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Formal Methods
in Software
and Systems Modeling

Essays Dedicated to Hartmut Ehrig
on the Occasion of His 60th Birthday

Springer

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Hartmut Ehrig

Preface

This Festschrift is dedicated to Hartmut Ehrig on the occasion of his 60th birthday on December 6, 2004. The contributions discuss various aspects of the formal and visual modeling of software and systems. The authors are some of Hartmut Ehrig's former students and collaborators who are established researchers in their fields. All essays were invited, but they nevertheless went through a reviewing process.

Hartmut Ehrig is a leading, very enthusiastic and highly inspiring scientist who has made lasting contributions to the theoretical foundations of software and system modeling and in particular to graph transformation, algebraic specification and net theory. For more than 30 years his name has been associated with the double-pushout approach, which is the most frequently used and most successful framework in graph transformation. For nearly as long, his work on structuring, parameterization, refinement, and modularization of algebraic specifications has helped to develop this area in an important and sustainable way. Also net theory owes him a very powerful notion and a fundamental study of high-level nets. While Hartmut Ehrig is a category theorist and has advocated the use of category theory in most of his research, he has also undertaken many successful efforts to cooperate with researchers in applied areas such as database systems, software engineering, and even mechanical engineering.

The essays in this book are divided into three parts, each consisting of eight papers: graph transformation, algebraic specification and logic, and formal and visual modeling. Five papers from the first part concern syntactic and semantic aspects of graph transformation (concurrent semantics, interconnection of graph transformation modules, graph processes, graph transformation with variables, and changing labels in the double-pushout approach). The other three papers relate graph transformation with net theory, software engineering, and molecular biology. The papers from the second part address a wide spectrum of topics ranging from data types, coalgebras and interfaces, through functorial semantics of rewrite theories and interactive formal reasoning, to the integration of logics and schema theory. Moreover, one paper relates conditional specifications and interaction charts. The third part contains all further contributions concerning formal and visual modeling including four papers on statechart models, link graphs, architectural connectors for UML, and concurrent object-based systems. Two papers deal with Petri nets considering them as a foundation for a system theory for transportation on the one hand and providing them with a loose semantics on the other hand. And the other two papers in this part discuss nested constraints for high-level systems and transformation units with interlinking semantics.

We felt privileged to be able to edit this volume for Hartmut, expressing in this way our admiration for his scientific work and our thanks for his friendship and collaboration. We would like to express our gratitude to all contributors to

this volume. We are also indebted to the referees and in particular to Roberto Bruni and Horst Reichel, who served as reviewers without being authors. We are grateful to Peter Knirsch for his support in editing the book and careful unification of all the print files. Very special thanks go to DADARA, who provided the beautiful cover illustration. Finally, we would like to acknowledge the excellent cooperation with Springer, the publisher of this Festschrift.

Dezember 2004   Hans-Jörg Kreowski
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Bibliography of Hartmut Ehrig

Books

[6]   H. Ehrig, B. Mahr, F. Cornelius, M. Große-Rhode, and P. Zeitz. *Mathematisch-strukturelle Grundlagen der Informatik*. Springer, 1999.

[5]   I. Claßen, H. Ehrig, and D. Wolz. *Algebraic Specification Techniques and Tools for Software Development – The ACT Approach*. AMAST Series in Computing Vol. 1. World Scientific, 1993.

[4]   H. Ehrig and B. Mahr. *Fundamentals of Algebraic Specification 2: Module Specifications and Constraints*, Vol. 21 of *EATCS Monographs on Theoretical Computer Science*. Springer, 1990.

[3]   H. Ehrig and B. Mahr. *Fundamentals of Algebraic Specification 1: Equations and Initial Semantics*, Vol. 6 of *EATCS Monographs on Theoretical Computer Science*. Springer, 1985.

[2]   H. Ehrig, K. D. Kiermeier, H.-J. Kreowski, and W. Kühnel. *Universal Theory of Automata*. Teubner, 1974.

[1]   H. Ehrig and M. Pfender. *Kategorien und Automaten*. de Gruyter Lehrbuch, 1972.

Edited Books

[17] H. Ehrig, G. Engels, F. Parisi-Presicce, and G. Rozenberg, editors. *Graph Transformations. Second International Conference, ICGT 2004, Rome, Italy*, LNCS 3256. Springer, 2004.

[16] H. Ehrig, editor. *Integration of Software Specification Techniques for Applications in Engineering: Priority Program SoftSpez of the German Research Foundation (DFG), Final Report*. LNCS 3147. Springer, 2004.

[15] R. Bardohl and H. Ehrig, editors. *Proc. Uniform Approaches to Graphical Process Specification Techniques (UNIGRA'01), Electronic Notes in TCS (ENTCS)*, Vol. 82, Warsaw, Poland, Elsevier, 2003.

[14] H. Ehrig, W. Reisig, G. Rozenberg, and H. Weber, editors. *Advances in Petri Nets: Petri Net Technology for Communication Based Systems*. LNCS 2472. Springer, 2003.

[13] W. Brauer, H. Ehrig, J. Karhumäki, and A. Salomaa, editors. *Formal and Natural Computing: Essays Dedicated to Grzegorz Rozenberg*. LNCS 2300. Springer, 2002.

[12] H. Ehrig, B. J. Krämer, and A. Ertas, editors. *Proc. Int. Conf. on Integrated Design and Process Technology (IDPT'02), Pasadena, USA*. Society of Process Technology, 2002.

[11] A. Corradini, H. Ehrig, H.-J. Kreowski, and G. Rozenberg, editors. *Proc. 1st Int. Conference on Graph Transformation (ICGT'02)*. LNCS 2505. Springer, 2002.

[10] H. Ehrig and J. Padberg, editors. *Component-Based System Development*, Vol. 82 (7) of *Journal of Integrated Design and Process Science*. Society for Design and Process Science (SDPS), 2003.

[9]   H. Ehrig, G. Juhás, J. Padberg, and G. Rozenberg, editors. *Advances in Petri Nets: Unifying Petri Nets*. LNCS 2128. Springer, 2001.

[8]   H. Ehrig, G. Engels, H.-J. Kreowski, and G. Rozenberg, editors. *Handbook of Graph Grammars and Computing by Graph Transformation, Vol. 2: Applications, Languages and Tools*. World Scientific, 1999.

[7]   H. Ehrig, H.-J. Kreowski, U. Montanari, and G. Rozenberg, editors. *Handbook of Graph Grammars and Computing by Graph Transformation. Vol 3: Concurrency, Parallelism and Distribution*. World Scientific, 1999.

[6]   J. Cuny, H. Ehrig, G. Engels, and G. Rozenberg, editors. *Graph Grammars and Their Application to Computer Science*. LNCS 1073. Springer, 1996.

[5]   H. Ehrig, H.-J. Kreowski, and G. Rozenberg, editors. *4th Int. Workshop on Graph Grammars and Their Application to Computer Science*. LNCS 532. Springer, 1991.

[4]   H. Ehrig, H. Herrlich, H.-J. Kreowski, and G. Preuß, editors. *Int. Workshop on Categorical Methods in Computer Science with Aspects from Topology*. LNCS 393, Springer, 1989.

[3]   H. Ehrig, M. Nagl, G. Rozenberg, and A. Rosenfeld, editors. *3rd Int. Workshop on Graph Grammars and Their Application to Computer Science*. LNCS 291. Springer, 1987.

[2]   H. Ehrig, M. Nagl, and G. Rozenberg, editors. *2nd Int. Workshop on Graph Grammars and Their Application to Computer Science*. LNCS 153. Springer, 1983.

[1]   H. Ehrig, V. Claus, and G. Rozenberg, editors. *1st Int. Workshop on Graph Grammars and Their Application to Computer Science and Biology*. LNCS 73. Springer, 1979.

Papers

[238] Compositional Semantics of Open Petri Nets Based on Deterministic Processes. *Mathematical Structures in Computer Science* (with P. Baldan, A. Corradini, and R. Heckel), 2004.

