(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 December 2016 (22.12.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/202547 A1

(51) International Patent Classification:
G05B 19/4097 (2006.01) *B23K 26/38* (2014.01)

(21) International Application Number:
PCT/EP2016/061911

(22) International Filing Date:
26 May 2016 (26.05.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
15172123.0 15 June 2015 (15.06.2015) EP

(71) Applicant: **TOMOLOGIC AB** [SE/SE]; c/o Frick-Jensen & Norberg Ohlsson, Inedalsgatan 9 B LGH 1102, 112 33 Stockholm (SE).

(72) Inventor: **NORBERG OHLSSON, Magnus**; Inedalsgatan 9 B LGH 1102, 112 33 Stockholm (SE).

(74) Agent: **EHRNER & DELMAR PATENTBYRÅ AB**; P.O. Box 10316, 100 55 Stockholm (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR MACHINE CUTTING IN SHEET MATERIAL

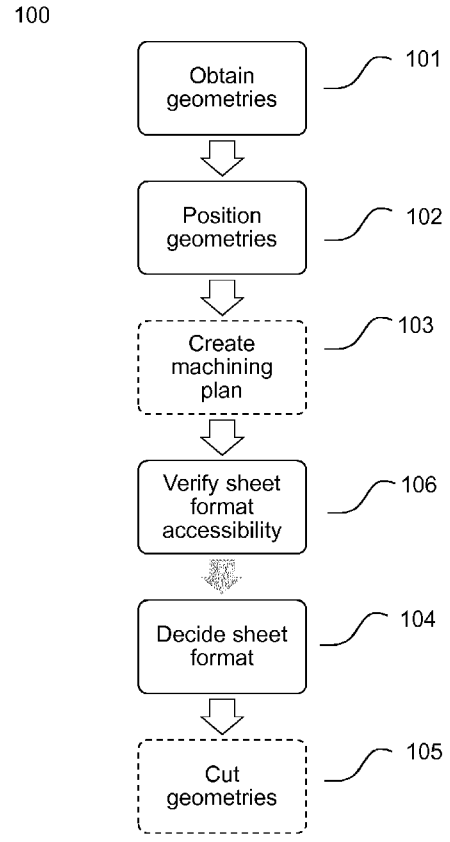

Fig. 1

(57) Abstract: The invention relates to a method (100) for preparing machine cutting in sheet material, comprising the steps of obtaining (101) a set of geometries to be cut, positioning (102) the set of geometries for cutting, and thereafter deciding (104) on a format of sheet material based on the positioned geometries. The invention further relates to a corresponding system for machine cutting in sheet material, and a corresponding computer program product.

WO 2016/202547 A1

MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *with amended claims (Art. 19(1))*

METHOD AND SYSTEM FOR MACHINE CUTTING IN SHEET MATERIAL

TECHNICAL FIELD

[0001] The invention relates to a method for machine cutting in sheet material, to a corresponding system, computer program product and non-transient computer-readable medium.

BACKGROUND

[0002] There are various cutting technologies available to cut parts out of sheet material. The parts may be cut out by e.g. punch pressing or beam cutting. Beam cutting is defined as having some kind of beam as the cutting means, such as laser cutting, plasma cutting, ion beam cutting, flame or torch cutting, water cutting, pellet cutting or air cutting. In punch pressing a punch and a die is used to cut material from a sheet material.

[0003] With conventional cutting technology there is a huge problem with waste, and a normal production reliable cutting plan has 20-50 percent waste. It is thus general desirable to minimize the waste material. Conventionally, each single part to be cut is defined with a cutting path which encloses that single part, and the parts are positioned with a safety distance to any adjacent part. One major source of waste is scrap material formed by the safety distances provided between parts being cut out from a sheet material.

[0004] In WO 2011/042058 A1 a method is disclosed for machine cutting of several parts out of a piece of material using a beam cutting technology. The invention disclosed therein provides a set of controlling rules and variables for forming of a cluster of parts with free form shapes, the parts being positioned so close to each other so that only one cut from the cutting beam is found between adjacent parts whenever the shape of said parts allows it. This method reduces the need of safety distances between individual parts and thus reduces the waste material between the parts substantially.

[0005] However, another source of waste is due to the conventional process of cutting from sheet material. Conventionally, the operator first selects a sheet format to form the basis for the cutting operation. The geometries to be cut are approximated by regular polygons and placed and positioned in the format with safety distances provided between the parts. The safety distances are provided by expanding the approximated polygon for each part to provide a corresponding safety distance. The polygons are positioned on the sheet format (also a polygon) by a no-fit polygon (NFP) algorithm, to ensure that the polygons do not overlap with each other or the edge of the sheet format. Any leftover material when finished positioning and cutting of the geometries is either considered scrap, or residual

sheet material. Residual material is cut to a new sheet format and scrap material goes to waste.

[0006] In US 2013/0218627 A1 a method is disclosed for generating a plurality of groups each comprising a plurality of rectangular elements. The method includes a step of deciding a format of the plate to be used. Typically, the format of the plate is decided from a steel roll with a specific width such that at least one length of the sheet is pre-determined. This method reduces the scrap material, but it still has limitations and is not well adapted to the cutting of free form shapes.

[0007] Hence, there is a need of further improvements in the cutting of geometries of non-rectangular shape.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to reduce the shortcomings of conventional technology, and in particular to reduce the amount of scrap produced when cutting a set of geometries from sheet material.

