

# NanoStream



*Building a search engine for nanotechnology.*

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## **Introduction**

The project consists of creating a specialized nanotechnology search engine using Nutch/Lucene. Group 2 has tailored the engine to meet the needs of our customers. Our customers, Dr. Yen and Dr. Zhang will be using this search engine to aid them with their research. The goal is to give them a tool or new resource they can use to be more efficient.

A few things our customers requested to be implemented in this engine are the ability to find news, publications, portal pages, generic pages, and info on people and human involvement all related to nanotechnology. It is important of course that they receive relevant and upcoming news results for their queries.

So, what is Nanotechnology? “Nanotechnology is a field of applied science and technology covering a broad range of topics. The main unifying theme is the control of matter on a scale below 100 nanometers, as well as the fabrication of devices on this same length scale.” (Wiki) This is a very current, ever changing topic so it can be difficult to keep up to date with new and current information. The reason we are building this search engine is to fill that need. The engine is not only customized for our customers, but also will be accessible for other users that have a need for such an engine.

The main goal of the system is to provide results with high precision that are relevant to nanotechnology. The second goal was to make the engine fast and responsive so the user does not get aggravated and try another engine. The third goal was to make an interface that is pleasing to the eye. One without clashing colors that make the user’s eyes bleed. The final goal was to have the engine update its keywords to be able to always have the most current crawled information.

## **Design of the Crawler**

One of the more important aspects of a specialty search engine’s design is the set of seed sites it uses to start crawling the internet. Because the field of nanotechnology is changing so rapidly, our design need to use an evolving set of seed sites as well. To reduce the workload for the development team in the future, and the ensure that quality sites were crawled, NanoStream uses the Open Source Directory Project to obtain its seed sites. The OSDP is a categorical listing of sites that is moderated by individuals in the field. New sites are constantly being added and more information is available. By using the sites from the Nanotechnology portion of the OSDP, our crawler is able to find new sites quickly and with little work from developers in the future.

The unique part of the NanoStream crawler is the Annotation Engine. The design for this part of the crawler was inspired by a product called eRace. After a page is crawled, eRace compares the page to a preferences file, where the user has put keyterms that are important. If a page contains many of the keywords, its depth is augmented before its children links are fed into the crawl manager, resulting in the engine crawling deeper on more relevant sites. For NanoStream, we adapted the idea to Nutch’s implementation of PageRank. When NanoStream fetches a page, it compares it to the XML preference file with a list of nanotechnology keywords weighted by their importance. The more keywords that appear in a page, the more NanoStream

augments its PageRank. This PageRank is then passed on to the page's linked children, increasing the importance of pages that include nanotechnology keywords.

The final customization of Nutch is the query logging and processing we implemented. Again because nanotechnology is a rapidly evolving field, we wanted to design a search engine that could adapt to it. To this end we wrote a query log processing program that determines what the most commonly searched terms are. Using the tool we wrote, the maintainers of NanoStream in the future will have a quick and easy way to find out what users are searching for, and update the XML preference file accordingly. With an updated preference file and user-maintained seed site list, NanoStream should be able to stay on top of the field with surprising ease.

## Results

We developed a series of tests to analyze NanoStream results and determine if it met our customer's goals. We compared NanoStream to commercial search engines and our custom Google Search Engine. Our tests were designed to determine advantages of using NanoStream over commercial search engines, especially for research driven searches. We also wanted to determine NanoStream's performance for delivering the results based on our customer's needs. These included results for nanotechnology news, publications, vertical portals, generic pages, and information on human involvement. The tests will also include an analysis of precision of pages returned. We will also determine the impact our modifications have made on the performance of our search engine. We weren't able to get relevance feedback from our customers because they were not directly involved in nanotechnology research.