[237] Integrating Meta Modelling with Graph Transformation for Efficient Visual Language Definition and Model Manipulation. In M. Wermelinger and T. Margaria-Steffen, editors, *Proc. Fundamental Aspects of Software Engineering 2004*. LNCS 2984, pp. 214–228, Springer (with R. Bardohl, J. de Lara, and G. Taentzer), 2004.

[236] Constraints and Application Conditions: From Graphs to High-Level Structures. In F. Parisi-Presicce, P. Bottoni, and G. Engels, editors, *Proc. 2nd Int. Conference on Graph Transformation (ICGT'04)*, LNCS 3256, pp. 287–303, Springer (with K. Ehrig, A. Habel, and K.-H. Pennemann), 2004.

[235] Adhesive High-Level Replacement Categories and Systems. In F. Parisi-Presicce, P. Bottoni, and G. Engels, editors, *Proc. 2nd Int. Conference on Graph Transformation (ICGT'04)*, LNCS 3256, pp. 144–160, Springer (with A. Habel, J. Padberg, and U. Prange), 2004.

[234] Integration of Software Specification Techniques for Applications in Engineering: Introduction and Overview of Results. In Ehrig [16], 2004.

[233] Behaviour and Instantiation of High-Level Petri Net Processes. *Fundamenta Informaticae*, 64:1–37, 2004.

[232] On the Relevance of High-Level Net Processes. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: The Challenge of the New Century*, pp. 89–95. World Scientific, 2004.

[231] Bigraphs Meet Double Pushouts. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: The Challenge of the New Century*, pp. 27–41. World Scientific, 2004.

[230] Deriving Bisimulation Congruences in the DPO Approach to Graph Rewriting. In *Proc. FOSSACS 2004.* LNCS 2987, pp. 151–166, Springer (with B. König), 2004.

[229] A Component Framework for System Modeling Based on High-Level Replacement Systems. *Software and Systems Modeling*, 3, pp. 114–134 (with F. Orejas, B. Braatz, M. Klein, and M. Piirainen), 2004.

[228] Graph Grammars and Petri Net Transformations. In *Lectures on Concurrency and Petri Nets. Special Issue Advanced Course PNT.* LNCS 3098, pp. 496–536, Springer (with J. Padberg), 2004.

[227] A Generic Framework for Connector Architectures Based on Components and Transformations. In *Proc. FESCA'04*, pp. 151–166, ENTCS (with J. Padberg), 2004.

[226] Fundamental Theory for Typed Attributed Graph Transformation. In F. Parisi-Presicce, P. Bottoni, and G. Engels, editors, *Proc. 2nd Int. Conference on Graph Transformation (ICGT'04)*, LNCS 3256, pp. 161–177, Springer (with U. Prange and G. Taentzer), 2004.

[225] The Role of Mathematics in Software System Development. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: The Challenge of the New Century*, pp. 5–15. World Scientific (with G. Schröter), 2004.

[224] Anwendung softwaretechnischer Komponentenkonzepte auf die Produktionsautomatisierung. *Automatisierungstechnische Praxis (atp)*, pp. 46–56, with (M. Klein, B. Braatz, G. Schröter, and M. Bengel), 2004.

[223] Petri Net Modules in the Transformation-Based Component Framework. In *Journal of Logic and Algebraic Programming*, 35 pages (with J. Padberg), 2004. To appear.

[222] Semantische Konsistenz viewpointorientierter Modellierungstechniken am Beispiel der Produktionsautomatisierung. *Automatisierungstechnische Praxis (atp)*, pp. 26–36 (with G. Schröter, B. Braatz, H. Ehrig, M. Klein, and M. Bengel), 2004.

[221] Konzeption und Entwicklung eines UML-basierten Funktionsblockmodells für den objektorientierten Steuerungsentwurf. In *Tagungsband Entwicklung und Betrieb komplexer Automatisierungssysteme EKA 2003*, 15 pages. Institut für Regelungs- und Automatisierungstechnik TU Braunschweig (with A. Braatz, M. Klein, and E. Westkämper), 2003.

[220] Generation of Animation Views for Petri Nets in GenGED. In Ehrig et al. [14], pp. 25–37 (with C. Ermel and R. Bardohl), 2003.

[219] B. Braatz, H. Ehrig, and M. Urbášek. Petri Net Transformations in the Petri Net Baukasten. In Ehrig et al. [14], pp. 37–65 (with B. Braatz and M. Urbášek), 2003.

[218] Behavior and Instantiation of High-Level Net Processes. In R. Bardohl and H. Ehrig, editors, *Proc. Workshop on Uniform Approaches to Graphical Process Specification Techniques (UNIGRA),* ENTCS, Vol. 82, 16 pages. Elsevier, 2003.

[217] Formal Specification Techniques for Software and Systems Engineering. In *Proc. FORMS 2003*, pp. 23–36, Budapest (with O. Kluge), 2003.

[216] A Transformation-Based Component Framework for a Generic Integrated Modeling Technique. *Journal of Integrated Design and Process Science*, 6(4):78–104 (with F. Orejas, B. Braatz, M. Klein, and M. Piirainen), 2003.

[215] The Petri Net Baukasten of the DFG-Forschergruppe Petri Net Technology. In Ehrig et al. [14], pp. 8–21 (with W. Reisig and H. Weber), 2003.

[214] Components for Algebra Transformation Systems. In R. Bardohl and H. Ehrig, editors, *Proc. Workshop on Uniform Approaches to Graphical Process Specification Techniques (UNIGRA)*, ENTCS, Vol. 82, 16 pages. Elsevier (with F. Orejas), 2003.

[213] Application of Graph Transformation Techniques to the Area of Petri Nets. In H.-J. Kreowski, editor, *Proc. AGT 2002: APPLIGRAPH Workshop on Applied Graph Transformation*, pp. 35–44 (with B. Braatz, K. Hoffmann, J. Padberg, and M. Urbášek), 2002.

[212] High-Level Net Processes. In W. Brauer, H. Ehrig, J. Karhumäki, and A. Salomaa, editors, *Formal and Natural Computing*, LNCS 2300, pp. 191–219, Springer (with K. Hoffmann, J. Padberg, P. Baldan, and R. Heckel), 2002.

[211] Basic Results for Two Types of High-Level Replacement Systems. In M. Bauderon and A. Corradini, editors, *Proc. GETGRATS Closing Workshop*, ENTCS, Vol. 51, 12 pages. Elsevier (with A. Habel and F. Parisi-Presicce), 2002.

[210] A Transformation-Based Component Framework for a Generic Integrated Modeling Technique. In *Proc. of the Sixth World Conference on Integrated Design & Process Technology (IDPT'02)*, CD-ROM, 15 pages (with F. Orejas, B. Braatz, M. Klein, and M. Piirainen), 2002.

[209] A Component Framework Based on High-Level Replacement Systems. In *Proc. Int. Workshop on Graph Transformation and Visual Modeling Techniques (GT-VMT'02), Satellite Event of ICGT'02*, pp. 124–138 (with F. Orejas, B. Braatz, M. Klein, and M. Piirainen), 2002.

[208] A Generic Component Concept for System Modeling. In *Proc. FASE 2002: Formal Aspects of Software Engineering, Grenoble*, LNCS 2306, pp. 32–48. Springer (with F. Orejas, B. Braatz, M. Klein, and M. Piirainen), 2002.

[207] Concurrency and Loose Semantics of Open Graph Transformation Systems. *Mathematical Structures in Computer Science*, 12(4):349–376 (with R. Heckel, M. Llabres, and F. Orejas), 2002.

[206] Compositional Modeling of Reactive Systems Using Open Nets. In K. G. Larsen and M. Nielsen, editors, *Proc. of CONCUR 2001*, LNCS 2154, pp. 502–518, Springer (with P. Baldan, A. Corradini, and R. Heckel), 2001.

[205] UML-basierte Software-Spezifikation und Entwicklungswerkzeuge für Systeme der Automatisierungstechnik. In *Proc. Engineering komplexer Automatisierungssysteme, Braunschweig* (with B. Braatz, M. Große-Rhode, and E. Westkämper), 2001.