[0009] Thus the invention relates to a method for machine cutting in sheet material, comprising the steps of,
- obtaining a set of geometries to be cut,
- positioning the set of geometries for cutting,
- presenting at least one format of sheet material based on the positioned geometries that would result in a low amount of scrap,
- verifying the accessibility of at least one format of sheet material via a central computer, and
- deciding on a format of sheet material based on the presented formats and their accessibility.

[0010] The steps of the method according to the invention may be made in different orders than as specified in the claim. For instance, the step of verifying the accessibility of formats of sheet material via a central computer may be made as a first step, wherein the step of presenting at least one format of sheet material based on the positioned geometries that would result in low amount of scrap will be after said verifying-step and hence limited to a choice between the accessible formats.

[0011] The invention also provides for the possibility to, via the central computer, verify accessibility from different providers and/or in different storages, which are connected or

connectable to the central computer. The verification of accessibility via the central computer may be made automatically, semi-automatically or manually by an operator.

[0012] In a subsequent step the positioned geometries from the decided format of sheet material are cut. The computer typically includes a processor and a memory for storing information, such as accessible sheet formats.

[0013] Thus, an important aspect of the present invention is that the format of sheet material is decided after the set of geometries is positioned in a two dimensional space. The invention has the advantage that the format of the sheet material used in subsequent cutting operation may be optimized to the actual decided distribution of the set of geometries. Thus the amount of scrap produced may be significantly reduced with respect to conventional technology. This has the benefit of reducing manufacturing costs and reducing environmental impact. Optimized positioning of geometries (e.g. by conventional NFP) is a computational intensive process, and the present invention has the further benefit of reducing the amount of computing tasks needed to optimize the sheet format to any set of geometries while reducing scrap material. Further, the step of controlling the accessibility of such formats via a central computer makes it possible to connect the cutting tool and/or computing device for programming a cutting tool and/or a deciding sheet format with a central storage of sheets, physically or virtually and/or with a producer of sheet material automatically, dynamically, semi-automatically and/or in real time. This also makes it possible to make data driven decisions on sheet formats, automatically, semi-automatically or manually and that data such as availability, cost, size, shape, quality of sheet formats is dynamically updated according to other systems and/or processes. Thereby, the central storage or sheet supplier will be involved in the process of reducing scrap, which will render the process more effective and lessen the overall waste of scrap material. Further, this is achieved without slowing down any step of the overall process.

[0014] The format of the sheet material is defined as the two-dimensional extension of the material in the plane of the sheet material. The format may be a quadratic format, a rectangular format or an irregular format. The format includes shape and dimensions of the sheet material in the plane of the sheet material.

[0015] The step of verifying accessibility of one or several sheet format may be done at any point before the cutting of the shapes to be cut. Hence, if the step of checking the accessibility of a desired format is made after the decision of a preferred format has been made the decision may have to be remade if said format is not available. In another alternative, more than one format is presented, e.g. in order of preference, such that the

accessibility may be checked for each format and the first format of acceptable accessibility is chosen. The accessibility may be verified before the sheet format is chosen. This may be advantageous because it reduces the number of calculations that needs to be made. In one possible embodiment there is no limitation in the format that is accessible. In such an embodiment the step of verifying the accessibility is merely a formality. The definition of accessibility may include several variables such as availability, cost, size, machine size, size of cutting table, shape, quality or other properties, and accessibility may be verified automatically, semi-automatically or manually. Information or data that define properties for accessibility may be dynamically updated according to other data, processes and their status in e.g. ERP, MES, or other management systems.

[0016] The central computer via which the accessibility is verified may be physically located at any location. The term central indicates that the computer provides a connection between a cutting tool and/or a computing device for e.g. controlling or programming the cutting tool and/or a storage of sheet material formats which may be both physically or virtually and/or a provider of sheet material. The central computer allows for an end user, e.g. an operator and/or programmer of a cutting machine, or an intermediary service provider to control the accessibility of formats in order to instantly verify the accessibility of a desired format.

[0017] In response to a successful match between a desired format and an accessible format an order of one or several sheets of the same or different format may be made. The order may or may not need to be confirmed by an operator. Further, the order may be an internal order, e.g. consisting of a verification and order that a specific format is available in a local storage, or it may be an external order to another entity and may involve the transaction of money and/or commitment of any value.

[0018] In addition to storing the accessibility of sheet formats including residual sheet formats, the method may include the step of storing orders made,

[0019] In order to manage orders and to verify accessibility of one or several sheet format information is shared between systems and/or people over the Internet, Lan or other network. The information is shared locally and/or externally, e.g. between a cutting machine location, a central computer, and a sheet provider.

[0020] The step of verifying the accessibility of different sheet formats may include verifying the logistics of one or more sheet formats between different places such as producers of sheets, storages, cutting machines and in specific cases vendors or storages of pieces cut from specific sheet formats.

[0021] The method may further include a step of presenting candidates of accessible sheet formats to an operator, such that the operator can decide on a sheet format. Optionally, in addition to sheet formats information such as scrap rate, availability, location, cutting layout etc. may be presented to an operator who can use such information to decide on a sheet format.

[0022] Hence, the inventive step of verifying the accessibility may be automatically, semi-automatically, or manually based on information presented to an operator reflecting the accessibility of different format options. The accessibility may be dynamically adjusted depending on time and other decisions in connected processes and/or systems such as ERP, MES or other management systems.