The first test was to compare the performance of our search engine to commercial search engines and the Google custom search. For the first query we used "nanoscale," a common term in nanotechnology. We searched for this query in NanoStream, our custom Google search engine, Google, and Ask. We found that all of these search engines delivered very high precision as all of the results were relevant to this query. For a query like this, we should expect high precision. The difference between the search engines here was how the pages were ranked and which pages appeared in the top ten results. Out of Google's top ten ranked pages, our search engine retrieved three similar hits within our top ten. We didn't compare as well to Ask, retrieving only one similar hit within the top ten. The custom Google search engine included many of the top ten pages ranked in Google, but also included our sites. The reason NanoStream differed from the other search engines was due partly in the fact that we mostly crawled academic sites, and also the differences in our page ranking algorithms and keyword scoring. The majority of sites returned by NanoStream were from academic (.edu) sources while the commercial search engines had many more commercial sites (.com) than us. See Appendix for search results.

We also wanted to determine how NanoStream would respond to a common query that wasn't directly related to nanotechnology. This test will determine the relevance of our index and to determine if our focused crawler worked properly. We searched for "John" and "materials" to see if we would still get relevant results. The results for "John" returned results related to people involved in nanotechnology, however there were a few results that weren't relevant (see appendix). The results for "materials" returned relevant results about materials related to

nanotechnology and nanomaterials. These results indicated that we were successful in our crawling strategy because most of the results returned were relevant to the nanotechnology.

NanoStream passed these test by providing relevant results for a common query in the topic of nanotechnology and also providing relevant results for nanotechnology in an unrelated query. For the first test, the returned results were more focused on academic sources than commercial, which was not the case with Google or Ask. We feel that this would give a researcher an advantage of using NanoStream over commercial search engines such as Google or Ask because it provides more reliable sources for academic research. The custom Google Search engine was useful here because it provided Google's top ranked search results along with including the sites that we put in for Google to prioritize. This may give the user a better feel of what's available on web, but also giving priority to the sites that we included for the search.

Our second tests were focused on determining what was returned and if we were successful at returning the desired sources for our customers. The first query we tested was "nanoparticles news" to determine if we would retrieve results from news sources. Our second query was "nanoparticles pdf" to determine if would retrieve publications in PDF format. The next query was "nanotechnology professors," which would be used to determine if we would retrieve documents on human involvement in nanotechnology. Our search engine successfully passed all of these tests as it returned pages from news sources, PDF publications, and information about professors involved in nanotechnology (see appendix for results). We also used our custom Google search engine to help determine the sources of our results. The refinement labels that Google offers was a useful tool in determining the value of our seed set by the number of results returned based on each refinement label. This allowed us to look at our results from categories including research, academic, people, books, conferences and personal pages. Our search results indicated that all these categories were represented in the results.

Our next test was to determine what impact our modifications had on the crawler and search results. We accomplished this by analyzing the results prior to any modifications and analyzing the same query with the modifications added. Our goal was to determine how effective our keyword weighting was at augmenting the page ranking. We compared our before and after modifications to the queries: materials, medical nanotechnology, and NASA. The first five results in all these queries were impacted by the page ranking algorithm. For some queries it changed the ordering of the top 5, for others it added new documents into the top 5. The pages that were boosted should be more relevant to the customer because it boosted those pages that contained the keywords that they weighted as the most important. See the appendix for the before and after results for our page rank.

## **Conclusion**

The main goal of this search engine was to provide an effective search engine focused on nanotechnology for academic research at Penn State. The search engine needed to be capable of returning nanotechnology related news, publications, portals and personal pages. Our customers also wanted to be able to capture current trends and topics, the evolution of nanotechnology over time, and return information about the people involved in this project. To accomplish this we used our customer's recommendation of using Dmoz, an open directory, to compile a list of

seeds sets for the crawler. Our test results indicated that our index was effective at returning these categories of pages and that our focused crawl was successful in building a nanotechnology focused index.

The next step was determining how we wanted to rank our results. We came up with a list of keywords and scored them based on the relevance to the subject. These keywords and scores were used to alter our page ranking algorithm, which was implemented on the crawler via an XML file. The higher the score of the keyword, the higher a page that contains the keyword(s) will be ranked. This allowed us to boost those pages that had the contained the highest scored keywords to return the most relevant results in order of their importance. Our test results indicated that our page ranking algorithm was successful in augmenting the page rank and boosting the appropriate pages.