[204] Specification and Implementation of Animation Views for Petri Nets. In DFG Research Group "Petri Net Technology", editor, *Proc. of 2nd International Colloquium on Petri Net Technology for Communication Based Systems*, 12 pages. Berlin (with C. Ermel and R. Bardohl), 2001.

[203] On Formal Semantics and Integration of Object Oriented Modeling Languages. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 226–232. World Scientific (with R. Geisler, M. Große-Rhode, M. Klar, and S. Mann), 2001.

[202] Integration von Techniken der Softwarespezifikation für ingenieurwissenschaftliche Anwendungen. *Informatik Forschung und Entwicklung*, 16:100–117, Springer (with M. Große-Rhode), 2001.

[201] On the Role of Formal Specification Techniques: From TAPSOFT 1985 to ETAPS 2000. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 131–133. World Scientific, 2001.

[200] Algebraic Techniques in Software Development: A Review of Progress up to the Mid Nineties. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 134–152. World Scientific (with B. Mahr), 2001.

[199] Theory and Practice of Software Development: A Review of Driving Forces and Expectations of TAPSOFT from 1985 to 1997. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 118–130. World Scientific (with B. Mahr), 2001.

[198] Integration Paradigm for Data Type and Process Specification Techniques. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 192–201. World Scientific (with F. Orejas), 2001.

[197] A Conceptual and Formal Framework for the Integration of Data Type and Process Modeling Techniques. In *Proc. GT-VMT 2001, ICALP 2001 Satellite Workshops*, pp. 201–228, Greece (with F. Orejas), 2001.

[196] Dynamic Abstract Data Types: An Informal Proposal in 1994. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 180–191. World Scientific (with F. Orejas), 2001.

[195] From Basic Views and Aspects to Integration of Specification Formalisms. In G. Păun, G. Rozenberg, and A. Salomaa, editors, *Current Trends in Theoretical Computer Science: Entering the 21st Century*, pp. 202–214. World Scientific (with J. Padberg and F. Orejas), 2001.

[194] The Relevance of Mathematics in Software System Development. *International Journal of Differential Equations and Applications*, 3:169–182 (with G. Schröter), 2001.

[193] The "Petri Net Baukasten": An Overview. In H. Ehrig, G. Juhás, J. Padberg, and G. Rozenberg, editors, *Unifying Petri Nets*, Advances in Petri Nets, LNCS 2128, pp. 26–53. Springer (with M. Gajewsky), 2001.

[192] Double-Pullback Transitions and Coalgebraic Loose Semantics for Graph Transformation Systems. *Journal of Applied Categorical Structures*, 9(1):83–110 (with R. Heckel, U. Wolter, and A. Corradini), 2001.

[191] *Tight and Loose Semantics for Transformation Systems*, pp. 238–255. LNCS 2267, Springer (with F. Orejas and E. Pino), 2001.

[190] Parametrized Net Classes: A Uniform Approach to Petri Net Classes. In H. Ehrig, G. Juhás, J. Padberg, and G. Rozenberg, editors, *Advances in Petri Nets: Unifying Petri Nets*, LNCS 2128, pp. 173–229. Springer (with J. Padberg), 2001.

[189] Behaviour and Realization Construction for Petri Nets Based on Free Monoid and Power Set Graphs. In H. Ehrig, G. Juhás, J. Padberg, and G. Rozenberg, editors, *Advances in Petri Nets: Unifying Petri Nets*, LNCS 2128, pp. 230–249. Springer (with J. Padberg and G. Rozenberg), 2001.

[188] Cooperability in Train Control Systems Specification of Scenarios Using Open Nets. *Journal of Integrated Design and Process Technology*, 5:3–21 (with J. Padberg, L. Jansen, E. Schnieder, and R. Heckel), 2001.

[187] Conceptual Model of the Graphical Editor GenGEd for the Visual Definition of
       Visual Languages. In H. Ehrig, G. Engels, H.-J. Kreowski, and G. Rozenberg,
       editors, *Proc. 6th Int. Workshop on Theory and Applications of Graph Transfor-
       mation (TAGT'98), Selected Papers*, LNCS 1764, pp. 252–266. Springer (with
       R. Bardohl), 2000.
[186] Generic Description, Behavior and Animation of Visual Modeling Languages. In
       Proc. Integrated Design and Process Technology (IDPT 2000), USA, CD-ROM,
       11 pages. Society for Design and Process Science (SDPS) (with R. Bardohl and
       C. Ermel), 2000.
[185] Double-Pullback Graph Transitions: A Rule-Based Framework with Incomplete
       Information. In H. Ehrig, G. Engels, H.-J. Kreowski, and G. Rozenberg, editors,
       *Proc. 6th Int. Workshop on Theory and Applications of Graph Transformation
       (TAGT'98), Selected Papers*, LNCS 1765, pp. 85–102. Springer (with R. Heckel,
       M. Llabres, F. Orejas, J. Padberg, and G. Rozenberg), 2000.
[184] On the Role of Mathematics and Formal Specification in Software System De-
       velopment. *EACTS*, 72:69–76 (with G. Schröter), 2000.
[183] A Proposal for Consistent Integration of Visual Computing with Visual Soft-
       ware Development. In *Proc. of Workshop on Graph Transformation and Visual
       Modeling Techniques (GT-VMT 2000)*, pp. 427–434. Carleton Scientific (with
       G. Taentzer), 2000.
[182] Concurrency of Double-Pullback Graph Transitions. In H. Ehrig and G.
       Taentzer, editors, *Proc. of Joint APPLIGRAPH/GETGRATS Workshop on
       Graph Transformation (GRATRA 2000)*, pp. 146–154. Berlin (with R. Heckel,
       M. Llabres, and F. Orejas), 2000.
[181] Modeling Train Control Systems: From Message Sequence Charts to Petri Nets.
       In *Proc. Formale Techniken für die Eisenbahnsicherung (FORMS)*, pp. 25–42.
       Fortschritt-Berichte VDI, Reihe 12, Nr. 44, VDI Verlag (with O. Kluge and
       J. Padberg), 2000.
[180] New Concepts for High-Level Petri Nets in the Application Domain of Train
       Control. In E. Schnieder and U. Becker, editors, *Proc. 9th Symposium on Trans-
       portation Systems*, pp. 153–160 (with J. Padberg and P. Schiller), 2000.
[179] Consistency Analysis of UML Class and Sequence Diagrams Using Attributed
       Graph Grammars. In H. Ehrig and G. Taentzer, editors, *Proc. of Joint APPLI-
       GRAPH/GETGRATS Workshop on Graph Transformation (GRATRA 2000)*,
       pp. 77–86. Berlin (with A. Tsiolakis), 2000.
[178] Semantics of Distributed System Specifications Based on Graph Transformation.
       In *GI Workshop "Rigorose Entwicklung software-intensiver Systeme", Berlin*,
       LMU-Report 0005, pp. 57–72 (with G. Taentzer), 2000.
[177] Concurrent Semantics of Algebraic Graph Transformations. In H. Ehrig, H.-J.
       Kreowski, H. Montanari, G. Rozenberg, editors, *Handbook of Graph Grammars
       and Computing by Graph Transformations, Vol. 3: Concurrency, Parallelism
       and Distribution*, pp. 107–188. World Scientific (with P. Baldan, A. Corradini,
       U. Montanari, F. Rossi, and M. Löwe), 1999.
[176] Abstract and Behaviour Module Specifications. *Mathematical Structures in
       Computer Science*, 9:21–62 (with F. Cornelius, M. Baldamus, H. Ehrig, and
       F. Orejas), 1999.
[175] High-Level Replacement Systems with Applications to Algebraic Specifications
       and Petri Nets. In H. Ehrig, H.-J. Kreowski, H. Montanari, G. Rozenberg, edi-
       tors, *Handbook of Graph Grammars and Computing by Graph Transformations,
       Vol. 3: Concurrency, Parallelism, and Distribution*, chapter 6, pp. 341–400.
       World Scientific (with M. Gajewsky and F. Parisi-Presicce), 1999.