[0023] Deciding on a format of sheet material may comprise selecting a best fit of format from a candidate set of formats.

[0024] Thus, an available set of formats, such as standard formats, formats in store etc. may form basis for a decision on the selection of format of the sheet material.

[0025] The method may comprise repeatedly altering the positioning of the set of geometries, and deciding on the best fit of format to the altered positioning of the set of geometries, to obtain a candidate set of positioning and format of sheet material combinations.

[0026] Thereby a number of different positioning and sheet material format combinations may be obtained as candidates for deciding on the format of the sheet material for cutting.

[0027] Deciding on a format of sheet material may be based on;
- the extension of the positioned geometries in relation to the size of the format of sheet material;
- the amount of scrap material not belonging to the set of geometries to be cut obtained by the format of sheet material; and/or
- cost of different formats of sheet material.

[0028] Thus the extension of the positioned geometries and/or the amount of scrap, possibly in combination with the cost of different formats may be used as a basis for the decision on a format of sheet material. Thereby the cost and/or scrap minimization may be used to decide on the best fit of sheet format. The extension of the positioned geometries may be an approximation of the outer contour of the positioned geometries, e.g. by a

polygon. The approximation of the outer contour may be a regular polygon, such as a rectangle, or an irregular polygon, having non-equal lengths of sides and/or angles.

[0029] The decided format of sheet material may be based on the extension of the positioned geometries with an additional safety region, forming a frame when the geometries are cut from the sheet material. The frame may have a width in the range of 0.01-250 mm, or even above 1000 mm, but preferably in the range of 5-50 mm.

[0030] The method may further comprise creating a machining plan for the cutting of the positioned geometries.

[0031] The machining plan may be created before or after deciding on the format of sheet material.

[0032] The method may comprise machine cutting of geometries in sheet material with a beam cutting technology. The beam cutting technology may be laser cutting, plasma cutting, ion beam cutting, flame or torch cutting, water cutting, pellet cutting or air cutting, etc. Alternatively the method may comprise machine cutting by punch pressing, knife cutting etc. The sheet material may be e.g. metal sheet material, plastic sheet material, textile sheet material, fabric sheet material, paper or cardboard sheet material, wood sheet material, composite sheet material etc.

[0033] The set of geometries may comprise at least one cluster of parts comprising at least one part of free form shape, the parts of the cluster being positioned so close to one another so that only the thickness of one cut of the cutting device is found between adjacent parts where the shape of the parts allows it.

[0034] Thereby the amount of scrap in the cluster of parts may be reduced, and the cluster of parts may be positioned with other geometries in the set of geometries. The set of geometries may alternatively be a plurality of clusters of parts comprising at least one part of free form shape. The cluster(s) may consist of a plurality of parts of free form shape.

[0035] A shape may be defined as a closed contour comprising at least one curve or line. A free form shape may be defined as an irregular shape, such as having irregular lengths of sides and/or angles and/or comprising at least one curve. Regular shapes are e.g. squares, rectangles, triangles etc. A free form shape may be defined as a closed contour comprising at least one curve or line, wherein the contour defines at least one concave portion. The concave portion may be a concave curve portion or may be formed by one or more lines and/or curves. The free form shape is represented by its actual shape during

positioning, and is not represented by an approximated regular polygon such as a rectangle. Thus free form shapes may be positioned closer to one another.

[0036] The method may be implemented as a tool for computer aided design (CAD) or computer aided manufacturing (CAM).

[0037] Thus the method may be an integral part in a computer based system for designing or manufacturing.

[0038] The invention further relates to a system for machine cutting several parts out of a piece of material, comprising
a processing unit configured to obtaining a set of geometries to be cut, positioning the set of geometries for cutting, and thereafter deciding on a format of sheet material based on the positioned geometries,
a cutting device,
a central computer for controlling the accessibility of formats of sheet for the processing unit to decide between, and
a control unit, wherein the control unit is configured to controlling the cutting device to cut the positioned geometries from the decided format of sheet material.

[0039] The cutting device may be a beam cutting device. The processing unit may further be configured to create a machining plan for the cutting of the positioned geometries, and wherein the control unit is configured to controlling the cutting device to cut the positioned geometries according to the machining plan.

[0040] The invention further relates to a computer program product comprising computer program code, which when executed enables a processor in a computer to perform the method disclosed herein.

[0041] The invention further relates to a non-transient computer-readable medium or media comprising data representing coded instruction sets configured for execution by a processor in a computer, the instructions comprising the method as disclosed herein.

[0042] The system, computer program product and non-transient computer-readable medium provide similar advantages as noted in relation to the corresponding features of the method disclosed herein.

BRIEF DESCRIPTION OF DRAWINGS

[0043] Various embodiments and examples related to the invention will now be described with reference to the appended drawing, where;

Fig. 1 shows a method of preparing machine cutting in sheet material.

Fig. 2 shows steps of a method of preparing machine cutting in sheet material.

Fig. 3 shows a system for machine cutting in sheet material.

DETAILED DESCRIPTION OF EMBODIMENTS

[0044] In Fig. 1 a method 100 of preparing machine cutting in sheet material is disclosed. The method first comprises obtaining 101 a set of geometries to be cut. The geometries may be any kind of shape or cluster of parts. The set of geometries are positioned 102 for cutting, preferably to minimize scrap between adjacent parts. Based on the positioned set of geometries a format of sheet material is thereafter decided 104.