Another problem we had to solve was how to keep the index updated with new and current trends in the industry. The goal was to provide a way to allow our customers to keep the search engine up to date on the latest nanotechnology trends. Our solution to this was to save all of the queries to a text file which would be analyzed in a Java program to determine the most popular search terms. We were able to implement this, but we discovered a problem in analyzing these terms since it doesn't account for stop words. We realized that this would be a monumental task trying to figure out which words to exclude from the list, so we decided not to automate this feature. This feature can still be utilized to determine new queries and topics that evolve in nanotechnology, but will have to be implemented manually. After running multiple queries, the Java program was effective at capturing all the terms entered and scoring them based on the number of appearances See Appendix for sample result.

This was a challenging a project but we learned a great deal about crawlers and search engines through our research. We researched crawling strategies based on the eRace project and modified Nutch by writing programs in Java, XML, and JSP. Some of our toughest challenges though, were working effectively as a team. Everyone in the group had busy schedules and we wanted to be able to set a time to have a weekly meeting with our customer to discuss design ideas and keep them updated on our progress. We also had to deal with a loss of a team member which complicated things and made it even tougher to meet deadlines. Despite these problems, we were able to produce a quality search engine that satisfied our customer's goals for the project. We found this project to be very useful since it will actually be used by our customers. This gave us motivation to provide quality work and supply our customers with something that they can continue to use after the completion of the project for this course.

## Appendix

Top 5 results for “nanoscale” using Nutch

Precision: 5/5 (100%)

All results were relevant and academic sources

### NanoStream

 [About Nutch](#) [FAQ](#)

nanoscale  [help](#) Hits **1-10** (out of about 2,398 total matching pages):

[The Centre for Nanoscale Physics](#)  
... The Centre for **Nanoscale** Physics HOME CONTACT About Acknowledgement ...  
<http://hanoscale.phys.ualberta.ca/> ([cached](#)) ([explain](#)) ([anchors](#)) ([more from nanoscale.phys.ualberta.ca](#))

[the Nanoscale Physics Research Laboratory](#)  
... Directory Vacancies THE **NANOSCALE** PHYSICS RESEARCH LABORATORY Local Links ... Welcome to the **Nanosc**  
<http://hprl.bham.ac.uk/> ([cached](#)) ([explain](#)) ([anchors](#))

[Nanoscale Science Research Group](#)  
... Welcome to the **Nanoscale** Science Research Group (NSRG). We ... of various groups studying **nanoscale** scie  
<http://www.cs.unc.edu/Research/hano/index.html> ([cached](#)) ([explain](#)) ([anchors](#))


[Nanoscale Physics, Purdue University](#)  
**Nanoscale**  
<http://www.physics.purdue.edu/hanophys/> ([cached](#)) ([explain](#)) ([anchors](#))

[The Centre for Nanoscale Physics](#)  
... The Centre for **Nanoscale** Physics HOME CONTACT About Acknowledgement ...  
<http://hanoscale.phys.ualberta.ca/archive.php> ([cached](#)) ([explain](#)) ([anchors](#)) ([more from nanoscale.phys.ualberta.ca](#))

Top 5 search results for “nanoscale” using Google

Precision: 5/5 (100%)

Although Google had high precision as well, the first two results are for commercial site (.com)

 [Web](#) [Images](#) [Video](#) [News](#) [Maps](#) [more »](#)

nanoscale  [Advance](#)  
[Preference](#)

**Web**

[NovaCentrix](#)  
Company uses pulsed plasma device to produce nanoparticles with unique size and composition.  
[www.nanoscale.com/](http://www.nanoscale.com/) - 7k - [Cached](#) - [Similar pages](#)

[NanoScale Materials, Inc. is a marketer, developer, producer, and ...](#)  
**NanoScale** Materials, Inc. is an advanced materials company that supplies NanoActive™ materials to consumer and military product manufacturers for ...  
[www.nanoactive.com/](http://www.nanoactive.com/) - 20k - [Cached](#) - [Similar pages](#)

[The Richard E. Smalley Institute for Nanoscale Science and Technology](#)  
Multidisciplinary research in science and technology at the nanometer scale.  
[cnst.rice.edu/](http://cnst.rice.edu/) - 13k - [Cached](#) - [Similar pages](#)

