Using PatBase for Patent Landscaping: a case study on 3D printing techniques

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Subject Matter

Enclosed is a case study demonstrating how unique features of PatBase can be used to create insightful Patent Landscapes, taking as its subject 3D printing techniques and apparatus. All use of 3D printing in manufacturing, as well as additional features for 3D printers, are excluded by removing records related to inkjet printing, imaging or medical use, such as records containing terms like producing bones, dental implants or prostheses in the title.
Introduction

Over the last few years several patent landscape reports in 3D printing have been created, amongst them reports from Patent Insight Pro / Patseer, IFI Claims, Gridlogics and the UK-IPO. This report demonstrates how the advanced features of PatBase can be used effectively to create a comprehensive and reliable patent landscape. The main features used are PatBase Analytics, advanced statistical analysis and citation ranking.

The methodology used in this landscape report can easily be transferred into other areas of interest. Of course, some basic knowledge of the area is necessary, which can be obtained from overviews available for most technical areas.

“3D printing” is a very popular topic and as a search term in Google it gives approximately 34 million hits. To get a basic understanding of the topic the Wikipedia overview was very useful, as was the brief history of 3D printing and the website of the 3D printing industry. One very interesting area is the use of 3D printing in the Life Sciences industry. A recent review of this area was written by Ursan et al and covers articles published between January 1, 1990, and August 31, 2012.

The basic invention of 3D printing technology comes from Chuck Hull from 3D Systems, who described in US4575330 the basic technology of Stereo Lithography (or additive manufacturing, also referred to as SLA). This was further improved by the Massachusetts Institute of Technology in US5204055.

Later, several methods have become common practice including selective laser melting (SLM), direct metal laser sintering (DMLS), selective laser sintering (SLS), fused deposition modelling (FDM) and laminated object manufacturing (LOM).

For categorizing the IP in this area, the documents are located in the classification B29C67 (80%), with an additional coding in B22F3 (20%, for stereo lithography, SLA).

Summary

This report shows how the advanced features in PatBase can be used to create clean and reliable patent landscapes, in an efficient manner.

The main features of PatBase highlighted in this report include:

- PatBase Analytics
- Advanced Statistical Analysis
- Citation ranking
- Advanced keyword highlighting
- Use of the “Similar” function to find similar documents
Procedure

The landscape search commenced with a broad outlook, by reading the main articles in this area. Searching some basic keywords (in this case “3D printing” and “stereo lithography”) in PatBase identified additional relevant keywords and active assignees. Additionally, a statistical analysis of the IPC and CPC codes used to classify the initial answer set helped identify relevant classifications which were added to the search strategy.

After developing a comprehensive search strategy, encompassing keywords, classification codes, assignees and inventors, the search results were focused to the subject matter of interest by a number of limitation steps. This process is difficult and needs to be checked at every step, in order to be sure that relevant records are not eliminated.

In this example, the landscape search was limited to patents related to 3D printers or printing techniques and which were published in one of the main countries (US, WO, EP or JP). Overall a set of 2513 records was retrieved.

Strategies

Step 1: Preparation phase to devise a comprehensive search strategy

A basic keyword search is completed in the title, abstract and claims:
(tac=stereolithography or tac=("3d print"))

Additional keywords are identified by using PatBase Analytics:

- Perform the search as indicated above
- Go to Search History and click on “more” and click on “PatBase Analytics”

A list of primary keywords are generated which can be added to your search strategy:
You can also generate an overview of keywords by selecting the grid or circle option in the keyword menu. An example of the circle option is displayed below:

Several interesting options are available from here. By clicking a specific keyword, all records containing with this keyword are displayed (see screen below). These records can easily be transferred into PatBase with the “View in PatBase” option on the right upper corner.

A new screen will open with the results shown in PatBase. For further analysis you can add them to your search history, enabling you to review the results in greater detail and/or to exclude any irrelevant results from your final answer set.
Hence, starting with a basic keyword search, you can use PatBase Analytics to identify additional keywords, active assignees and inventors in the area and to exclude potential sources of irrelevant results, enabling a more comprehensive and clean final landscape search.

