Extensible software products [1, 2, 11, 12, 21, 23, 24, 26, 32] combine the merits of universal and specialized programs and are free of the specific shortcomings of either, in terms of linguistic and systemic characteristics [5, 8, 9, 11, 15, 16, 19, 29, 33, 34]. The schemes of general systemic extensions were proposed for the first time in [3]. In [12] a scheme of vertical extension of algorithmic languages was suggested. Studies of the various aspects and shades of extensible languages and systems have been reported in [1, 2, 4, 6, 10, 14, 16, 17, 22, 24-29, 31-37]. Recently, research was focused on the characteristics of extensible programming tools [3, 7-9, 11, 13, 15, 18-21, 30]. As a result, languages such as ALGOL-68, PASCAL, ADA and other languages and systems offering mechanisms of extension were created. It became necessary [5] to set up a subgroup for extensible programming tools under the working group on "Implementation of Programming Languages" at the Mathematical Software Commission of the Coordination Committee for Computer Technology (SMOKKVT) of the USSR Academy of Sciences. Many of the recent studies [3, 8, 9, 11, 15, and others] and, in particular, the present paper, have been presented at meetings of the subgroup, which recommended them for publication.

This paper is an attempt at a description and analysis of the definitions of a general model for the construction of extensible tools of programming; components of these tools have been studied and used by the author and his co-workers in developing and updating extensible languages and programming systems. The discussion is concerned with definitions of the components of extensible programming tools and schemes of extenders of data and operations; general schemes of algorithms of components of extensible programming systems are presented, specifying their place in the design and use of extensible programming tools.

1. Definition of Extensible Programming Tools

A programming tool used for the introduction of new means of programming and their future use is called an extender.

A distinction is made between data extenders and action extenders. An extender is presented as a declaration of an extension and as a reference to an extension. As a systemic component in a programming system, an extender appears as a language extender and as its corresponding realizer of an extension (Fig. 1). Arrows in Fig. 1 indicate the interrelationships and interactions of the component parts of an extender and its environment and the operation sphere of extensible programming tools.

A language extender is an element of a language that allows declaring and making references to new language elements. It consists of two parts: the declarer of the extender (declaring the extension of a new language element) and the reference to an extension (the
use of the new language element and its introduction into operation).

The declarer of an extension is used to expand the language by adding new (arbitrary) language elements; it executes the declaration of an extension. It includes the declaration of the pragmatics of the new language element, its syntax, semantics, the context in which it is used, and other language information characterizing the element. A declaration of an extension can introduce one or more forms (varieties of use and reference) of a new language element.

A library of extensions is a library consisting of extension declarations.

Reference to an extension allows utilizing, in the course of programming, a new language element introduced in its various forms by the respective extension declarer. The syntax of the reference to an extension is defined by the syntactic part of its corresponding extension declarer; its pragmatics and semantics with inclusion of other characteristic information in the extension declaration is coordinated with the context of reference (use) of the extension.

A programming language which, in addition to basic and derivative elements, includes language extenders is called an extensible programming language. An extensible language consisting of basic elements and extenders is referred to as the BASE of the extensible language (a BASE, a basic extensible language, an extensible basic language, or an extensible base).

A program written in an extensible programming language is called an extensible program; it comprises elements of the BASE and language extenders. Extensible programs form collectively a library of extensible programs.

The realizer of an extender is a translating element which realizes the language extender. It consists of two parts: the realizer of extension declarer, and the realizer of reference to the extension.

The realizer of extension declarer (ROR) is a translating element of a programming system, and prepares the new language element added through the extension for practical use. ROR is represented in the programming system by a single programming module or a string of interacting and interconnected programming modules.

Realizer of the reference to extension (ROKR) is a translating element which identifies (recognizes) a reference to an extension in its various forms (in accordance with the declaration of the extension) and compiles and/or interprets a reference to an extension. ROKR can be represented in a programming system by one programming module or a string of interacting and interconnected programming modules.

An extensible translator is a translator that realizes extensible programs. In addition to the realizers of the basic elements of an extensible language and the service and control modules, an extensible translator comprises realizers of extenders that translate derivative language elements.

An extensible programming system is a system comprised of an extensible language and its corresponding extensible translator.

An extensible software product is a product consisting of extensions, extensible programs, libraries of extensions and extensible programs, an extensible programming system, in combination with the procedures for the design, maintenance, and use of all those programs and tools.

An extensible programming technology is a technology for the creation, maintenance, and use of a software product in the operational environment of an extensible programming system.

Extensible programming tools are tools used for the creation, maintenance, and utilization of extensible programming products. They include a computer network, an extensible programming system, the library of extensions and extensible programs, and extensible programming technology.

2. Extender — An Element of Extensible Language

Through the use of extenders an extensible language can be enriched (expanded) to include new (derivative) data, operations, operators, and controls. Extenders are characterized by features that are typical for those language elements they serve to extend.