Introduction

This project paper presents an overview of ongoing research from within a larger European project into the development of CAD tools for the design and realization of “non-standard” concrete structures. The European research project combines the knowledge and resources of architects, designers, concrete technologists, civil and structural engineers and robot experts with the practical experiences of key players in the construction sector in a 4-year collaborative venture. Fourteen academic and industrial partners will develop a set of new technologies including digital design and fabrication tools, new formwork and reinforcement systems to radically change the way concrete is currently produced and used. With a construction process spanning a broad range of expertise, collaboration through an effective digital workflow is vital to the successful execution of free-form concrete structures. The state of research widely applied in academic institutions is to directly link design and fabrication in an iterative feedback loop (Bechthold, 2011). The software tools that enable this type of interaction are often custom-made and project specific (Oesterle, 2009).

Software Framework: Design Tool

In any construction process there exists a network of organizations connected both upstream and downstream in the process. The collaboration in non-standard building practices called-for requires the integration

Figure 1 Workflow diagram for non-standard concrete construction process, showing key use cases design, planning and fabrication

S. Brell-Çokcan et al. (eds.), Rob | Arch 2012 © Springer-Verlag/Wien 2013
of this range of expertise. The research presented here develops a use case model that addresses the key steps in decision making for concrete construction projects from design through to fabrication (Williams, 2011). The following parties have been identified through experience gained in the development of a number of key non-standard projects: architect - planner - fabricator (Fig. 1).

A flexible software framework derived from the use case model enables a seamless flow of information between these parties. It provides a specific software tool for each use case party but all software tools load the same technology data. In this sense the tools provide a use case specific view of the construction process (Fig. 2).

The focus of this project paper is on the fabrication use case and the fabrication tool implementing it. The tool allows construction ready geometry to be assigned to different fabrication cells using a new data format called Open Fabrication Language (OFL). It employs open standards and file formats and is intended to be open and extensible.

Fabrication cells are provided to the tool as plugins. Each cell can accept or decline individual operation types and can also have additional constraints like a maximum size of the working area. The tool provides feedback about the applicability of geometry assigned to a cell and the location of constraints and limits. Output from the fabrication plugin can be any kind of fabrication data. It is not covered by the tool anymore and therefore is not restricted in any way. It can describe anything from a direct machine connection to a manual process and to network communication. In this project paper we will focus on the robotic fabrication plugins for double curved milled formwork and steel reinforcement structures.

Robotic Formwork Fabrication Plugin

The fabrication of non-standard formwork