Generating Classifications by PatBase Analytics:

An additional use of PatBase Analytics is the identification of relevant classification codes which can be used to supplement your search strategy. Below is an example of the CPC classification codes from the basic keyword answer set, which can be analyzed at multiple levels (families, applications, grants or publications).
To identify relevant classifications, it is necessary to analyze the data at a subclass level. This can be done by clicking on the relevant bar in the graph. An example is shown below for B29C67. Note that scrolling over the class in the graph enables you to see the definition of the classification code.

The same analysis can be done for IPC classifications:
Additionally, altering the settings provides flexibility in the amount of data, the number of classifications, the level (group or subclass) and threshold for the data displayed.

After analyzing the classifications, the relevant ones can be selected and added to the search strategy. The most relevant classification for 3D printing is B29C67, both for CPC and IPC.

**Step 2: Executing a comprehensive landscape search:**

Having completed an initial search and used PatBase Analytics to identify additional keywords, relevant classification codes and active assignees, a comprehensive search strategy was compiled and run in PatBase:

TAC=((“3D” OR “3-D” or “3 D” OR 3-dimension* OR 3 dimension* OR (three* w2 dimension*) ) w2 (print* OR fabricat* OR manufactur* or process* or object* or layer*))

or

FT = ((stereolithography or (stereo lithography)) or (additive manufacturing) or lasercusing or (laser cusing) or (laser sintering) or lasersintering or beam sintering or beamsintering or selective sintering or selectively sintering or flexography or (fused deposition modeling) or (laminated object manufacturing) or (spin casting) or robocasting or photolithography or three-dimensional printing or (multiphoton lithography))

or

tac=(SLM or DMSL or SLS or FDM or SLA or LOM or STL)

And

CPC=(“B28B1/001” OR “B29C67/00*” OR “B22F3/1055” or “G05B2219/49013” or “G03F7/70416” OR “A61C13/0019” OR “A61C13/0013” OR “A61F2002/30962”)

Or:

IC=(“B29C67/00*” OR “G06F17/50” or “B28B1/00”) and cpc=no
(to include records from countries with no IPC, like Japan)

Set xx not cc=((CN or KR or TW) and nc=1)
(to exclude Asian records with only 1 member)

Set xx not ti=(inktjet or imag* or dent* or implant* or prothes*)
(exclude specific use of 3D printing)
(It’s important to manually check what has been excluded here!)

Set xx and (IC=(g06f17/50 not B29C67*) or cpc=(g06f17/50 not B29C67*) or (IC=G06F17/50 not CPC=B29C67*)) or Ti=((Computer Aided Design))
(exclude all CAD records, see remark above!)

Set xx not (CPC=(C07* or A61*))
(Exclude all chemistry and human use, see remark above!)

Set xx and (CC=(WO or US or EP or DE or GB or FR or JP or CA) not (NP=1 and KD=DEU1))
(limit results to main countries)

Additional searches were performed for the key inventors; Charles Hull, S, Scott Crump, Joseph Beaman, James Darrah, Carl Deckard and for the key assignees: 3D Systems and Stratasys

**A final answer set of 2513 records was retrieved.** This set can be saved in a folder and activated at any time by going to the “History” and choose “more...”(1). By clicking “Add to result folder”(2) a new screen will pop-up and ask to give a name to the new folder. After clicking “Save” (3) the new folder is stored and can be activated later from “My saved folders”.
A quick review of the final answer set revealed over 80% relevant answers, which is sufficient for a reliable patent landscape analysis. Furthermore, the final answer set included the main patents in this area (US4575330, US5204055 and US5182056) which had been previously identified from the literature.

Sorting an answer set by the most cited (a unique feature in PatBase) reveals that both US4575330 and US5204055 are by far the most cited publications in this area. This feature is an easy way to identify the key patents in a certain technical area. In this example, the patent families containing US4575330 and US5204055 have 974 and 812 forward citations respectively.

Moreover, given that citations can provide an additional source of relevant prior art, the forward citations of the five most cited records were selected and reviewed. In this case, no additional relevant records were identified.
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Results

Patbase Analytics provides an excellent platform from which to gain a visual overview of a landscape search. The ability to view the data from a number of angles (jurisdiction, year, assignee, inventor, etc.) and at multiple levels (families, priorities, applications, grants, etc.) can quickly reveal a number of conclusions. For example, the graph below displays our dataset based on earliest priority year and reveals a growing activity with the basic ideas originating in the 1980’s.

