Contemporary Engineering Sciences, Vol. 6, 2013, no. 5, 203 - 211
HIKARI Ltd, www.m-hikari.com
http://dx.doi.org/10.12988/ces.2013.3316

A Language for 2D Parametric and Geometric Modelling - PrESMod and Entity Selection

Željko Popović[1], Ivan Aranđelović[2] and Jelena Nikolić[3]

[1]TEHNIKUM TAURUNUM, Nade Dimic 4, 11080 Zemun, Serbia

[2]Faculty of Mechanical Engineering, Kraljice Marije 16, 11000 Belgrade, Serbia

[3]Inovation Centre, Faculty of Mechanical Engineering
Kraljice Marije 16, 11000 Belgrade, Serbia

Abstract

The first part of this paper contains a theoretical definition of a language for 2D modeling – PrESMod with several characteristic definitions. This language can be used to describe forms with dimensions (constants), general dimensions (variables) and a combination of concrete and general dimensions.

If the same theoretical approach used in the PrESMod modeling language is used in modeling operations in CAD systems, then such an approach can be supplemented with a conceptually similar approach used for selection. An approach to describing requirements for entity selection for modifications of CAD systems is given here. An attempt was made to organize this field in a universal fashion. Choice, i.e. selection of basic entities can be performed using any element from the description set. Besides this, part of the space (area) inside which, or outside which entities are selected can be possibly defined for selection.

Keywords: 2D modeling, modeling language, CAD systems

1 Introduction

AutoCAD as the CAD packet most present on the market contains quite rigid procedures when describing forms which are being drawn/modeled. Besides that, in this and other CAD/CAM systems diversity of descriptions is small. It is not possible to in the primary (geometrical) description simultaneously use characteristic points, point coordinates separately and other parameters, and especially not relation statements. Modeling with general dimensions (variables) or a combination of general and concrete dimensions (constants) is different from drawing with concrete dimensions. With the PrESMod language for 2D geometrical modeling description of the form of technical objects is simple and direct. Description is possible in many ways (diverse descriptions) and it is easy without rigid rules. The approach to entity selection for modifications in existing CAD systems is not all-inclusive. Partial approaches to this problem are present. In this paper an attempt is made to solve the approach to entity selection in a more universal fashion.

2 A general approach to 2D form description

The PrESMod modeling language is primarily intended for modeling, i.e. drawing elements and details and other graphs, i.e. graphical elements used when designing.

This language is used to describe a form with general or a form with concrete dimensions or a combination of general and concrete dimensions of the modeled object.

Expressions containing standard mathematical operations (adding, subtracting, multiplying, dividing, powering), standard mathematical functions (sine, cosine, tangent, logarithm etc.) variables, constants, coordinates of entity section points and other characteristic parameters (diameter, radius, angle, length etc.) of an entity and also the distance between defined points and coordinates of entity section points can be used when defining values of any point (its set of coordinates), point coordinates and other characteristic parameters. Besides that, the value of the coordinate subset of some characteristic points of any other entity can be added to the description of the value of a characteristic point. When an entity is described with a function, the function expression (domain and co-domain) can be formed in a similar way as when defining values of characteristic coordinates and other characteristic geometric parameters. Relation expressions (tangential, perpendicular, parallel, etc.) are used to define the entity position in reference to another entity.

Relation expressions can be used to give the relation between positions of points of the described entity (using point coordinates and other characteristic geometrical parameters in the relation expression). These are relation expressions where the left and right sides of the expression (larger, smaller and all relations containing the relation larger or smaller) contain expressions which can use coordinates and other characteristic entity parameters besides standard mathematical operations, standard mathematical functions, variables, constants etc. The expressions on the left and right side of the relation can be formed in the same way as when defining values of any other geometrical characteristic of an entity.

Besides this, a special type of expression, which has an expression on only one side of the relation (larger, smaller or relations containing these relations) and nothing on the other side, can be used here.

These two types of relation expressions can be used for describing entities, when, based on the remaining part of the primary entity, description two or more solutions can exist, i.e. two or more sets of points for the given entity. In this case this expression determines (requests) which of these two point sets should be singled out.

This is solved by including coordinates and other characteristic geometrical parameters in the relation expression. For a special type of relation expression this is most easily solved by requesting that the value of some coordinate of a specific point or the value of some parameter is larger or smaller (for example the x coordinate of some characteristic point is larger, the angle smaller, diameter larger and similar).