[174] Refinement and Implementation. In E. Astesiano, H.-J. Kreowski, and B. Krieg-Brückner, editors, *Algebraic Foundations of Systems Specification*, chapter 7, pp. 201–242. Springer (with H.-J. Kreowski), 1999.

[173] Relevance, Integration and Classification of Specification Formalisms and Formal Specification Techniques. In *Proc. FORMS'99, Braunschweig, Germany*, pp. 31–54. Fortschritt-Berichte VDI, Reihe 12, Nr. 436, VDI Verlag (with F. Orejas and J. Padberg), 2000.

[172] Graphical Representation and Graph Transformation. In P. Degano, R. Gorrieri, A. Marchetti-Spaccamela, and P. Wegner, editors, *Symposium on Theoretical Computer Science: A Retrospective*. Computing Surveys 31/3 (with G. Taentzer), 1999.

[171] Classification and Comparison of Modularity Concepts for Graph Transformation Systems. In H. Ehrig, G. Engels, H.-J. Kreowski, G. Rozenberg, editors, *Handbook of Graph Grammars and Computing by Graph Transformation. Vol 2: Applications, Languages and Tools*, pp. 669-690. World Scientific (with R. Heckel, G. Engels, and G. Taentzer), 1999.

[170] A View-Based Approach to System Modeling Based on Open Graph Transformation Systems. In H. Ehrig, G. Engels, H.-J. Kreowski, G. Rozenberg, editors, *Handbook of Graph Grammars and Computing by Graph Transformation. Vol 2: Applications, Languages and Tools*, pp. 639-668. World Scientific (with R. Heckel, G. Engels, and G. Taentzer), 1999.

[169] Formale Techniken für die Eisenbahnsicherungstechnik: Anforderungskatalog – Zusammenfassung der Arbeitsunterlagen. *Signal und Draht (Rail Signalling and Telecommunication)*, 10:38–42 (with E. Schnieder and S. Einer), 1999.

[168] Conceptual Model of the Graphical Editor GenGEd. In *Proc. 6th Int. Workshop on Theory and Application of Graph Transformation (TAGT'98)*, pp. 32–45. Universität Paderborn (with R. Bardohl), 1998.

[167] DFG-Schwerpunktprogramm ab 1998: Integration von Techniken der Softwarespezifikation für ingenieurwissenschaftliche Anwendungen. *Informatik – Forschung und Entwicklung*, 13(1):43–46, Springer (with R. Geisler and M. Klar), 1998.

[166] From Abstract Data Types to Algebraic Development Techniques: A Shift of Paradigms. In *Proc. of Workshop on Algebraic Development Techniques*, LNCS 1376, pp. 1–17. Springer (with M. Gajewsky and U. Wolter), 1998.

[165] Applications of Category Theory to the Area of Algebraic Specification in Computer Science. *Applied Categorical Structures*, 6(1):1–35 (with M. Große-Rhode and U. Wolter), 1998.

[164] Construction and Characterization of Double-Pullback Graph Transitions. In G. Engels and G. Rozenberg, editors, *Proc. 6th Int. Workshop on Theory and Applications of Graph Transformation (TAGT'98)*, Reihe Informatik, tr–ri–98–201, pp. 308–315 (with R. Heckel, M. Llabres, and F. Orejas), 1998.

[163] Categorical Concepts for Logical Systems and Formal Specification in Computer Science. Seminarberichte aus dem Fachbereich Mathematik, Band 63, Teil 1, Fernuniversität Hagen, pp. 131–148 (with A. Martini and U. Wolter), 1998.

[162] Graph Transformations and Other Rule-Based Formalisms with Incomplete Information. In G. Engels and G. Rozenberg, editors, *Proc. 6th International Workshop on Theory and Application of Graph Transformation*, pp. 268–278. Paderborn (with G. Rozenberg and J. Padberg), 1998.

[161] Classification and Comparison of Modularity Concepts for Graph Transformation Systems. In *Proc. 6th Int. Workshop on Theory and Application of Graph Transformation (TAGT'98)*, pp. 278–289, Paderborn (with R. Heckel, G. Engels, and G. Taentzer), 1998.

[160] Interoperability in Train Control Systems Specification of Scenarios Using Open Nets. In *Proc. Integrated Design and Process Technology*, pp. 17–24. Society for Design and Process Science (with J. Padberg, L. Jansen, and R. Heckel), 1998.

[159] Algebraic Approaches to Graph Transformation. Part I: Basic Concepts and Double Pushout Approach. In G. Rozenberg, editor, *Handbook of Graph Grammars and Computing by Graph transformation, Vol. 1: Foundations*, pp. 163–246. World Scientific (with A. Corradini, U. Montanari, F. Rossi, R. Heckel, and M. Löwe), 1997.

[158] A Combined Reference Model- and View-Based Approach to System Specification. *Int. Journal of Software and Knowledge Engineering*, 7(4):457–477 (with G. Engels, R. Heckel, and G. Taentzer), 1997.

[157] Horizontal and Vertical Structuring Techniques for Statecharts. In A. Mazurkiewicz and J. Winkowski, editors, CONCUR'97: Concurrency Theory, 8th Int. Conf., Warsaw, Poland, LNCS 1243, pp. 181–195. Springer (with R. Geisler, M. Klar, and J. Padberg), 1997.

[156] Reverse Petri Net Technology Transfer: On the Boundary of Theory and Application. In L. Groves and S. Reeves, editors, *Formal Methods Pacific '97*, pp. 297–298. Springer (with M. Gajewsky, S. Lembke, and J. Padberg), 1997.

[155] Action Nets and Abstract Statecharts in the Theory of High-Level Structures. In *Proc. of First European GETGRATS Workshop*, Bordeaux (with M. Gajewsky and J. Padberg), 1997.

[154] Algebraic Approaches to Graph Transformation II: Single Pushout Approach and Comparison with Double Pushout Approach. In G. Rozenberg, editor, *Handbook of Graph Grammars and Computing by Graph Transformation, Vol. 1: Foundations*, chapter 4, pp. 247–312. World Scientific (with R. Heckel, M. Korff, M. Löwe, L. Ribeiro, A. Wagner, and A. Corradini), 1997.

[153] A View-Oriented Approach to System Modelling Using Graph Transformation. In *Proc. of ESEC/FSE'97, Zürich*, LNCS 1301, pp. 327–343. Springer (with G. Engels, R. Heckel, and G. Taentzer), 1997.

[152] Correctness of Horizontal and Vertical Composition for Implementation Concepts Based on Constructors and Abstractors. *Revista Matemática de la Universidad Complutense de Madrid, vol. 10, no. 2*, pp. 365–387 (with H.-J. Kreowski and F. Orejas), 1997.

[151] Future Trends of TAPSOFT. In M. Bidoit and M. Dauchet, editors, *TAPSOFT'97*, LNCS 1214, pp. 6–10. Springer (with B. Mahr), 1997.

[150] A Uniform Approach to Petri Nets. In Ch. Freksa, M. Jantzen, and R. Valk, editors, *Foundations of Computer Science: Potential – Theory – Cognition*, LNCS 1337, pp. 219–231. Springer (with J. Padberg), 1997.

[149] Integrating the Specification Techniques of Graph Transformation and Temporal Logic. In *Proc. of MFCS'97, Bratislava*, LNCS 1295, pp. 219-228. Springer (with R. Heckel, U. Wolter, and A. Corradini), 1997.

[148] Institutions for Logic Programming. In *TCS 173*, pp. 485–511 (with F. Orejas and E. Pino), 1997.

[147] The Category of Typed Graph Grammars and Its Adjunctions with Categories of Derivations. In *Proc. 5th Int. Workshop on Graph Grammars and Their Applications to Computer Science*, LNCS 1073, pp. 56–74. Springer (with A. Corradini, M. Löwe, U. Montanari, and J. Padberg), 1996.

[146] An Event Structure Semantics for Graph Grammars with Parallel Productions. In Cuny et al. [6], pp. 240–256 (with A. Corradini, M. Löwe, U. Montanari, and F. Rossi), 1996.