[0045] A machining plan, e.g. a cutting plan, is created 103 for the cutting of the positioned geometries. The machining plan may be created prior to deciding on the format of sheet material, as illustrated in the figure, but it may alternatively be created after deciding on the format of sheet material. The machining plan defines how and in what order the cutting process will be conducted. The geometries are thereafter cut 105 according to the cutting plan, from the decided sheet format. A step of verifying 106 the accessibility of the sheet format is made before the final decision of the sheet format to be used. The step of verifying 106 the accessibility of the sheet format may however be made before the geometries are positioned 102. In such a case the step of positioning the geometries may be made on a set of different accessible formats, whereupon the most advantageous format is decided 104 to be used. The step of verifying 106 the accessibility of the sheet format may also be made before the set of geometries are obtained. In such an embodiment the step of verifying accessibility may be made continuously, e.g. by obtaining updates from the central computer on the accessibility of different sheet formats.

[0046] The step of deciding 104 on a format of sheet material is based on one or more of the extension of the positioned geometries in relation to the size of the format of sheet material, the amount of scrap material not belonging to the set of geometries to be cut obtained by the format of sheet material; and the cost of different formats of sheet material. The extension of the positioned geometries may be an approximation of the outer contour of the positioned geometries, e.g. by a polygon. The approximation of the outer contour may be

a regular polygon, such as a rectangle, or an irregular polygon, having non-equal lengths of sides and/or angles. The amount of scrap obtained from the format of sheet material may be balanced to the cost of providing a particular format of sheet material, and/or cost per weight of the sheet material. The decided format of sheet material may have a regular or an irregular shape.

[0047] As one alternative the deciding on a format of sheet material comprises selecting a best fit of format for the geometries from a candidate set of formats. This may be provided by repeatedly altering the positioning of the set of geometries, and deciding on the best fit of format to the altered positioning of the set of geometries, to obtain a candidate set of positioning and format of sheet material combinations. From this candidate set of positioning and format of sheet material combinations the sheet format may be decided based on the criteria discussed above. Thus the best positioning and format of sheet material combination may be selected, which reduces the amount of scrap material and materials cost.

[0048] The set of geometries may comprise at least one cluster of parts of free form shape, the parts being positioned so close to one another so that only the thickness of only one cut of the cutting beam is found between adjacent parts whenever the shape of the parts allows it. Thus the amount of scrap between adjacent parts may be significantly reduced. As one alternative the set of geometries includes only a plurality of such clusters of parts of free form shape. Thus the sheet format may be utilized most efficiently.

[0049] In Fig. 2 some steps of the method is shown graphically. In Fig. 2(a), a set 200 of geometries 201, 201' and 201'' is provided. The set of geometries illustrated shows a regular geometry in the form of a rectangle 201, and two free form, irregularly shaped, geometries 201' and 201''. Both free form shaped geometries comprise concave portions along the circumference. The geometries 201, 201', 201'' are represented by their respective actual shape during positioning, i.e. not represented by an approximated regular polygon such as a rectangle.

[0050] The set of geometries are positioned with respect to each other, in the example shown in Fig. 2(b) forming a cluster 202 of parts, including both free form shaped parts and a regular shaped part. Since the geometries are represented by their respective actual shape during positioning they may be positioned close to each other, as shown in Fig. 2(b). The forming and cutting of clusters of parts of free form shapes is further disclosed in WO 2011/042058 A1.

[0051] In Fig. 2(c), a format 203 of sheet material is decided based on the positioned geometries. The format of the sheet is defined as the extension of the positioned geometries in the plane of the sheet material, and in this case the format has a common rectangular shape. However, also irregularly shaped sheet formats may be decided based on the present invention. It should be noted that the illustration shown in Fig. 2 is simplified, and that in regular production scale processing, the number of geometries may very well exceed 10, 100 or 1000 parts.

[0052] Further, in Fig. 2d an example where a plurality of clusters 202 as shown in Fig. 2(b) are obtained as a set of geometries which are positioned, whereafter a format 203 of sheet material is decided based on the positioned geometries. This is in accordance with the invention done via a central computer which is connected to one or more providers of sheet formats and/or one or more storages for storing sheet formats.

[0053] In Fig. 3 a system 300 for machine cutting several parts out of a piece of sheet material 303 is shown. The system comprises a processing unit 301 configured to obtaining a set of geometries to be cut, positioning the set of geometries for cutting, and thereafter deciding on a format of sheet material based on the positioned geometries. As described above the decision of which format to use is preceded or followed by a step of verifying accessibility of sheet formats. The processing unit is further configured to create a machining plan for the cutting of the positioned geometries.

[0054] The system further comprises a cutting device 304, and a control unit 302, wherein the control unit is configured to controlling the cutting device to cut the positioned geometries from the decided format of sheet material, according to the machining plan. In the example shown in Fig. 3 the cutting device is a beam cutting device. As further alternatives, a system with a punch press as cutting device and a system utilizing knife cutting is also proposed.