Expressions containing relations closer, further, closest and furthest exist besides these two types of relation expressions. Characteristic entity points are used in these expressions besides the stated relations.

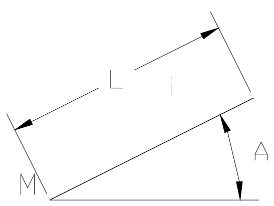
Real and imaginary entities can exist in this case, i.e. entities which are drawn and ones that are not. Imaginary entities are primarily used for an easier description of a real entity. Imaginary entities have all characteristics of a real entity and in relation to them can use position relations and all other characteristics (characteristic points, coordinates of characteristic points, characteristic geometrical parameters and other characteristics) for the description of another real or imaginary entity.

These characteristics can be loaded directly or indirectly (they are considered to be there). One file (list and similar) containing a description of a group of basic entities (where descriptions of individual basic entities are clearly separated) can be used to describe any complex graphical entity:

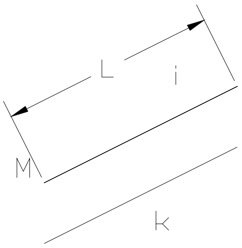
3 Examples of entity definitions

We have here several definitions of entities straight line and arc. A scheme, general definition and examples of entity definition are given for each definition.

Oriented straight line

<table>
<tr><td rowspan="2">a)

</td><td><u>General definition</u>
i; L: M=am1, am2; L=al; A=aa LT</td></tr>
<tr><td>Examples of definitions of a straight line
18;L: M=2,2;L=20.5;A=pi/6 _._
19;L: L=(xm(15)-xn(15))*sin(beta);A=PI;M=S(1)
20;L: M=xm(1)+10,ym(1);A=45%;L=a+b-6
21;L: M=N(4);L=L(5);a=30% __
22;L: M=N(2);L=xm(4)-xm(3);A=A(1)+(pi/6)</td></tr>
</table>

b)

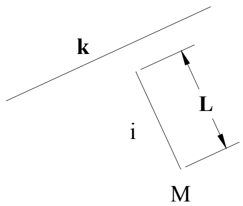


<u>General definition</u>
i; L: M=am1, am2; L=al; //(k); direction LT

Examples of definitions of a straight line

23;L: M=30,10;//(2);L=25;xm<xn _._
24;L: M=(d1+d2)*2,d3;L=L(5);//(12);ym+yc(3)<yn
25;L://(10);L=b1;XM=xm(10)+10;YM=ab;yn>

c)



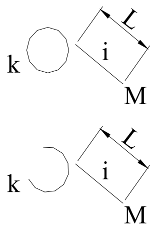
<u>General definition</u>
i; L: M=am1, am2; L=al; I-(k); direction LT

Examples of definitions of a straight line

23;L: M=30,xm(5)+2;I-(2);L=20;xm>xn _._
24;L: M=xm(12)+5,ym(12);L=L(5);I-(15);A<
25;L:I-(11);L=b1;XM=xm(10)+10;YM=20;yn>

If the length and the relation expression for direction are omitted in the description, the straight line reaches entity k.

d)



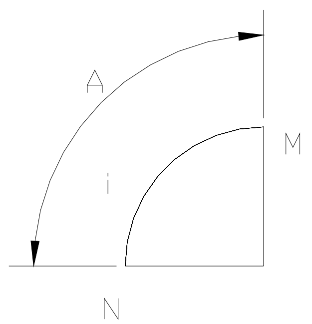
<u>General definition</u>
i; L: M=am1, am2; IC(k); L=al; position LT

Examples of definitions of a straight line
11;L: M=1,6;L=l1;IC(2);A<arctg(yc(1)-ym)/(xc(1)-xm))
12;L: M=m(1);L=l1*sin(ax);IC(4);A<
13;L: M=a*cos(b1),e1+2.0;IC(3);L=e1+e2;A> __

The line position in relation to the arc or circle can be determined using the relation statement that the angle of line A is smaller or equal to line M(i)-C(k) – example line 11 ;
If the relation statement for the position is left out then a line with a lower angle is drawn A;
If it is defined that A< (line 12) a line with a smaller angle is drawn
If it is defined that A> (line 13) a line with a larger angle is drawn

Arc

a)