[145] A New Integration Paradigm for Formal Specification of Safe Software Systems. In *Proc. 10th Japan-Germany Forum on Information Technology*. Gesellschaft für Mathematik und Datenverarbeitung (with R. Bardohl, F. Cornelius, R. Geisler, M. Große-Rhode, and J. Padberg), 1996.

[144] Pragmatic and Semantic Aspects of a Module Concept for Graph Transformation Systems. In Cuny et al. [6], pp. 137–154 (with G. Engels), 1996.

[143] On the Role of Category Theory in the Area of Algebraic Specifications. In *Proc. WADT11, Oslo*. LNCS 1130, pp. 17–48. Springer (with M. Große-Rhode and U. Wolter), 1996.

[142] Requirements Engineering of a Medical Information System Using Rule-Based Refinement of Petri Nets. In D. Cooke, B. J. Krämer, P. C.-Y. Sheu, J. P. Tsai, and R. Mittermeir, editors, *Proc. Integrated Design and Process Technology*, Vol. 1, pp. 186–193. Society for Design and Process Science (with C. Ermel and J. Padberg), 1996.

[141] Horizontal and Vertical Structuring of Typed Graph Transformation Systems. *Math. Struc. in Comp. Science*, 6(6):613–648 (with R. Heckel, A. Corradini, and M. Löwe), 1996.

[140] Towards a Module Concept for Graph Transformation Systems: The Software Engineering Perspective. In G. Valiente Feruglio and F. Rosello Llompart, editors, *Proc. Colloquium on Graph Transformation and Its Application in Computer Science*, pp. 25–28. Spain (with G. Engels), 1995.

[139] Introduction to COMPUGRAPH. *Proc. of SEGRAGRA'95 "Graph Rewriting and Computation"*, ENTCS, Vol. 2, 1995.

[138] Compositionality Results for Different Types of Parameterization and Parameter Passing in Specification Language. *Special Issue of Mathematical Structures in Computer Science*, 5(2):283–314 (with R. M. Jimenez and F. Orejas), 1995.

[137] Computing with Algebraic Graph Transformations: Overview of Recent Results. In G. Valiente Feruglio and F. Rosello Llompart, editors, *Proc. Colloquium on Graph Transformation and Its Application in Computer Science*, pp. 17–23. Spain (with M. Korff), 1995.

[136] Dynamic Abstract Data Types Based on Algebraic Graph Transformations. In *Proc. of ADT-COMPASS Workshop*. LNCS 906, pp. 236–254. Springer (with M. Löwe and F. Orejas), 1995.

[135] A Decade of TAPSOFT: Aspects of Progress and Prospects in Theory and Practice of Software Development. In *LNCS 915*, pp. 3–24. Springer (with B. Mahr), 1995.

[134] Algebraic High-Level Net Transformation Systems. *Mathematical Structures in Computer Science*, 5:217–256 (with J. Padberg and L. Ribeiro), 1995.

[133] How to Cope with the Spectrum of SPECTRUM. In *LNCS 1009*, pp. 173–189. Springer (with U. Wolter, K. Didrich, F. Cornelius, M. Klar, and R. Wessäly), 1995.

[132] Functorial Semantics for Safe Graph Grammars Using Prime Algebraic Domains and Event Structures. In *Proc. 5th Int. Workshop on Graph Transformation, USA*, pp. 120–126 (with A. Corradini, M. Löwe, U. Montanari, and J. Padberg), 1994.

[131] Typed Graph Grammars and Their Adjunction with Categories of Derivations. In *Proc. 5th Int. Workshop on Graph Transformations, USA* (with A. Corradini, M. Löwe, U. Montanari, and J. Padberg), 1994.

[130] Abstract Graph Derivations in the Double Pushout Approach. In *Proc. Graph Grammar Workshop Dagstuhl '93*, LNCS 776, pp. 86–103. Springer (with A. Corradini, M. Löwe, U. Montanari, and F. Rossi), 1994.

[129] An Event Structure Semantics for Safe Graph Grammars. In E.-R. Olderog, editor, *Programming Concepts, Methods and Calculi*. IFIP Transactions A-56. North-Holland (with A. Corradini, M. Löwe, U. Montanari, and F. Rossi), 1994.

[128] An Event Structure Semantics for Safe Graph Grammars. In *Proc. PRO-COMET'94, IFIP TC2 Working Conf., San Miniato, 1994*, pp. 417–439 (with A. Corradini, M. Löwe, U. Montanari, and F. Rossi), 1994.

[127] Note on Standard Representation of Graphs and Graph Derivations. In *Proc. Graph Grammar Workshop Dagstuhl '93*, LNCS 776, pp. 104–118. Springer (with A. Corradini, M. Löwe, U. Montanari, and F. Rossi), 1994.

[126] Specification Techniques Using Dynamic Abstract Data Types and Application to Shipping Software. In *Proc. of the International Workshop on Advanced Software Technology, Shanghai*, pp. 70–85 (with R. Bardohl), 1994.

[125] Functorial Theory of Parameterized Specifications in a General Specification Framework. *Theoretical Computer Science*, 135:221–266 (with M. Große-Rhode), 1994.

[124] Algebraic Specification Concepts and Languages for Modular Software Systems. In *Proc. Workshop on Software Technology*. Shanghai, 1994.

[123] Computing with Algebraic Graph Transformations: An Overview of Recent Results. In *Proc. of Graph Grammar Workshop, Spain* (with M. Korff), 1994.

[122] Canonical Derivations for High-Level Replacement Systems. In *LNCS 776*, pp. 153–169. Springer (with H.-J. Kreowski and G. Taentzer), 1994.

[121] Behaviour and Realization Construction for Petri Nets Based on Free Monoid and Power Set Graphs. In *Workshop on Concurrency, Specification & Programming*. Berlin (with J. Padberg and G. Rozenberg), 1994.

[120] Algebraic High-Level Nets: Petri Nets Revisited. In *Recent Trends in Data Type Specification*, LNCS 785, pp. 188–206, Springer (with J. Padberg and L. Ribeiro), 1994.

[119] Algebraic Methods in the Compositional Analysis of Logic Programs. In *Proc. MFCS'94*. Springer (with F. Orejas and E. Pino), 1994.

[118] GRAPHIT: Graphical Support and Integration of Formal and Semiformal Methods for Software Specification and Development. In *Proc. Workshop on Information Technology: Cooperative Research with Industrial Partners Between Germany and Brazil*. PUC/Rio Press (with B. Bardohl, R. Bardohl, P. Castro, M. Korff, J. Padberg, R. Ribeiro, D. Nunes, J. Martins, and A. Martini), 1993.

[117] Combined Algebraic Specification Techniques for Concurrent and Distributed Systems. In H. Reichel, editor, *Proc. GI-Annual Meeting, Dresden*, pp. 528–533. Informatik, Wirtschaft, Gesellschaft, 1993.

[116] Algebraic Specification. In G. Rozenberg and A. Salomaa, editors, *Current Trends in Theoretical Computer Science*, chapter 2, pp. 49–222. World Scientific, 2001.

[115] Compositionality Results for Different Types of Parameterization and Parameter Passing in Specification Language. In *Proc. TAPSOFT '93, Paris*, LNCS 668, pp. 16–30. Springer (with R. M. Jimenez and F. Orejas), 1993.

[114] Categorical Principles, Techniques and Results for High-Level Replacement Systems in Computer Science. *Applied Categorical Structures*, 1(1):21–50 (with M. Löwe), 1993.

[113] Parallel and Distributed Derivations in the Single Pushout Approach. *Theoretical Computer Science*, 109:123–143 (with M. Löwe), 1993.

[112] The ESPRIT Basic Research Working Group COMPUGRAPH "Computing by Graph Transformation": A Survey. In *TCS 109*, pp. 3–6, North-Holland (with M. Löwe), 1993.

[111] High-Level Replacement Systems for Equational Algebraic Specifications. In *Proc. 3rd Conf. on Algebraic and Logic Programming, Pisa* (with F. Parisi-Presicce), 1993.