CLAIMS

1. A method for preparing machine cutting in sheet material, comprising the steps of;
   - obtaining a set of geometries to be cut,
   - positioning the set of geometries for cutting,
   - presenting at least one format of sheet material based on the positioned geometries that would result in low amount of scrap,
   - controlling the accessibility of at least one format of sheet material via a central computer, and
   - deciding on a format of sheet material based on the presented formats and their accessibility
2. The method according to claim 1 wherein deciding on a format of sheet material is based on;
   - the extension of the positioned geometries in relation to the size of the format of sheet material;
   - the amount of scrap material not belonging to the set of geometries to be cut obtained by the format of sheet material; and/or
   - cost of different formats of sheet material.
3. The method according to claim 1 or 2 wherein deciding on a format of sheet material comprises selecting a best fit of format from a candidate set of formats.
4. The method according to any one of the preceding claims comprising repeatedly altering the positioning of the set of geometries, and deciding on the best fit of format to the altered positioning of the set of geometries, to obtain a candidate set of positioning and format of sheet material combinations.
5. The method according to any one of the preceding claims further comprising creating a machining plan for cutting of the positioned geometries, prior to or after deciding on the format of sheet material.
6. The method according to any one of the preceding claims wherein the set of geometries comprises at least one a cluster of parts of free form shape, the parts being positioned so close to one another so that only the thickness of one cut of the cutting device is found between adjacent parts whenever the shape of the parts allows it.
7. The method according to claim 6 wherein the set of geometries are a plurality of clusters of parts of free form shape.
8. The method according to any one of the preceding claims comprising machine cutting of geometries in sheet material with a beam cutting technology.

9. The method according to any one of the preceding claims implemented as a tool for computer aided design (CAD) or computer aided manufacturing (CAM).
10. A method for machine cutting several parts out of a piece of material according to any one of the preceding claims, further comprising cutting the positioned geometries from the decided format of sheet material.
11. A system for machine cutting several parts out of a piece of material, comprising
a processing unit configured to obtaining a set of geometries to be cut, positioning the set of geometries for cutting, and thereafter deciding on a format of sheet material based on the positioned geometries,
a cutting device,
a central computer for controlling the accessibility of formats of sheet for the processing unit to decide between, and
a control unit, wherein the control unit is configured to controlling the cutting device to cut the positioned geometries from the decided format of sheet material.
12. The system according to claim 11 wherein the cutting device is a beam cutting device.
13. The system according to claim 11 or 12 wherein the processing unit is further configured to create a machining plan for the cutting of the positioned geometries, and wherein the control unit is configured to controlling the cutting device to cut the positioned geometries according to the machining plan.
14. Computer program product comprising computer program code, which when executed enables a processor in a computer to perform the method according to any one of claims 1 to 10.
15. A non-transient computer-readable medium or media comprising data representing coded instruction sets configured for execution by a processor in a computer, the instructions comprising the method according to any one of claims 1 to 10.

AMENDED CLAIMS
received by the International Bureau on 29 September 2016

1. A method for preparing machine cutting in sheet material, comprising the steps of;
- obtaining a set of geometries to be cut,
- positioning the set of geometries for cutting,
- presenting at least one format of sheet material based on the positioned geometries that would result in low amount of scrap,
- controlling the accessibility of the at least one presented format of sheet material via a central computer that is connected or connectable to one or more providers of sheet formats, and
- deciding on a format of sheet material based on the presented formats and their accessibility.
2. The method according to claim 1 wherein the central computer is connected or connectable to one or more storages for storing sheet formats for controlling accessibility in said one or more storages,
3. The method according to claim 1 or 2 wherein the accessibility may be dynamically adjusted depending on decisions in connected processes and/or systems such as ERP, MES or other management systems.
4. The method according to claim 1 wherein deciding on a format of sheet material is based on;
- the extension of the positioned geometries in relation to the size of the format of sheet material;
- the amount of scrap material not belonging to the set of geometries to be cut obtained by the format of sheet material; and/or
- cost of different formats of sheet material.
5. The method according to claim 1 or 4 wherein deciding on a format of sheet material comprises selecting a best fit of format from a candidate set of formats.
6. The method according to any one of the preceding claims comprising repeatedly altering the positioning of the set of geometries, and deciding on the best fit of format to the altered positioning of the set of geometries, to obtain a candidate set of positioning and format of sheet material combinations.
7. The method according to any one of the preceding claims further comprising creating a machining plan for cutting of the positioned geometries, prior to or after deciding on the format of sheet material.
8. The method according to any one of the preceding claims wherein the set of geometries comprises at least one a cluster of parts of free form shape, the parts being positioned so close to one another so that only the thickness of one cut of the

cutting device is found between adjacent parts whenever the shape of the parts allows it.

9. The method according to claim 8 wherein the set of geometries are a plurality of clusters of parts of free form shape.

10. The method according to any one of the preceding claims comprising machine cutting of geometries in sheet material with a beam cutting technology.

11. The method according to any one of the preceding claims implemented as a tool for computer aided design (CAD) or computer aided manufacturing (CAM).

12. A method for machine cutting several parts out of a piece of material according to any one of the preceding claims, further comprising cutting the positioned geometries from the decided format of sheet material.

13. A system for machine cutting several parts out of a piece of material, comprising
a processing unit configured to obtaining a set of geometries to be cut, positioning the set of geometries for cutting, and thereafter deciding on a format of sheet material based on the positioned geometries,
a cutting device,
a central computer for controlling the accessibility of formats of sheet for the processing unit to decide between, and
a control unit, wherein the control unit is configured to controlling the cutting device to cut the positioned geometries from the decided format of sheet material.

