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Preface

Today, we all know that the combination of a conventional injection procedure, a single analytical column and a selective detector often does not suffice to recognize and quantify all analytes of interest in a sample. During the eighties, the use of *multidimensional* approaches slowly began to make headway to help solve the many, and often complex, problems concerning: (i) the provisional identification, or confirmation of the presence, of analytes of interest, (ii) the design of separation systems with a considerably improved separation efficiency, and (iii) the generally felt need to incorporate the sample preparation in the total analytical procedure.

Two major branches emerged – *hyphenation*, which is often defined as the on-line combination of a separation technique and a spectroscopic detection device which provides structural information, and *coupled-column techniques*, a term which does not require further explanation. Other workers, by the way, use *hyphenation* to describe both of these branches, a practice that has also been followed when selecting the title of the present volume. Combining both approaches in one set-up further increases the potential – and unfortunately, also the cost – of our analytical instruments. At the same time, it enhances the versatility of the developed analytical procedures.

What were the main driving forces behind all these developments? One aspect was that, in modern analytical chemistry, the determination of trace-level concentrations of (in)organic compounds – pesticides, industrial chemicals, drugs, active substances, etc. – in environmental, agricultural, food and biomedical/biological samples is highly important. In many instances, for health, safety or commercial reasons, 'trace-level' over the years became to indicate low or even sub ng/g rather than the earlier high ng/g concentrations. In other words, demands often became 100-fold more stringent. In addition, the multitudes of peaks showing up regularly in chromatograms (and, more recently, electropherograms) made analysts increasingly aware that 'a peak at the appropriate retention time' does not necessarily imply that it is the compound of interest which is there: co-elution can become a doughty opponent during legal procedures. Thirdly, the dramatic increase of the number of samples that have to be analysed each day, stimulated workers to set up more efficient, i.e. at-line or on-line, procedures and to introduce (semi-)automation – all of which made *interfacing* a key operation. Finally, when analytical chemists started to find out that most modern instruments are sufficiently robust to be incorporated in integrated systems, the glamour of hyphenation began to be recognised, and the hype and fascination were born.

With hyphenation – the theoretical aspects, its scope, the technical problems and the real-life applications – attracting so much attention, the approaching turn of the century seemed to be an appropriate moment in time to publish a series of reviews on hyphenated topics which are in vogue today. Sample preparation (with solid-phase extraction, membrane-based techniques and procedures using supercritical fluids), a variety of separation techniques (LC, GC, planar chromatography and CE) and many spectroscopic detection procedures (MS, NMR, FTIR, AED and ICP-MS) all get their fair share of attention. Reviews on closely related though, by themselves, sometimes rather less hyphenated techniques, fill in the picture. These include microcolumn LC, progress in the field of inorganic analysis, modern injection

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techniques and high-speed analysis in GC, highly promising comprehensive GC, and overviews of several electrophoretic techniques (and their application). Their distinct back-up value in a volume on hyphenation should be clear to the reader.[1]

Sadly, one of the contributors to this volume, Professor John B. Phillips, died shortly after completing the draft of his contribution to this volume. Professor Phillips was a pioneer in the field of comprehensive gas chromatography and greatly contributed to the advances in this exciting field. His review article on comprehensive two-dimensional gas chromatography for this volume was completed by Dr. J. Beens.

As many readers will know, I have been active in the field of on-line sample preparation and post-column reaction detection (together with my colleague, Professor Roland Frei, whose enthusiasm is still vividly remembered in our Department) since the late seventies. Designing, optimizing – and applying! – hyphenated and coupled-column techniques became my primary field of interest 10–15 years ago, and this is still true today. It has, therefore, been a real pleasure to co-operate with many friends and colleagues to get the present project completed.

As for the reader, I do hope that he, or she, will realise that the present text is a reflection on what has been achieved in the past two decades rather than a prediction of what will be achieved in the next ten or twenty years (let alone the 21st century or, even the 'next millennium'!). If the present volume will stimulate scientific discussion, and help to turn what is mere hype into fascination, and fascination into relevant application – I shall be perfectly happy.

Udo A.Th. Brinkman

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[1] Because the thematic volumes on Contemporary Capillary Gas Chromatography (*Journal of Chromatography A*, Vols. 842 and 843) were ready for publication while the present volume was being prepared, we could not avoid including three review articles from those volumes, in essentially unaltered form, in the present publication (W. Engewald et al., p. 259; J.J. Vreuls et al., p. 279; C.A. Cramers et al., p. 315).