[Virtual Journal of Nanoscale Science & Technology](#)  
A weekly multijournal compilation of the latest research on **nanoscale** systems. Published by the American Institute of Physics and the American Physical ...  
[www.vjnano.org/nano/](http://www.vjnano.org/nano/) - 20k - [Cached](#) - [Similar pages](#)

[NanoScale Science Education](#)  
**NanoScale** Science Education K-12 Instructional Materials (New Activities Available) | Contact Us ... 2004 **NanoScale** Science Education Research Group ...  
[ced.ncsu.edu/nanoscale/](http://ced.ncsu.edu/nanoscale/) - 3k - [Cached](#) - [Similar pages](#)

Top 5 search results for “nanoparticles news”

Precision: 5/5 (100%)

All of these documents are news sources relevant to nanotechnology

**NanoStream**

About Nutch    FAQ

nanoparticles news    Search    help    Hits 1-10 (out of about 687 total matching pages):

**[Foresight Nanotech Institute News & Events](#)**

... System with Atomic Resolution Foresight **News News** about Foresight Institute, about nanotechnology ... Institute press releases Home Page **News & E**  
[http://www.foresight.org/news/news\\_events.html](http://www.foresight.org/news/news_events.html) (cached) (explain) (anchors)

**[Small Times Magazine: News about MEMS, Nanotechnology, Nanoparticles, Microsystems and Nanotechnolog](#)**

... Small Times Magazine: **News** about MEMS, Nanotechnology, **Nanoparticles**, Microsystems and Nanotechnology ... use of gold **nanoparticles** ...  
<http://www.smalltimes.com/> (cached) (explain) (anchors) (more from www.smalltimes.com)

**[Nano World News™](#)**

... Chemicals industry Business NSTI RSS **News News** Nano World **News News** Nano World **News™** Story Exclusives: Nanotech 2007 Poised ...  
<http://www.nsti.org/news/> (cached) (explain) (anchors) (more from www.nsti.org)

**[ANU - Nanotube Research -](#)**

... Boron Nitride Nanotubes Nanowires Nanorods **Nanoparticles** Publications Latest **News** Conferences/Seminars Commercial Services Contact ... of Electr  
<http://wwwrphysse.anu.edu.au/nanotube/nanoparticles.php> (cached) (explain) (anchors)

**[Nanodot: Nanotechnology News and Discussion](#)**

... List Email Search About Foresight **News & Events** Foresight Challenges About ... 2005: Glass-treating spray containing **nanoparticles** recalled in Germa  
<http://www.foresight.org/nanodot/> (cached) (explain) (anchors)

Top 5 search results for “PDF nanoparticles”

Precision: 5/5 (100%)

All of these documents were PDFs or linked to PDFs relevant to nanotechnology

**NanoStream**

About Nutch    FAQ

PDF nanoparticles    Search    help    Hits 1-10 (out of about 148 total matching pages):



... SEMICONDUCTOR AND METAL **NANOPARTICLES**: SYNTHESIS, FUNCTIONALISATION AND SHAPE ... of Zululand, KwaDla  
<http://www.sani.org.za/pgm.pdf> (cached) (explain) (anchors)

**[http://www.nanoscience.gatech.edu/zwang/paper/2006/06\\_SCI\\_2.pdf](http://www.nanoscience.gatech.edu/zwang/paper/2006/06_SCI_2.pdf)**

[http://www.nanoscience.gatech.edu/zwang/paper/2006/06\\_SCI\\_2.pdf](http://www.nanoscience.gatech.edu/zwang/paper/2006/06_SCI_2.pdf) (cached) (explain) (anchors)

**[http://www.nanoscience.gatech.edu/zwang/paper/2006/06\\_NT\\_3.pdf](http://www.nanoscience.gatech.edu/zwang/paper/2006/06_NT_3.pdf)**

[http://www.nanoscience.gatech.edu/zwang/paper/2006/06\\_NT\\_3.pdf](http://www.nanoscience.gatech.edu/zwang/paper/2006/06_NT_3.pdf) (cached) (explain) (anchors)