14. The system according to claim 13 wherein the cutting device is a beam cutting device.

15. The system according to claim 13 or 14 wherein the processing unit is further configured to create a machining plan for the cutting of the positioned geometries, and wherein the control unit is configured to controlling the cutting device to cut the positioned geometries according to the machining plan.

16. Computer program product comprising computer program code, which when executed enables a processor in a computer to perform the method according to any one of claims 1 to 12.

17. A non-transient computer-readable medium or media comprising data representing coded instruction sets configured for execution by a processor in a computer, the instructions comprising the method according to any one of claims 1 to 12.

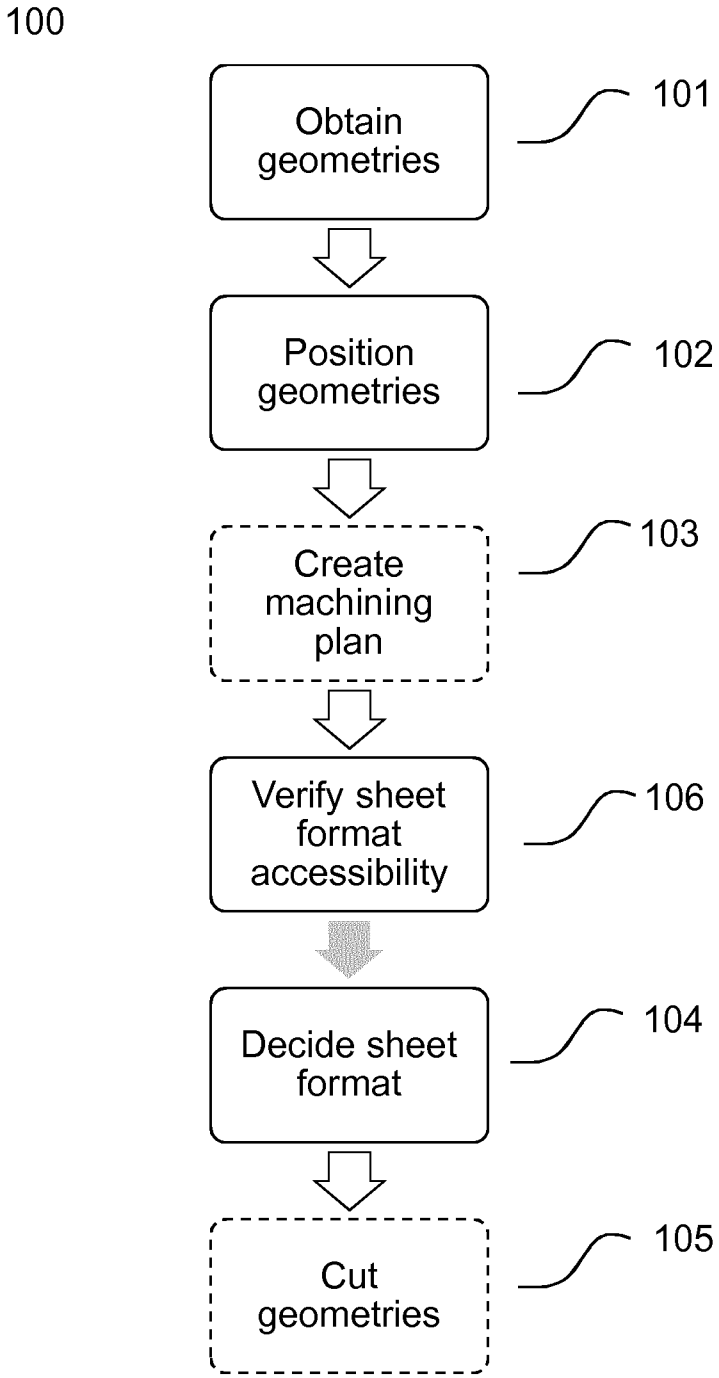
100
Obtain geometries
101
Position geometries
102
Create machining plan
103
Verify sheet format accessibility
106
Decide sheet format
104
Cut geometries
105