Furthermore, PatBase Analytics provides the user with great flexibility by being able to adjust the date setting (2) for the analysis, the chart type (4) and the ability to export the charts and data (1,3).
Assignees:

3D Systems Inc. and Stratasys Inc. are the most active assignees in patenting 3D technology. However, the analysis below identifies a number of other active assignees, including EOS GMBH. Located in Germany, this company has a strong focus on additive manufacturing by using selective laser sintering.
Classifications:

The most relevant classification for 3D printing is B29C67. An interesting observation from the data and graphs was the enhanced level of detail in the CPC classifications, compared to the IPC classification. This was most evident at the subclass level:
Scrolling the cursor over the bars in the graph reveals the classification definitions which can provide an additional source of keywords. In combination with the specific CPC codes, these can be used to further optimize the search strategy. However, some care does need to be taken as not all families have a CPC assigned. *(In this case 90.5 \% of the families have a CPC).*

Additional statistical analysis is possible by using the pull-down menus as shown below (e.g.: jurisdiction, inventor, etc.):
A pull down menu shows the different breakdown possibilities (by family, priority, etc.)

Statistical Analysis

In the advanced statistical analysis option, there is the possibility to review two variables against each other. This can be done from the search history (1) and clicking “more” (2) under options. On the right you see the statistical analysis button (3).
For example, in order to compare the most active companies over the last few years, the final answer set was limited to those records with an earliest priority date of 2000 to date (e.g. “SS and epr>2000”) and a statistical analysis was completed on the “Assignee” field, selected from the “Advanced” tab:

During the next three steps, you have the ability to set the criteria for the statistical analysis, merge identical assignees or known subsidiaries (e.g. 3D Systems Inc and 3 D Systems Inc) and select the second field on which to complete the analysis. In this case, the “earliest publication year” was selected:
### Statistical analysis (Search 58): 1-1781 matching the query: "5"

#### TOP 25 Assignee

<table>
<thead>
<tr>
<th>Assignee</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRATASYS INC</td>
<td>72</td>
</tr>
<tr>
<td>EOS ELECTRO OPTICAL SYST</td>
<td>60</td>
</tr>
<tr>
<td>3D SYSTEMS INC</td>
<td>59</td>
</tr>
<tr>
<td>HEWLETT PACKARD DEVELOPMENT CO</td>
<td>40</td>
</tr>
<tr>
<td>BOEING CO</td>
<td>36</td>
</tr>
<tr>
<td>3D SYSTEMS INC</td>
<td>24</td>
</tr>
<tr>
<td>MTU AERO ENGINES GMB</td>
<td>24</td>
</tr>
<tr>
<td>SONY CORP</td>
<td>24</td>
</tr>
<tr>
<td>CL SCHUTZRECHTSVERWALTUNGS GMB</td>
<td>23</td>
</tr>
<tr>
<td>ARCAM AB</td>
<td>22</td>
</tr>
<tr>
<td>SIEMENS AG</td>
<td>22</td>
</tr>
<tr>
<td>CL SCHUTZRECHTSVERWALTUNGS GMB</td>
<td>18</td>
</tr>
<tr>
<td>SEIKO EPSON CORP</td>
<td>18</td>
</tr>
<tr>
<td>DEGUSSA</td>
<td>17</td>
</tr>
<tr>
<td>DAIMLER AG</td>
<td>16</td>
</tr>
<tr>
<td>HONEYWELL INT INC</td>
<td>16</td>
</tr>
<tr>
<td>MATUSUSHITA ELECTRIC WORKS LTD</td>
<td>16</td>
</tr>
<tr>
<td>UNITED TECHNOLOGIES CORP</td>
<td>16</td>
</tr>
<tr>
<td>CMET INC</td>
<td>15</td>
</tr>
<tr>
<td>FRAUNHOFER GES FORSCHUNGN</td>
<td>14</td>
</tr>
<tr>
<td>GEN ELECTRIC</td>
<td>14</td>
</tr>
<tr>
<td>PANASONIC CORP</td>
<td>14</td>
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<tr>
<td>PARALLEL CORP</td>
<td>14</td>
</tr>
<tr>
<td>BAYERISCHE MOTOREN WERKE AG</td>
<td>13</td>
</tr>
<tr>
<td>DSM IP ASSETS BV</td>
<td>13</td>
</tr>
<tr>
<td>OBJEKT GEOMETRIES LTD</td>
<td>13</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>619</strong></td>
</tr>
</tbody>
</table>