**[Nanotechnology files, pdf, docs, zips .... | Nanovip.com](#)**

... Imaging and microscopy | Pdf The Titan 80 ... Category tags: Calendar event | Environment | Pdf | USA | Ohio | Cincinnati The ...  
<http://www.nanovip.com/nanotechnology-files> (cached) (explain) (anchors)

**[3-D X-Ray Images of Nanoparticles](#)**


... Ray Images of **Nanoparticles** Save as PDF Print Email Blog It - + Using ... National Cancer Institute Save as ...  
<http://www.physorg.com/news85070488.html> (cached) (explain) (anchors)

Top 5 search results for “nanotechnology professors”

Precision: 5/5 (100%)

The first document was a page relevant to a nanotechnology conference that professors attended; the second was a link to a university page, the 3 and 5<sup>th</sup> documents were links to professor’s site and the 4<sup>th</sup> document was a nanotechnology site that had information regarding professors.

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[About Nutch](#) [FAQ](#)

[help](#) Hits **1-10** (out of about 66 total matching pages):

[2002 Foresight Conference on Molecular Nanotechnology](#)  
... is the first molecular **nanotechnology** company. We are taking an ... of Nanoscience and **Nanotechnology** (JNN), American Scientific Publishers Join  
<http://www.foresight.org/Conferences/MNT10/> ([cached](#)) ([explain](#)) ([anchors](#))

[Institute for Nanotechnology](#)  
... The Institute for **Nanotechnology**, an umbrella organization for ... the multi-million-dollar **nanotechnology** research efforts at Northwestern, and ...  
<http://www.nanofabrication.northwestern.edu/index.html> ([cached](#)) ([explain](#)) ([anchors](#))

[School of Physics: People : Professors : Uzi Landman](#)  
... School of Physics: People : **Professors** : Uzi Landman Interest Research Awards ... School of Physics People » **Professors** Uzi Landman Regents'  
<http://www.physics.gatech.edu/people/faculty/ulandman.html> ([cached](#)) ([explain](#)) ([anchors](#))

[Nanotechnology Industries + News](#)  
... implications of advanced **nanotechnology**. Wise-Nano.org is a ... program in cancer **nanotechnology**. The National Institutes ...  
<http://www.nanoindustries.com/news/index.html> ([cached](#)) ([explain](#)) ([anchors](#))


[Brad Hein's Nanotechnology Site](#)  
... University. Research focused on carbon **nanotechnology**, DNA **nanotechnology**, and nanostructures. Back ... Smalley and several Rice **professors** .  
[http://www.nanosite.net/resources/nanotechnology\\_resources\\_groups.html](http://www.nanosite.net/resources/nanotechnology_resources_groups.html) ([cached](#)) ([explain](#)) ([anchors](#))

Top 5 search results for “john”

Precision: 4/5 (80%)

The first 3 and 5th results returned pages on people involved in nanotechnology. The 4<sup>th</sup> document was not relevant to nanotechnology.

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[About Nutch](#) [FAQ](#)

[help](#) Hits **1-10** (out of about 1,742 total matching pages):

[Fourmilab](#)  
Fourmilab This document requires frames, which your browser does not appear to support. Please visit our no- ...  
<http://www.fourmilab.ch/> ([cached](#)) ([explain](#)) ([anchors](#))

[John von Neumann](#)  
**John** von Neumann **John** von Neumann Various links to ... a self replicating system. **John** von Neumann . "**John** ...  
<http://www.zyvex.com/nanotech/vonNeumann.html> ([cached](#)) ([explain](#)) ([anchors](#))

[Durint Biomimetics: Evans's Group](#)  
... Under Construction Others: Francois Baneyx **John** Evans Alex Jen Samson A ...  
<http://depts.washington.edu/bionano/main/Evans.html> ([cached](#)) ([explain](#)) ([anchors](#))

[The Books: Dear John by Nicholas Sparks](#)  
... men and women, **John** must choose between love and ... returns to North Carolina, **John** will discover that loving Savannah ...  
<http://www.hachettebookgroupusa.com/books/4370446528056/index.html> ([cached](#)) ([explain](#)) ([anchors](#))

