufmann, 1994.

The O-Plan research has simplified the way in which detailed constraints within plans can be managed, and has introduced a way in which constraint managers could be plugged into a planner using a well defined protocol. This paper describes the approach adopted to enable this.

PAPER L: Tate, A. and Drabble, B., PlanWorld Viewers, Proceedings of the 14th Workshop of the UK Planning and Scheduling Special Interest Group, Colchester, UK, November 1995.

The user interface to O-Plan makes use of plug-in viewers which can support technical plan views (e.g. workflows and charts) or domain related world views (e.g. maps and animations). This paper describes the ways in which a user can interact with O-Plan and describes the PlanWorld Viewer interface.

PAPER M: Tate, A., Mixed Initiative Planning in O-Plan2, Proceedings of the ARPA/Rome Laboratory Planning Initiative Workshop at Tucson, Arizona, USA, (ed. M. Burstein), Morgan-Kaufmann, 1994.

Planning is not done as an isolated activity. It relies on cooperative work between many people and systems. This paper describes O-Plan's approach to mixed initiative and co-operative planning. It is based on the mutual process of placing constraints on behaviour.

PAPER N: Reece, G.A., Tate, A., Brown, D. and Hoffman, M., The PRECiS Environment, Paper presented at the ARPA-RL Planning Initiative Workshop at AAAI-93, Washington D.C., July 1993. Also available as University of Edinburgh, Artificial Intelligence Applications Institute Technical Report AIAI-TR-140.

The O-Plan research and prototype implementation has been applied to specific logistics problems related to military Non-combatant Evacuation Operations (NEOs). This paper describes a non-confidential demonstration and test environment and example scenarios in which the requirements for O-Plan were established and demonstrations provided. It involves NEOs from the fictional island of Pacifica.

PAPER O: Drabble, B. and Tate, A. *Applying O-Plan to the NEO Scenarios*

This paper describes the evaluation experiments conducted as part of the O-Plan project. The paper shows how each experiment can be related to the categorisation of experiment types defined in the ARPI Evaluation Handbook. The paper describes and evaluates the application of O-Plan to the PRECiS/Pacifica NEO Scenarios. Additional evaluation experiments are described which investigated programmatic and scientific aspects of O-Plan.