**Breakdown results by:**
- Earliest Publication Year
- Earliest Priority Year
- Earliest Publication Country

**Options:**
- None
- Earliest Publication Year
- Earliest Priority Year
- Earliest Publication Country

**Select the desired breakdown options and click Analyse.**
After the analysis you have several options to display the results. In the **landscape view** you see a very informative 3D picture.

The 3D graph option of the same data is shown below and by scrolling the cursor over the graph in PatBase, you can get more details of the assignee, year and number of families:

This graph shows that 3D Systems Inc. has not been very active over the last years, but is still the leader in patent filings within this subject area.
Additional features of PatBase:

One of the interesting tools in PatBase is the “Similar” option. This can be used to identify patent families that are similar to the patent of interest based on their title & abstract, description, claims etc. In this case, we used US4575330 (the most cited record in 3D printing) to find similar documents and identified 463 records with a similar description, of which 121 families were already included in the retrieved set. The remaining 342 families are of possible interest as a source of art in this technical area and can be added to the final answer set to analyze.
Highlighting:

To enable a comprehensive and efficient review of a PatBase answer set, the advanced highlighting option can be activated by clicking on the pen in the top right of the screen. Keywords can be highlighted in the text in ten different colors and truncations (right and left hand) and Boolean operators can be used:

An example is shown below where “Stereolithography” is highlighted with the left and right hand truncation of “*lithogra*”.

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**PatBase**

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Conclusions

The patent landscape of 3D printing originated in the 1980’s and has grown in activity ever since. The landscape is dominated by 3D Systems Inc, having built up their IP portfolio many years ago but they have reduced their filing activity recently. Companies like EOS, Arcam, CL Schutzrechtsverwaltungs and Stratasys have taken over the lead in filing patents in this area.

The B29C67 CPC and IPC classification code is the most frequently used classification code in this technical area and can be used as part of the search strategy and/or to focus a keyword search. Interestingly, the results of this landscape search clearly demonstrate the enhanced level of detail and the greater number of sub-groups used within the CPC compared to IPC classification systems.

The step-by-step approach taken in this analysis is applicable for all patent landscape searches:

1. Prepare by studying some basic literature
2. Generate general keywords used for the specific technology
3. Generate keywords and classifications
4. Perform the search and analyze the result set
5. Clean the set
6. Generate statistical graphs

By utilizing the unique review and analysis features of PatBase, it is possible to easily create a thorough and insightful patent landscape report. Of particular note is the use of the PatBase Analytics software to identify relevant keywords, classifications, active assignees and inventors. In addition, the Analytics software can be used to remove irrelevant results identified by the keyword clusters. Sorting answer sets based on those “most cited” identifies patent families of particular interest in the field and using the advanced highlighting tool allows the comprehensive and efficient review of answer sets.

Finally, once satisfied with an answer set, the PatBase Analytics software can quickly and visually present the patent landscape in a series of graphs and charts revealing innovation trends, active assignees, key opinion leaders in the field (inventors), relevant classification codes and keywords of interest. As PatBase Analytics is an integral component of PatBase, all data within any graph or chart can easily be transferred to PatBase (with one click), enabling a more detailed review.

In conclusion, any patent landscape analysis can be created and enhanced using the innovative features available in PatBase including:
- PatBase Analytics
- Advanced Statistical Analysis
- Citation ranking
- Advanced keyword highlighting
- Finding similar documents

In combination with the extensive coverage in PatBase, these features allow any user to craft and visualize a meaningful patent landscape for any technical area.

For more information about PatBase and other Minesoft products, please contact Minesoft or see their website at www.minesoft.com.