[Nanotechnology at Zyvex:](#)  
... Nanotechnology at Zyvex: **John** Randall, PhD Chief Technical Officer ... to working at TI, **John** worked at MIT’s Lincoln ...  
<http://www.zyvex.com/AboutUs/Profiles/Randallbio.html> ([cached](#)) ([explain](#)) ([anchors](#))



Top 5 search results for “materials”  
 Precision: 5/5 (100%)  
 All of these sites were relevant to nanotechnology

**NanoStream**

About Nutch    FAQ

materials    Search    help    Hits 1-10 (out of about 5,945 total matching pages):

Materials News  
 ... Semiconductors Medical-Pharm Biotech-Genetics **Materials** Science Chemicals industry Business NSTI ... News **Materials**    **Materials** News Natur  
<http://www.nsti.org/news/matnews.html> (cached) (explain) (anchors)

PNNL Nanotechnology - Nano Materials  
 ... PNNL Nanotechnology - Nano **Materials** Nano **Materials** The Pacific Northwest ... fabrication of singular **materials** and ...  
<http://www.pnl.gov/nano/materials/index.html> (cached) (explain) (anchors)

Materials Research Science and Engineering Center on Nanostructured Interfaces  
 ... but the semiconductor **materials** used to manufacture ... friendly than the **materials** in today's ...  
<http://mrsec.wisc.edu/> (cached) (explain) (anchors)

RPI Research Priority: Nanotechnology  
 ... the center include advanced **materials** and coatings, biosciences ... applications as varied as nanocomposite **materials** with extraordinary strength,  
<http://www.rpi.edu/research/nanotechnology.html> (cached) (explain) (anchors)

Welcome to the Nanotechnology Centre, Materials Department at Cranfield University  
 ... Centre, within the **Materials** Department, was established in ... development of new functional **materials** through to prototyping ...  
<http://www.cranfield.ac.uk/sas/materials/nanotech/> (cached) (explain) (anchors)

Preferences file

nanoStreamTerms.xml

Last Saved: 12/15/06 10:30:03 PM  
 File Path: sftp://segp2:@search.ist.psu.edu/...8.1.custom/nanoStreamTerms.xml

nanoStreamTerms.xml    (no symbol selected)

```

<?xml version="1.0" encoding="UTF-8"?>
<vector>
  <keyword>
    <term>nanotechnology</term>
    <weight>1</weight>
  </keyword>
  <keyword>
    <term>nanoscience</term>
    <weight>1</weight>
  </keyword>
  <keyword>
    <term>nanostructure</term>
    <weight>3</weight>
  </keyword>
  <keyword>
    <term>nanoscale</term>
    <weight>3</weight>
  </keyword>
  <keyword>
    <term>nanoengineering</term>
    <weight>3</weight>
  </keyword>
  <keyword>
    <term>nanoparticle</term>
    <weight>5</weight>
  </keyword>
  <keyword>
    <term>nanosystem</term>
    <weight>1</weight>
  </keyword>
  <keyword>
    <term>nanotube</term>
    <weight>3</weight>
  </keyword>
  <keyword>
    <term>nanowire</term>
    <weight>3</weight>
  </keyword>

```

## Modifications to Nutch Page Rank

Search for “materials” Before

Search for “materials” After

**NanoStream**

materials  Search help Hits 1-10

**Materials News**  
... Semiconductors Medical-Pharm Biotech-Genetics **Materials** Science  
**Materials** Update Nanozone: News: Filling the ...  
<http://www.nsti.org/news/matnews.html> (cached) (explain) (anchors)

**RPI Research Priority: Nanotechnology**  
... the center include advanced **materials** and coatings, biosciences ...  
nanoconducting wires ...  
<http://www.rpi.edu/research/nanotechnology.html> (cached) (explain) (anchors)

**PNNL Nanotechnology - Nano Materials**  
... PNNL Nanotechnology - Nano **Materials** Nano **Materials** The Pacific N  
<http://www.pnl.gov/hano/materials/index.html> (cached) (explain) (anchors)

**Welcome to the Nanotechnology Centre, Materials Department**  
... Centre, within the **Materials** Department, was established in ... devel  
<http://www.cranfield.ac.uk/sas/materials/nanotech/> (cached) (explain) (anchors)