[110] Interaction Between Algebraic Specification Grammars and Modular Systems. In *Proc. AMAST 93* (with F. Parisi-Presicce), 1993.

[109] Formal Development of Concurrent Systems Using Algebraic High-Level Nets and Transformations. In *Proc. VII Simpósio Brasileiro de Engenharia de Software*, Rio de Janeiro, pp. 1–16 (with L. Ribeiro and J. Padberg), 1993.

[108] Specification Techniques for Concurrent and Distributed Systems. In *Proc. 2nd Maghr. Conference on Software Engineering and Artificial Intelligence, Tunis* (with M. Große-Rhode and A. Heise), 1992.

[107] Introduction to Graph Grammars with Applications to Semantical Networks. *Computers and Mathematics with Applications*, 23(6-9):557–572 (with A. Habel and H.-J. Kreowski), 1992.

[106] From Parallel to Distributed Derivations of Graphs in the Single Pushout Approach. *Memorial Volume for R. Frank, Inf. Fachberichte 309, Berlin*, pp. 47–65 (with M. Löwe), 1992.

[105] Introduction to Algebraic Specification – Part 1: Formal Methods for Software Development. *The Computer Journal*, 35(5):460–467 (with B. Mahr, I. Claßen, and F. Orejas), 1992.

[104] Introduction to Algebraic Specification – Part 2: From Classical View to Foundations of System Specifications. *The Computer Journal*, 35(5):468–477 (with B. Mahr and F. Orejas), 1992.

[103] Non-equivalence of Categories for Equational Algebraic Specifications in View of High-Level-Replacement Systems. In *Proc. WADT-COMPASS-Workshop, Dourdan*, LNCS 655, pp. 222–235. Springer (with F. Parisi-Presicce), 1992.

[102] From Parallel Graph Grammars to Parallel High-Level Replacement Systems. In *Lindenmayer Systems*, pp. 283–303. Springer (with G. Taentzer), 1992.

[101] Graph Grammars and Logic Programming. Graph Grammars and Their Application to Computer Science. In *LNCS 532*, pp. 221–237. Springer (with A. Corradini, U. Montanari, F. Rossi, and M. Löwe), 1991.

[100] Theory of Algebraic Module Specifications Including Behavioral Semantics and Constraints. In M. Nivat, C. Rattray, T. Rus, and G. Scollo, editors, *Algebraic Methodology and Software Technology (AMAST), Iowa City*, pp. 145–172. Springer Workshops in Computing 23 (with M. Baldamus, F. Cornelius, and F. Orejas), 1991.

[99] New Concepts for Amalgamation and Extension in the Framework of Specification Logics. In *Proc. ADT-Workshop, Dourdan*, LNCS 655, pp. 199–221 (with M. Baldamus and F. Orejas), 1991.

[98] Algebraic Concepts for Software Development in ACT ONE, ACT TWO and LOTOS. *Syst. Anal. Model. Simul.*, 8(4/5):353–373 (with I. Claßen, P. Boehm, W. Fey, M. Korff, and M. Löwe), 1991. Also in: Informatik Fachberichte 212.

[97] From Graph Grammars to High-Level Replacement Systems. In *4th Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 532, pp. 269–291. Springer (with A. Habel, H.-J. Kreowski, and F. Parisi-Presicce), 1991.

[96]   Parallelism and Concurrency in High-Level Replacement Systems. *Math. Struct. in Comp. Science*, 1:361–404 (with A. Habel, H.-J. Kreowski, and F. Parisi-Presicce), 1991.

[95]   Tutorial Introduction to the Algebraic Approach of Graph Grammars Based on Double and Single Pushouts. In Ehrig et al. [5], LNCS 532, pp. 24–37. Springer (with M. Korff and M. Löwe), 1991.

[94]   Computing by Graph Transformation – Overall Aims and New Results. In *4th Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 532, pp. 688–697. Springer (with M. Löwe), 1991.

[93]   Algebraic Specification Grammars: Adjunction Between Module Specifications and Graph Grammars. In *4th Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 532, pp. 292–310. Springer (with F. Parisi-Presicce), 1991.

[92]   A Match Operation for Rule-Based Modular System Design. In *Proc. ADT Workshop, Wusterhausen*, LNCS 534, pp. 74–97. Springer (with F. Parisi-Presicce), 1991.

[91]   Algebraic Approach to Graph Transformation Based on Single Pushout Derivations. In R. H. Möhring, editor, *Graph-Theoretic Concepts in Computer Science, WG'90*, LNCS 484, pp. 338–353. Springer (with M. Löwe), 1991.

[90]   On the Relationship Between Algebraic Module Specifications and Program Modules. In *Proc. TAPSOFT*, LNCS 494, pp. 83–98. Springer (with M. Löwe, W. Fey, and D. Jacobs), 1991.

[89]   Linking Schemas and Module Specifications for Distributed Systems. In *Proc. 2nd IEEE Workshop on Future Trends of Distributed Computing Systems*, pp. 165–171. IEEE Computing Society (with M. Arbib), 1990.

[88]   Algebraic Concepts for Formal Specification and Transformation of Modular Software Systems. In *Proc. 23rd Hawaii Int. Conf. on System Science, Kailua-Kona, Hawaii*, pp. 153–164. IEEE Comp. Sci. Press (with P. Boehm and W. Fey), 1990.

[87]   Compatibility Problems in the Development of Algebraic Module Specifications. *Theoretical Computer Science*, 77:27–71 (with W. Fey, H. Hansen, M. Löwe, D. Jacobs, and F. Parisi-Presicce), 1990.

[86]   Combining Data Type and Recursive Process Specifications Using Projection Algebras. *Theoretical Computer Science*, 71:347–380 (with F. Parisi-Presicce, P. Boehm, C. Rieckhoff, C. Dimitrovici, and M. Große-Rhode), 1990.

[85]   Transformation of Combined Data Type and Process Specifications Using Projection Algebras. In *Stepwise Refinement of Distributed Systems, REX-Workshop 1989*, LNCS 430, pp. 301–339. Springer (with M. Große-Rhode), 1990.

[84]   Algebraic Concepts for Software Development in ACT ONE, ACT TWO and LOTOS. In *Informatik Fachberichte 212*, pp. 201–224. Springer (with I. Claßen, P. Boehm, W. Fey, M. Korff, and M. Löwe), 1989.

[83]   Algebraic Concepts for the Evolution of Module Families. In *Proc. First Int. Conf. Algebraic Methodology and Software Technology (AMAST), Iowa City, USA* (with W. Fey, H. Hansen, M. Löwe, and D. Jacobs), 1989.

[82]   Algebraic Specifications of Modules and Configuration Families. *Journal Inf. Process. Cybern. EIK 25*, 5(6):205–232 (with W. Fey, H. Hansen, M. Löwe, D. Jacobs, A. Langen, and F. Parisi-Presicce), 1989.

[81]   Algebraic Software Development Concepts for Module and Configuration Families. In *Proc. 9th Conf. on Foundations of Software Technology and Theoretical Computer Science, Bangalore, India* (with W. Fey, H. Hansen, M. Löwe, and D. Jacobs), 1989.

[80] Categories for the Development of Algebraic Module Specification. In *Proc. Categorical Methods in Comp. Sci. with Aspects from Topology*, LNCS 393, pp. 157–184. Springer (with W. Fey, H. Hansen, M. Löwe, and F. Parisi-Presicce), 1989.

[79] The Construct PRO of Projection Spaces: Its Internal Structure. In *Categorical Methods in Computer Science*, LNCS 393, pp. 286–293 Springer (with H. Herrlich), 1989.

[78] A Categorical Concept of Constraints for Algebraic Specifications. In *Categorical Methods in Computer Science – With Aspects from Topology*, LNCS 393, pp. 1–15. Springer, 1989.

[77] On Recent Trends in Algebraic Specification. In *Invited Paper ICALP'89*, LNCS 372, pp. 263–288. Springer, 1989.

[76] Algebraic Specification of Modeules and Modular Software Systems Within the Framework of Specification Logics. In *Proc. 1st Maghr. Conference on Software Engineering and Artificial Intelligence, Constantine*, pp. 79–92, 1989.