Fig. 1

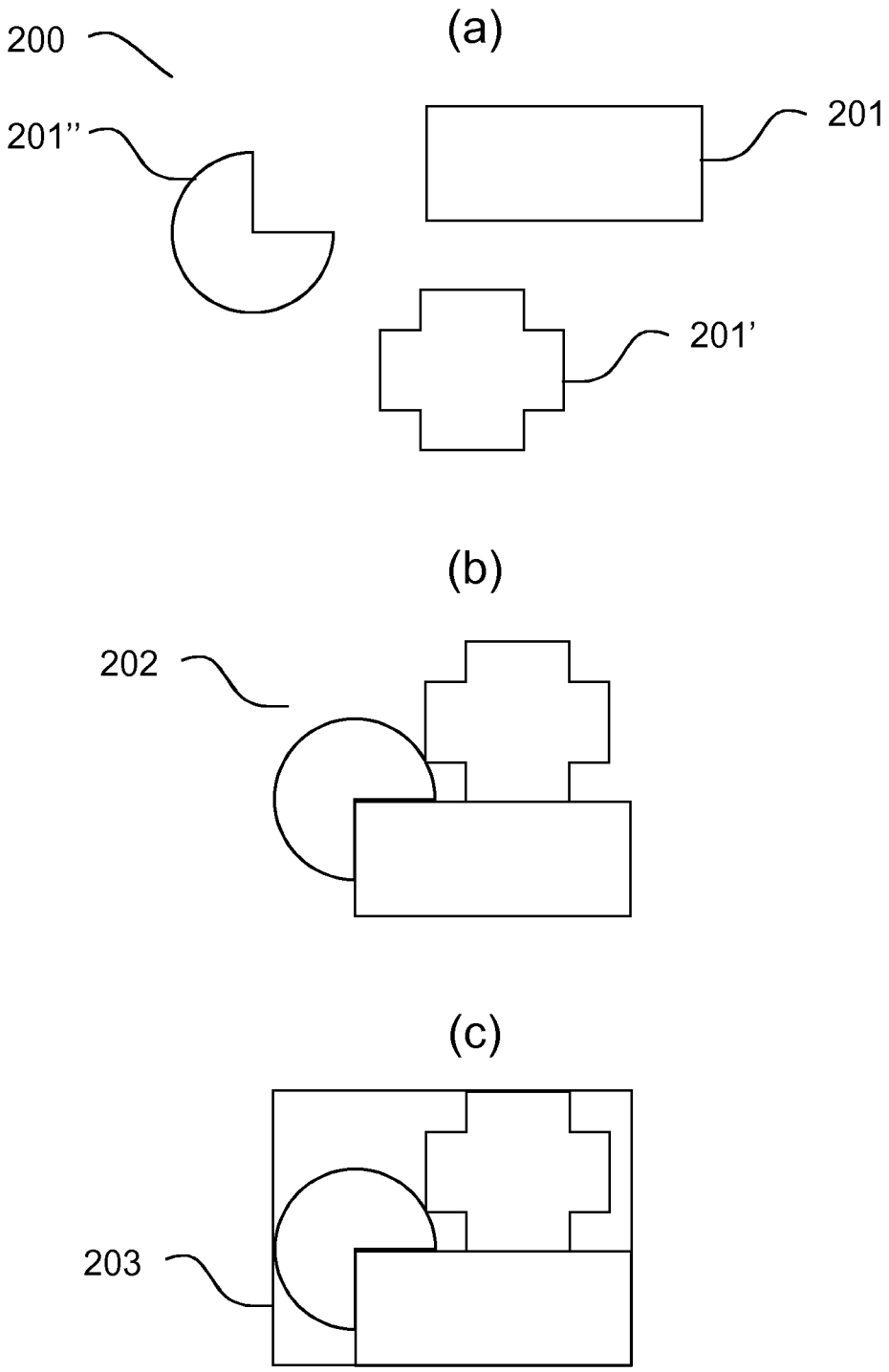

Fig. 2

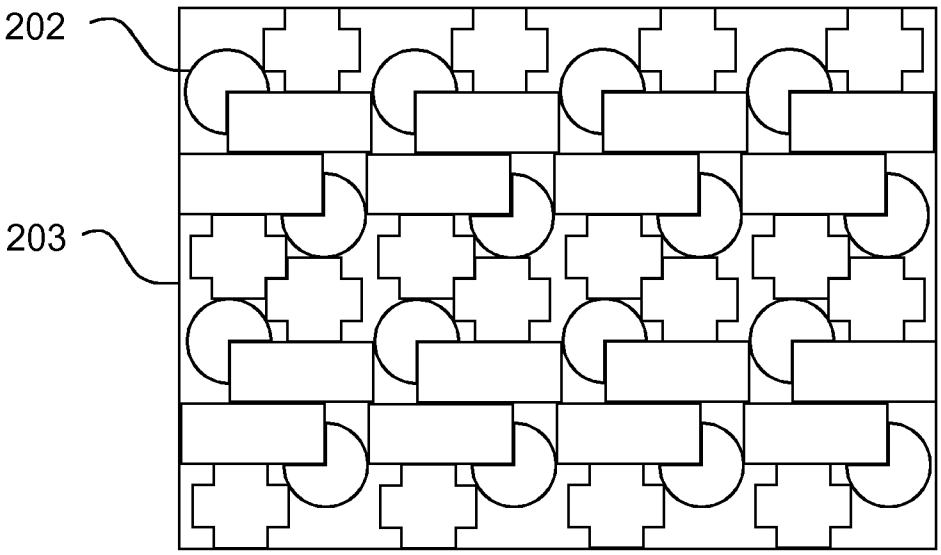

Fig. 2(d)

