The introduction of flexible robotic systems has been identified as a key enabler to increase the competitiveness of European Small and Medium Enterprises (SMEs) in high wage countries. Despite this, SMEs mostly refrain from using advanced robot technology—though recent years has seen an increased use of the new generation of lightweight and low-cost robots, such as the robots by Universal Robots and the Yumi robots by ABB. The main goals of these robots are usability and flexibility, thus users can with relative ease install, program and operate these. This is true as long as integration with external components such as sensors, actuators and external machinery is not required. When integrating with external components is necessary, the complexity increases and end-users often require external and expensive expertise. This inhibits investment in robotics by SMEs, and prevents further exploitation of robotics at SME-level.

The aim of this work is to enable the creation of cost-effective and flexible robotic systems for SMEs. This is addressed by a dedicated focus on flexibility, usability and reusability. A key observation is that these aspects are not one-dimensional, but multi-dimensional. The specific requirements, with respect to each of these, differ depending on the type of user interacting with a system. We identify four essential user-roles, which interact with the system in different ways, thus have different needs and requirements. The identified roles are Component Developers, System Developers, Process Modellers and Operators.

This dissertation presents a system-building platform—the Robot CoWorker Platform—which enables rapid creating of bespoke systems, targeted at SMEs, by enabling flexibility, usability and reusability and by separating the responsibilities of the identified key-roles. By separating the roles, they are individually empowered to do what they do best. Component Developers can focus on writing self-contained components; System Developers can focus on creating system through integration and configuration of available components. Process Modellers focus on defining the system behaviour through process modelling and Operators focus only on selecting and configuring appropriate process models using the system in production.

The Robot CoWorker Platform comprises three fundamental technical components: 1) A hardware-independent capability modelling framework, 2) Intuitive Human Robot Interaction (HRI) enabling instruction by non-technical users, and 3) an implementation of this in the Robot CoWorker Architecture. Each of these is described in detail.

The platform is evaluated with respect flexibility, usability and reusability through a set of seven cases where the Robot CoWorker Platform has been used to create bespoke robotic systems. Usability for non-technical users is

further evaluated through a usability study, comparing the HRI-interfaces of the platform with the PolyScope interface of Universal Robots, which is considered one of the most intuitive commercial interfaces available.

The Robot CoWorker Platform has been proven by the evaluation just mentioned, and has demonstrated its value in application to more than 14 cases of real or realistic industrial problems over the course of its development—seven of these cases are reported in this dissertation. It constitutes a significant resource for the Danish Technological Institute (DTI) and is currently being deployed in DTI's commercial activities.