[75] Semantical Constructions for Categories of Behavioral Specifications. In H. Ehrig, H. Herrlich, H.-J. Kreowski, G. Preuš, editors, *Computer Science – With Aspects from Topology*, LNCS 393, pp. 220–243. Springer (with F. Orejas and P. Nivela), 1989.

[74] Distributed Parallelism of Graph Transformation. In *13th Int. Workshop on Graph Theoretic Concepts in Computer Science*, LNCS 314, pp. 1–19, Springer (with P. Böhm, U. Hummert, and M. Löwe), 1988.

[73] Algebraic Data Type and Process Specifications Based on Projection Spaces. In D. Sannella and A. Tarlecki, editors, *Recent Trends in Data Type Specifications*, LNCS 332, pp. 23–43. Springer (with F. Parisi-Presicce, P. Boehm, C. Rieckhoff, C. Dimitrovici, and M. Große-Rhode), 1988.

[72] Algebraic Specification of Modules and Their Basic Interconnections. *Journal of Computer Systems Science*, 34(2/3):293–339 (with E. K. Blum and F. Parisi-Presicce), 1987.

[71] Towards Distributed Graph Grammars. In H. Ehrig, M. Nagl, G. Rozenberg, and A. Rosenfeld, editors, *3rd Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 291, pp. 86–98, Springer (with P. Böhm, U. Hummert, and M. Löwe), 1987.

[70] Graph Rewriting with Unification and Composition. In *3rd Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 291, pp. 496–514, Springer (with F. Parisi-Presicce and U. Montanari), 1987.

[69] Distributive Laws for Composition and Union of Module Specification for Software Systems. In *Proc. IFIP WG 2.1 Working Conf. on Program Specification and Transformation, Bad-Tölz*, pp. 293–312. North Holland (with W. Fey and F. Parisi-Prescicce), 1986.

[68] Concurrent Transformation of Relational Structures. *Fundamenta Informaticae*, IX:13–50 (with A. Habel and B. Rosen), 1986.

[67] Programming in the Large with Algebraic Module Specifications. *Information Processing*, 86:675–684 (with H. Weber), 1986. Invited Paper, IFIP'86 World Congress.

[66] Specification of Modular Systems. *IEEE Transactions on Software Engineering*, SE-12(7):784–798 (with H. Weber), 1986.

[65] Towards Abstract User Interfaces for Formal System Specifications. In *Recent Trends in Data Type Specification, Informatik Fachberichte 116*, pp. 73–88. Springer (with W. Fey and H. Hansen), 1985.

[64] Graph Grammars with Application Conditions. In G. Rozenberg and A. Salomaa, editors, *The Book of L*, pp. 87–100. Springer (with A. Habel), 1985.

[63] Algebraic Specification of Modules. In *Proc. IFIP Work Conf. 85: The Role of Abstract Models in Programming, Wien*, pp. 231–258. North Holland (with H. Weber), 1985.

[62] ACT ONE. An Algebraic Specification Language Based on Initial Algebra and Free Functor Semantics. In *Proc. of the 10th National Summer School "Application of Mathematics in Engineering" Varna*. University of Varna (with H. Hansen), 1984.

[61] Combining Initial and Loose Algebraic Specification Methods Including Compositionality and Modules. In *Proc. Workshop on Formal Software Development, Nyborg*. University of Copenhagen, 1984.

[60] Parameter Passing in Algebraic Specification Languages. *Theoretical Computer Science*, 28:45–81 (with H.-J. Kreowski, J. W. Thatcher, E. G. Wagner, and J. B. Wright), 1984.

[59] Algebraische Spezifikationen: Konzepte und Sprachen für die Software-Entwicklung. In *Festband 10 Jahre Informatik Dortmund*. Abt. Informatik, Universität Dortmund (with W. Fey and K. P. Hasler), 1983.

[58] Development, Specification and Semantics of Strictly Modular Systems. In *Lecture Notes Seminar on State of the Art and Perspectives of Software Technology in Europe, USA, and Japan*. ICC Berlin, 1983.

[57] Aspects of Concurrency in Graph Grammars. In H. Ehrig, M. Nagl, and G. Rozenberg, editors, *2nd Int. Workshop on Graph Grammars and Their Application to Computer Science*, LNCS 153, pp. 82–101. Springer, 1983.

[56] Concurrent Transformations of Graphs and Relational Structures. In M. Nagl and J. Perl, editors, *Proc. WG 1983, Int. Workshop on Graphtheoretic Concepts in Computer Science, Osnabrück*, pp. 76–88. Trauner-Verlag, 1983.

[55] Compatibility of Parameter Passing and Implementation of Parameterized Types. *TCS*, 27:255–286 (with H.-J. Kreowski), 1983.

[54] Church-Rosser Properties for Graph Replacement Systems with Unique Splitting. In H. Ehrig, M. Nagl, and G. Rozenberg, editors, *2nd Int. Workshop on Graph Grammars and Their Application to Computer Science, LNCS 153*, pp. 82–101. Springer (with J. Staples), 1983.

[53] Algebraic Specifications with Generating Constraints. In *Proc. ICALP'83*, LNCS, pp. 188–202. Springer (with E. G. Wagner and J. W. Thatcher), 1983.

[52] Algebraic Implementation of Abstract Data Types. *TCS*, 20:209–263 (with H.-J. Kreowski, B. Mahr, and P. Padawitz), 1982.

[51] Methodology for the Specification of Software Systems: From Formal Requirements to Algebraic Design Specifications. In *Informatik Fachberichte 50*, pp. 255–269. Springer (with W. Fey), 1981.

[50] Algebraic Theory of Parameterized Specifications with Requirements. In *Proc. CAAP '81*, LNCS 112, pp. 1–24. Springer, 1981.

[49] A Graph Theoretical Model for Multi-pass Parsing. In J. R. Mühlbacher, editor, *Proc. Workshop on Graphtheoretic Concepts in Computer Science, Linz*, pp. 19–31. Hanser-Verlag (with B. Hoffmann and I. R. Schmiedicke), 1981.

[48] Keywords in Context: An Algebraic Specification. In *Proc. Workshop on Program Specification, Aarhus, Denmark*, LNCS 134, pp. 78–83. Springer (with H.-J. Kreowski), 1981.

[47] Transformation of Structures: An Algebraic Approach. *Mathematical Systems Theory*, 14:305–334 (with H.-J. Kreowski, A. Maggiolo-Schettini, B. K. Rosen, and J. Winkowski), 1981.

[46] Parameter Passing in Algebraic Specification Languages. In *Workshop on Program Specification, Aarhus*, LNCS 134, pp. 322–369. Springer (with H.-J. Kreowski, J. W. Thatcher, E. G. Wagner, and J. B. Wright), 1981.

[45] Complexity of Algebraic Implementations for Abstract Data Types. *JCSS*, 23:223–253 (with B. Mahr), 1981.

[44] Algebraische Spezifikationen eines Stücklistensystems – Eine Fallstudie. In *Proc. 2nd German Chapter of the ACM Software Engineering – Entwurf und Spezifikation, Berlin*, pp. 75–90. Teubner Verlag (with W. Fey and H.-J. Kreowski), 1980.

[43] Applications of Graph Grammar Theory to Consistency, Synchronization, and Scheduling in Database Systems. *Information Systems*, 5:225–238 (with H.-J. Kreowski), 1980.

[42] Compound Algebraic Implementations: An Approach to Stepwise Refinement of Software Systems. In *Proc. Conf. Math. Foundations of Computer Science, Rydzyna*, LNCS 88, pp. 231–245. Springer (with H.-J. Kreowski, B. Mahr, and P. Padawitz), 1980.

[41] A Case Study of Abstract Implementation and Their Correctness. In *Proc. 4th Int. Symp. on Programming*, LNCS 83, pp. 108–122. Springer (with H.-J. Kreowski and P. Padawitz), 1980.