General definition

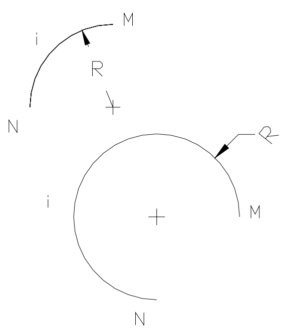
i; C: M=am1, am2; N=an1, an2; A=aa LT

Examples of definitions of an arc

15;c: M=20+b,c;N=n(5);A=45% __
16;C: A=a(5);N=xm(5),xn(5)+g1;M=(a+d)/2.0,d*cos(gama)
17;C: M=5,5;n=6,6;A=am(5)+pi _._
18;C: A=a(4)+(pi/4);M=Xm(2)+30,ym(2);N=xm,ym-30

The angle is given in radians; if it is given in degrees then this must be emphasized by adding % to the symbol, like in the example of arc 15.

b)



General definition

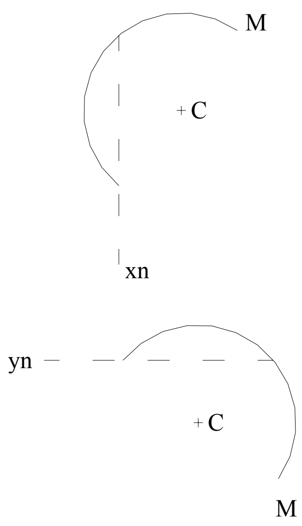
i; C:M=am1, am2; N=an1, an2; R=ar;position center LT

Examples of definitions of an arc

19;C: M=40,40;n=20,20;r=30 __
20;C: M=a,b;N=a+c,bc;N=s(3);R=d5/2;yc>(ym+yn)/2
22;C: M=2,2;n=1,1;R=(((xm-xn)~2+(ym+yn)~2)~0.5)/2.0

If the center is in the middle of the straight line joining points M and N (MN=2*R) then the relation expression for the arc center position is excessive.

c)



General definition

i; C: C=ac1, ac2; M=am1, am2; xn=an1;
position LT
i; C: C=ac1, ac2; M=am1, am2; yn=an2;
position LT

Examples of definitions of an arc

15;C: M=30,20;c=20,20;xn=15;L>
16;c: M=a,b+8;C=a,b;xn=a-4;L<
17;C:M=xm(5),xn(5);C=xm(5),ym(5)+b;yn=yc+b/2;xn<xc

The lexical, semantical and syntactic structure of the PrESMod modeling language is given in detail in [1]. In this case only element denotations are given, which are used in entity descriptions in definitions given here: M denotes the starting point; N denotes the final point; C denotes the arc center; L is the length of the straight line; R is the arc radius, A – angle; xm- x coordinate of the start point; xn-coordinate of the end point; //– parallel; I – perpendicular.; IC – tangential; yn – y coordinate of the end point.

4 Entity selection

Selection of basic entities can be performed using any element from the description set. Thus, selection of one or more entities can be defined by a description in the request:

- identification of one or more entities;
- the type of one or more entities;
- one or more functions used to describe entities, for entities described by functions;
- one or more elements from the geometry description set (characteristic points, their coordinates and other parameters such as diameter, radius, angle, etc.) and the ratio (parallel, perpendicular, tangential relations, etc.) between entities that need to be selected according to a defined entity;
- one or more types of lines (line-blank, line-blank-dot-blank, full line etc.);
- one or more colours.

Thus, all elements from the description set can be used to describe requests for the selection of an entity or a group of entities, including also parts of these elements if an element from the description set consists of several parts. This is valid not only for basic entities, but also for complex entities (text, coordinates and other complex entities)

The description of selection requests should if needed, contain besides characteristic values, the denotation of the variable, which is defined to be inside or outside the defined set of values for an individual characteristic.

Besides this, for selection, it is possible to define part of the area inside or outside which entities are chosen. A request can exist to select entities for which

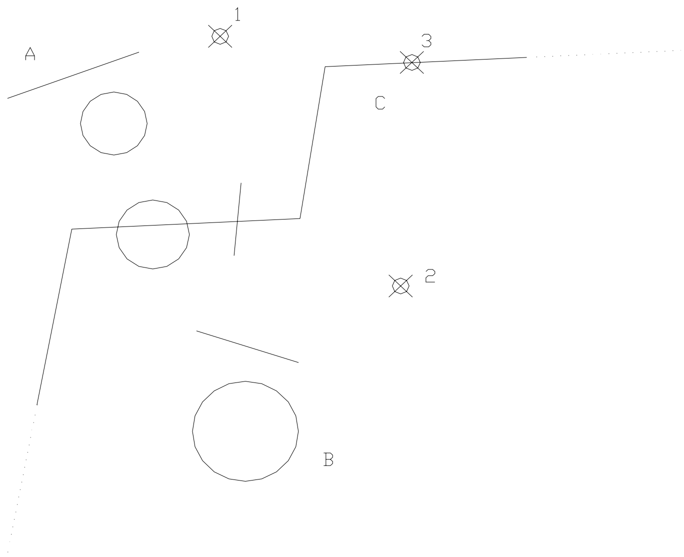
- all points are
  a) inside the described part of the area
  b) outside the described area part
- at least one point is
  a) inside the described part of the area
  b) outside the described area part