**Materials Research Science and Engineering Center on Nanostru**  
... amazing array of **materials**. A team, led ... Jack) Ma and **Materials** S  
<http://mse.wisc.edu/> (cached) (explain) (anchors)

**NanoStream**

materials  Search help Hits 1-10 (out of ab

**Materials News**  
... Semiconductors Medical-Pharm Biotech-Genetics **Materials** Science Chemicals  
**Materials** Update Nanozone: News: Filling the ...  
<http://www.nsti.org/news/matnews.html> (cached) (explain) (anchors)

**PNNL Nanotechnology - Nano Materials**  
... PNNL Nanotechnology - Nano **Materials** Nano **Materials** The Pacific Northwest  
<http://www.pnl.gov/hano/materials/index.html> (cached) (explain) (anchors)

**Materials Research Science and Engineering Center on Nanostructured In**  
... but the semiconductor **materials** used to manufacture ... friendly than the mat  
<http://mse.wisc.edu/> (cached) (explain) (anchors)

**RPI Research Priority: Nanotechnology**  
... the center include advanced **materials** and coatings, biosciences ... applicati  
nanoconducting wires ...  
<http://www.rpi.edu/research/nanotechnology.html> (cached) (explain) (anchors)

**Welcome to the Nanotechnology Centre, Materials Department at Cranfie**  
... Centre, within the **Materials** Department, was established in ... development o  
<http://www.cranfield.ac.uk/sas/materials/nanotech/> (cached) (explain) (anchors)

Search for “medical nanotechnology”  
Before

Search for “medical nanotechnology”  
After

**NanoStream**

medical nanotechnology  Search help Hits 1-10 (ou

**Nanomedicine by Robert Freitas**  
... Exploratory Design in **Medical Nanotechnology**" (April 1996)" Les Re  
<http://www.foresight.org/Nanomedicine/> (cached) (explain) (anchors)

**blog | nano**  
... from advances in **nanotechnology**. I feel that scientists and ... engineer  
<http://www.nanotechnology.com/blogs/blognano/> (cached) (explain) (anchors)

**Nanotechnology**  
... The journal **Nanotechnology** covers **nanotechnology** both in the ...  
<http://www.zvex.com/hano/> (cached) (explain) (anchors)

**Nanotechnology.com - Nanotechnology investing, nanotech news**  
**Nanotechnology.com - Nanotechnology** investing, nanotech news and  
<http://www.nanotechnology.com/sbr/> (cached) (explain) (anchors)

**RPI Research Priority: Nanotechnology**  
... the effects of **nanotechnology** on industry and society ... Computer  
...  
<http://www.rpi.edu/research/nanotechnology.html> (cached) (explain) (anchors)

**NanoStream**

medical nanotechnology  Search help Hits 1-10 (ou

**Nanomedicine by Robert Freitas**  
... Exploratory Design in **Medical Nanotechnology**" (April 1996)" Les Re  
<http://www.foresight.org/Nanomedicine/> (cached) (explain) (anchors) (more)

**Nanotechnology.com - Nanotechnology investing, nanotech news**  
**Nanotechnology.com - Nanotechnology** investing, nanotech news and  
<http://www.nanotechnology.com/financial/> (cached) (explain) (anchors) (more)

**blog | nano**  
... from advances in **nanotechnology**. I feel that scientists and ... engineer  
<http://www.nanotechnology.com/blogs/blognano/> (cached) (explain) (anchors)

**Nanomedicine FAQ**  
... who has been injected with **medical** nanorobots? In most ... Each spec  
<http://www.foresight.org/Nanomedicine/NanoMedFAQ.html> (cached) (explain) (anchors)

**Medical & Pharmaceutical Industry News**  
... Breaking News Subscribe Nanotech Week **Nanotechnology** Microsystem  
Business NSTI RSS News News **Medical** ...  
<http://www.nsti.org/news/medphamnews.html> (cached) (explain) (anchors)

## Search for "NASA" Before

### NanoStream

NASA  Search [help](#) Hits 1-10

#### [Self Replicating Systems](#)

... summer of 1980, **NASA** and the American ... a summer study by 15  
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