[40] Algebraic Implementation of Abstract Data Types: Concept, Syntax, Semantics, and Correctness. In *Proc. ICALP'80*, LNCS 85, pp. 142–156. Springer (with H.-J. Kreowski and P. Padawitz), 1980.

[39] Parameterized Data Types in Algebraic Specification Languages. In *Proc. ICALP'80*, LNCS 85, pp. 157–168. Springer (with H.-J. Kreowski, J. W. Thatcher, E. G. Wagner, and J. B. Wright), 1980.

[38] Complexity of Implementations on the Level of Algebraic Specifications. In *Proc. 12th ACM Symposium Theory of Comp., Los Angeles*, pp. 281–293 (with B. Mahr), 1980.

[37] Parallelism and Concurrency of Graph Manipulations. *Theoretical Computer Science*, 11:247–275 (with B. K. Rosen), 1980.

[36] Graph Grammars and Their Application to Computer Science and Biology. In *LNCS 79*. Springer (with V. Claus and G. Rozenberg), 1979.

[35] Introduction to the Algebraic Theory of Graph Grammars (A Survey). In *Graph Grammars and Their Application to Computer Science and Biology*, LNCS 73, pp. 1–69. Springer, 1979.

[34] Neue Aspekte algebraischer Spezifikationsschemata für Datenbanksysteme. In *Proc. Workshop Formale Modelle für Informationssysteme, IFB 21*, pp. 181–198 (with H.-J. Kreowski), 1979.

[33] Pushout-Properties: An Analysis of Gluing Constructions for Graphs. *Mathematische Nachrichten*, 91:135–149 (with H.-J. Kreowski), 1979.

[32] The Skeleton of Minimal Realization. *Studien zur Algebra und Anwendungen*, 7:137–154 (with H.-J. Kreowski), 1979.

[31] Categorical Approach to Nonlinear Constant Continuous Time Systems. *R.A.I.R.O*, 13(2):107–133 (with W. Kühnel), 1979.

[30] A Graph Grammar Approach to Optimal and Consistent Schedules in Data Base Systems. In U. Pape, editor, *Proc. Workshop WG'79 Graphentheoretische Konzepte in der Informatik, Berlin*, pp. 223–240. Hanser-Verlag (with H.-J. Kreowski), 1979.

[29] Locally Star-Gluing Formulas for a Class of Parallel Graph Grammars. In *Graph Grammars and Their Application to Computer Science and Biology*, LNCS 73. Springer (with A. Liedtke), 1979.

[28] Decomposition of Graph Grammars, Productions and Derivations. In *Graph Grammars and Their Application to Computer Science and Biology*, LNCS 73, pp. 192–205. Springer (with B. K. Rosen), 1979.

[27] Pushout Properties: An Analysis of Gluing Constructions for Graphs. In *Proc. Nordwestdeutsches Kategorienseminar, Bielefeld*, pp. 69–89. University of Bielefeld (with H.-J. Kreowski), 1978.

[26] Algebraic Theory of Graph Grammars Applied to Consistency and Synchronization in Data Base Systems. In *Proc. Workshop WG'78 Graphentheoretische Konzepte in der Informatik*, pp. 227–244. Hanser-Verlag (with H.-J. Kreowski), 1978.

[25] Deriving Structures from Structures. In *Proc. 7th Int. Symp. on Math. Found. of Comp. Science, Zakopane*, LNCS 64, pp. 177–190. Springer (with H.-J. Kreowski, A. Maggiolo-Schettini, B. K. Rosen, and J. Winkowski), 1978.

[24] Stepwise Specification and Implementation of Abstract Data Types. In *5th Int. Coll. Automata, Languages, and Programming*, LNCS 62, pp. 205–226. Springer (with H.-J. Kreowski and P. Padawitz), 1978.

[23] Algebraic Specification Schemes for Data Base Systems. In *Proc. 4th Int. Conf. Very Large Data Bases*, pp. 427–440. Hahn-Meitner-Institut für Kernforschung, HMI-B266 (with H.-J. Kreowski and H. Weber), 1978.

[22] Concurrency of Manipulations in Multi-dimensional Information Structures. In *LNCS 64*, pp. 65–176. Springer (with B. K. Rosen), 1978.

[21] Embedding Theorems in the Algebraic Theory of Graph Grammars. In LNCS 56, pp. 245–255. Springer, 1977.

[20] The Mathematics of Record Handling. In LNCS 52, pp. 206–220, Springer (with B. K. Rosen), 1977.

[19] Algebraic Graph Theory Applied in Computer Science. In Proc. Conf. Categorical and Algebraic Methods in Comp. Science and Systems Theory, Dortmund (with H.-J. Kreowski), 1976.

[18] Categorical Theory of Graphical Systems and Graph Grammars. In *Conf. Report Algebraic System Theory, Udine, 1975*, Lect Notes Econ, Math. Syst. 131 (1976), pp. 323–351. Springer (with H.-J. Kreowski), 1976.

[17] Minimization Concepts of Automata in Pseudoclosed Categories. In *Conf. Report Algebraic System Theory, Udine, 1975*, Lect Notes Econ, Math. Syst. 131 (1976), pp. 359–374. Springer (with H.-J. Kreowski), 1976.

[16] Parallel Graph Grammars. In A. Lindenmayer and G. Rozenberg, editors, *Automata, Languages, Development*, pp. 425–447. Amsterdam, North Holland (with H.-J. Kreowski), 1976.

[15] Parallelism of Manipulations in Multidimensional Information Structures. In *Proc. Conf. Math. Foundations of Computer Science*, LNCS 45, pp. 284–293. Springer (with H.-J. Kreowski), 1976.

[14] Systematic Approach to Reduction and Minimization in Automata and System Theory. *Journal Computer Syst. Science*, 12(3):269–304 (with H.-J. Kreowski), 1976.

[13] Some Definitional Suggestions for Parallel Graph Grammars. In A. Lindenmayer and G. Rozenberg, editors, *Formal Languages, Automata and Development*, pp. 443–468. North Holland (with G. Rozenberg), 1976.

[12] Grammars on Partial Graphs. *Acta Informatica*, 6:297–316 (with H. J. Schneider), 1976.

[11] Power and Initial Automata in Pseudoclosed Categories. In *Proc. 1st Int. Symp. Category Theory Applied to Computation and Control, San Francisco*, LNCS 25, pp. 144–150. Springer (with H.-J. Kreowski), 1975.

[10] Diagram Characterization of Recursion. In *Proc. 1st Int. Symp. Category Theory Applied to Computation and Control, San Francisco*, LNCS 25, pp. 137–143. Springer (with W. Kühnel and M. Pfender), 1975.

[9] Graph Grammars and Applications to Specification and Evolution in Biology. *Journal Computer System Science*, 11(2):212–236 (with K. W. Tischer), 1975.

[8] Development of Stochastic Graphs. In *Proc. Conf. on Uniformly Structured Automata Theory and Logic, Tokyo*, Vol. 11/2, pp. 1–6 (with K. W. Tischer), 1975.

[7] F-Morphisms. *Mathematische Nachrichten*, 59:75–93, 1974.

[6] Kategorielle Theorie von Automaten. *BI-Buch: Überblicke Mathematik VII*, pp. 167–218, 1974.

[5] Topological Automata. *R.A.I.R.O*, 3:73–91 (with W. Kühnel), 1974.

[4] Kategorielle Theorie der Reduktion, Minimierung und Äquivalenz von Automaten. *Mathematische Nachrichten*, 59:105–124 (with H.-J. Kreowski and M. Pfender), 1974.

[3] Graph Grammars for the Specialization of Organisms. In *Proc. Conf. on Biologically Motivated Automata Theory, Virginia, USA*, pp. 158–165. Record Mitre Corp. (with K. W. Tischer), 1974.

[2] Graph Grammars: An Algebraic Approach. In *14th Annual IEEE Symposium on Switching and Automata Theory*, pp. 167–180. IEEE (with M. Pfender and H. J. Schneider), 1973.

[1] *Übertragung universeller und spezieller Probleme in F-Morphismen-Darstellung*. PhD thesis, Technische Universität Berlin, 1971.