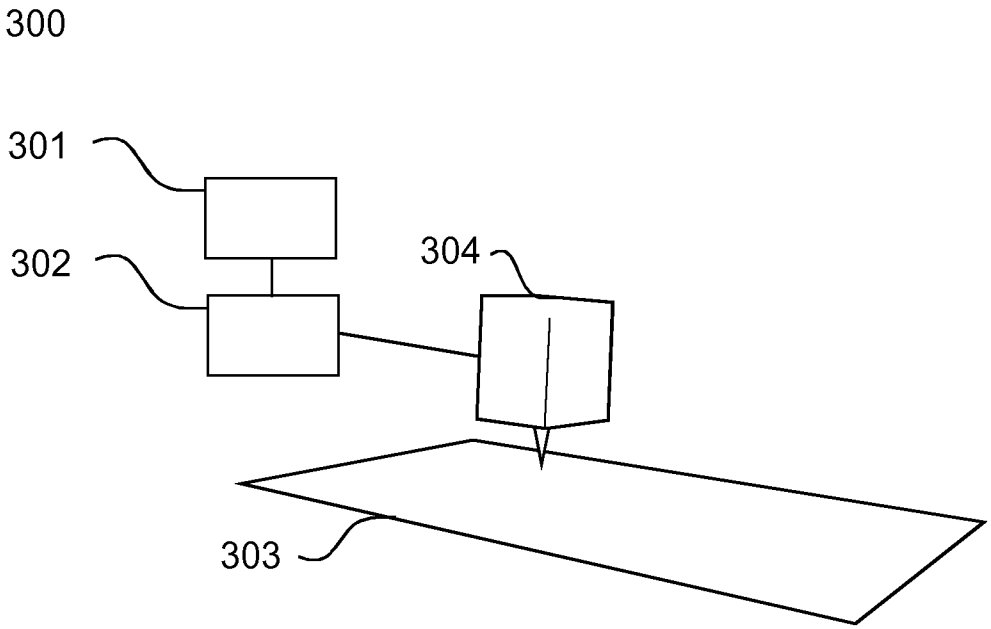

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/061911

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05B19/4097
ADD. B23K26/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G05B B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Anonymous: "PowerNest: Nesting and cutting optimization. Software component for 2D-shape automatic nesting", , 6 October 2014 (2014-10-06), pages 1-2, XP055247467, Internet Retrieved from the Internet: URL:http://nesting.almacam.com/wp-content/uploads/2014/10/powernest_en.pdf [retrieved on 2016-02-04] the whole document ----- -/--	1-15

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 August 2016	12/08/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Orobitg Oriola, R

2

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/061911

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/218627 A1 (YOSHIZUMI TAKAYUKI [JP]) 22 August 2013 (2013-08-22)	1-5,8-15
Y	paragraph [0002] - paragraph [0006] paragraph [0024] - paragraph [0069] paragraph [0096] - paragraph [0107] claims 6,13 figures 1,2,7	6,7

X	US 2006/100727 A1 (DASH SANJEEB [US] ET AL) 11 May 2006 (2006-05-11)	1-5,8-15
Y	paragraph [0006] - paragraph [0009] paragraph [0031] - paragraph [0059] paragraph [0078] - paragraph [0097] figures 1-7,15-19	6,7

X	US 2010/257011 A1 (TAKEYASU KAZUHIRO [JP] ET AL) 7 October 2010 (2010-10-07)	1-5,8-15
Y	paragraph [0001] - paragraph [0018] paragraph [0028] - paragraph [0092] paragraph [0128] - paragraph [0133] claims 1,8,10 figures 1-3	6,7

X	US 2003/114952 A1 (SCOTT WILLIAM [US]) 19 June 2003 (2003-06-19)	1-5,8-15
Y	paragraph [0005] - paragraph [0007] paragraph [0015] - paragraph [0045] paragraph [0074]	6,7

Y	WO 2011/042058 A1 (TOMOLOGIC AB [SE]; NORBERG OHLSSON MAGNUS [SE]) 14 April 2011 (2011-04-14) cited in the application	6,7
A	the whole document	1-5,8-15

A	US 6 788 995 B1 (LINDSTROM MIKKO [US]) 7 September 2004 (2004-09-07) column 1, line 10 - column 3, line 32 column 4, line 10 - column 6, line 57 figures 1, 3-9	1-5,8-15

A	WO 2008/128495 A1 (THOMAS MAGNETE GMBH [DE]; KRALLMANN JENS [DE]; KIRSCH BERNHARD [DE]) 30 October 2008 (2008-10-30) the whole document	1,11,14, 15

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/061911

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013218627 A1	22-08-2013	CN 103124970 A	29-05-2013
		DE 112011103259 T5	08-08-2013
		GB 2497041 A	29-05-2013
		JP 5528561 B2	25-06-2014
		KR 20130100119 A	09-09-2013
		US 2013218627 A1	22-08-2013
		US 2016203423 A1	14-07-2016
		WO 2012043217 A1	05-04-2012
US 2006100727 A1	11-05-2006	NONE	
US 2010257011 A1	07-10-2010	JP 5149907 B2	20-02-2013
		US 2010257011 A1	07-10-2010
		WO 2009038196 A1	26-03-2009
US 2003114952 A1	19-06-2003	NONE	
WO 2011042058 A1	14-04-2011	CN 102574244 A	11-07-2012
		DK 2485864 T3	03-11-2014
		EP 2485864 A1	15-08-2012
		ES 2521516 T3	12-11-2014
		JP 5714017 B2	07-05-2015
		JP 2013507253 A	04-03-2013
		KR 20120082440 A	23-07-2012
		US 2012192690 A1	02-08-2012
		WO 2011042058 A1	14-04-2011
US 6788995 B1	07-09-2004	EP 0769174 A1	23-04-1997
		FI 964995 A	14-02-1997
		JP H10502876 A	17-03-1998
		US 6377864 B1	23-04-2002
		US 6788995 B1	07-09-2004
		WO 9534865 A1	21-12-1995
WO 2008128495 A1	30-10-2008	DE 102007019618 A1	13-11-2008
		EP 2142967 A1	13-01-2010
		WO 2008128495 A1	30-10-2008