Descriptions of complex selection requests for one or more entities can be made. Complex selection requests for one or more entities can be combined in such a way to give parts of definitions in the request, used for describing entities, such as: identification, entity type, colour, elements from the geometrical description set such as characteristic points, coordinates of characteristic points, length, angle etc. The entity selection request can contain all characteristics which an entity or group of entities possess, including relations towards a defined entity (perpendicular, parallel and tangential). Combinations can be made with requests that some (stated) characteristics are included in the defined set of values of this characteristic or that the requested entities are in some relation with each other (perpendicular, parallel, and tangential) towards a defined entity with requests that all or at least one point are:

a) inside the described part of the area
b) outside the described part of the area.

Concrete examples of entity selection are given further.

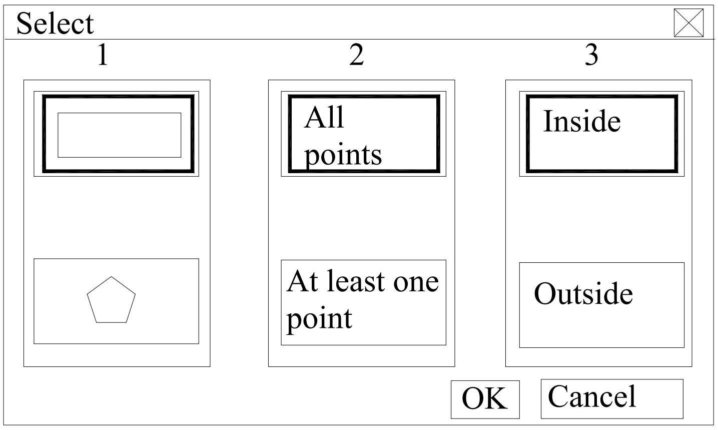
Selection using a broken line



A broken line is formed.
The mouse points to the side from which the entities are selected or the broken line is indicated.
The mouse points to (1), on one side of the broken line and entities given under A are selected.
The mouse points to (2), on the other side of the broken line and entities under b are selected.
The mouse points to (3) the broken line and entities given under C cut by this line are selected.

Selection using three choices

The option rectangle or polygon is selected (1)
The option All points or At least one point is selected (2)
If the All points option is selected then all entities with all points inside or outside the geometrical figure selected under (1) are selected.
If the At least one point option is selected then entities with at least one point inside or outside the geometrical figure selected under (1) are selected.
The option Inside or Outside is selected.
If the Inside option is selected then entities that are inside the geometrical figure selected under (1) are selected besides selecting one option under (2).
If the option Outside is selected then entities that are Outside the geometrical figure selected under option (1) are selected besides selecting one option under (2).
A rectangle or polygon is formed by interactive input or input from the keyboard, two opposite points for the rectangle or more points to form a polygon.



4 Conclusions

This paper presents a part of the developed language for 2D geometrical modelling. From the examples given it is possible to conclude about the flexibility provided to the designer in order to overcome rigidness of the present CAD/CAM and to improve the designer's performance. Future work surely implies development of user-friendly interfaces as well as integration functionality, e.g. STEP based, for its effective use in industry. Additionally, further improvement of intelligent functions is considered.

References

[1] Ž. Popović, Modelling Language PrESMod, (in Serbian) ISBN 86-902411-3-2, ASVCo, Belgrade, 2001.

[2] Ž. Popović, Computer Aided Geometric Modelling (2D) using relational expressions, Proceedings of the 28th JUPTER Conference, Belgrade, 2001.

[3] G. Putnik, Ž. Popović, I. Aranđelović, PrESmod Language for 2D Geometric Modelling–Some Specific Definitions, Proceedings of the 6th Int. symp. on Intelligent and Manufacturing systems, Sakarya, 2008, 939 – 943.

Received: March 11, 2013