0. Abstract.

By comparing the developments taken place in the field of consumer electronics, where large scale equipment has been miniaturized due to the integration of electronic functions in one and the same chip, it is made clear how in the same way the present large scale equipment for chemical analysis might be miniaturized to portable μTAS systems. The progress in silicon sensor technology as well as in the micro systems technology for liquid handling systems makes this miniaturisation possible, but for the practical realisation of μTAS systems a standardisation for the interconnection of the system components has to be developed.

1. Introduction.

After the first world war, more and more citizens came in the possession of a wireless radio set, which consisted in those days of a separate power supply, a so-called detector and a separate loudspeaker. It took at least one decade before the manufacturers integrated the different parts into one radio as a nice piece of furniture, primarily available for the upper class. These radio's were relatively large and heavy, due to the application of large vacuum tubes, transformers and detection coils. Only after world war two, the vacuum tubes became smaller and the radio's needed less energy, resulting in the development of portable radio's, of which initially the batteries formed the heaviest part. After the invention and application of the transistor, the energy need decreased tremendously and many types of transistorised radio's became available. The first types still used relatively large batteries as in use for electric torches, but as soon as integrated circuits became common, the transistor radio's came down in size and weight and soon became pocket radio's. Nowadays the whole radio consists of only one integrated circuit, to be supplied by one miniature battery, mounted in a matchbox-sized housing, to which an ear-phone can be connected.

The same story as given above can be told about to the development of many other electronic products, such as recorders, TV sets, computers etc. Beside the miniaturization of the equipment, the number of built-in functions greatly increased. These developments have been accepted world-wide as a logical progress in technological possibilities.
2. From single analyser to auto-analysers.

Already in the twenties many instruments existed or were under development in the field of analytical and clinical chemistry for the measurement of one specific parameter of a sample solution, mostly a concentration. Various calorimeters, photometers and a pH measuring apparatus are well known examples. The more parameters that could be analysed, the more equipment came into existence. In order not to divide samples in ever more portions to be analysed separately by the available equipment with their specific method of measurement, in the fifties the tendency arose to combine the different methods in one and the same apparatus. In this way, again as a logical consequence of the possibilities, multi analysers were built, completely automated with respect to sample manipulation, measurement, registration, data processing etc. The first auto-analysers were pieces of room filling equipment, but due to the introduction of, among other things, integrated circuit technology and the interrelated data processing and mechatronic control actions, many parts of the system could be miniaturized as in the case of the radio's mentioned above. At present the equipment contains much more functions, is highly automated and is still relatively small compared to the original designs. Nevertheless most of the equipment is too large to be applied outside a central laboratory and moreover needs skilled personnel for a proper operation. The question may arise whether, as in the case of electronic equipment as mentioned in the introduction, the development of auto-analysers will also show progress in further miniaturization. This might ultimately result in pocket size equipment, for application in the field of environmental or bedside monitoring, operated by relatively untrained personnel.

3. The development of chemical sensors.

Since about 1970, the construction of miniature sensors has been a promising field of research. The reason is that at this time the possibilities of applying silicon technologies for the construction of sensors became available. It was expected, as in the case of transistors, that many types of sensors could be produced in this way in large quantities and for a very low price. Especially university research groups took this challenge and indeed showed that the application of silicon and related technologies is very useful for the manufacturing of various types of physical and chemical sensors. The industry discovered however that it is not the chip price which determines the costs of the sensor, but the encapsulation which can hardly be standardised due to the wide range of specific applications. Therefore it took at least 20 years of development before the first solid state sensors became commercially available, especially the chemical- and biosensors. At present different types of electrochemical and optical sensors are available, but the application is rather traditional. The construction of the sensors is mainly in the form of dipstick and flow-through systems as miniature equivalents of conventional systems using the larger types of sensors. The main advantage of the smaller sensors is that they can handle smaller samples in shorter times due to their miniature design and faster response. With only some exceptions the sensors have, like