

Multimodal interaction in domain-specific communication



Cohesion and coherence in data-processing in construction, a sub-domain of mechanical engineering

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overview



- multimodal communication in data processing in construction
- corpus and computational linguistics
- systemic functional linguistics
- aims:
 - domain-specific types of multimodal documents
 - cross-modal cohesion and coherence
 - reception and production skills

multimodal communication in the target domain



“A multimodal text is a text that uses several modes of communication (e.g., speech, writing, image) in an integrated way to convey a message or content.”

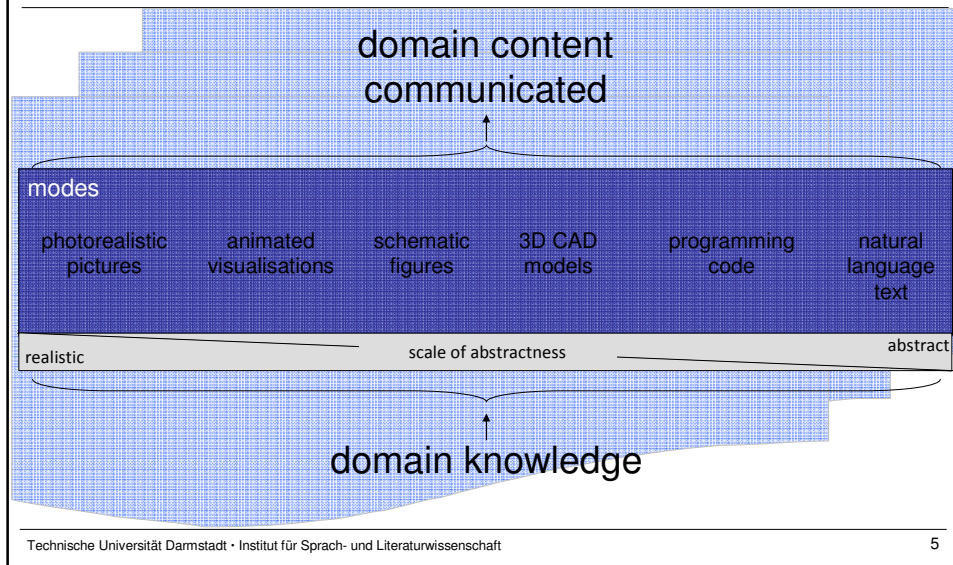
(Kress, van Leeuwen 2001)

multimodal communication in the target domain



- target domain: data processing in construction, a subdomain of mechanical engineering
- self-characterisation:
„the drawing is the language of the engineer“ (Reiner Anderl)
- modes:
 - natural language
 - formulae
 - visual representations such as pictures, schematic figures, sketches etc.
 - intermediary forms: tables, representations of data structures
 - virtual models such as CAD (Computer Aided Design) models

multimodal communication in the target domain



multimodal communication in the target domain

- types of written communication artefacts:
 - printed documents (books, journals, papers, reports)

computational communication artefacts:

- electronic documents (webpages, online papers, pdfs)
- visual and virtual 2D and 3D construction models
- intermediary types (3D pdf)
- user interfaces (databases, product data management systems, CAD construction software)
- databases (PDM, CAD development repositories)
- ...

examples

3 Rapid Prototyping Techniques

Most commercially available rapid prototyping machines use one of six techniques. At present, trade restrictions severely limit the import/export of rapid prototyping machines, so this guide only covers systems available in the U.S.

3.1 Stereolithography

Patented in 1986, stereolithography started the rapid prototyping revolution. The technique builds three-dimensional models from liquid photosensitive polymers that solidify when exposed to ultraviolet light. As shown in the figure below, the model is built upon a platform situated just below the surface in a vat of liquid epoxy or acrylate resin. A low-power highly focused UV laser traces out the first layer, solidifying the model's cross section while leaving excess resin liquid.

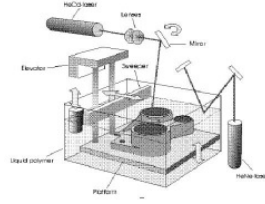


Figure 1. Schematic diagram of stereolithography.

Next, an elevator incrementally lowers the platform into the liquid polymer. A rewriter re-coats the solidified layer with liquid, and the laser traces the second layer atop the first. This process is repeated until the prototype is complete. Afterward, the solid part is removed from the vat and cured clean of excess liquid. Supports are broken off and the model is then placed in an ultraviolet oven for complete curing.

html-page: teaching materials

LV13200

Airflow
Operation
Turbine Stages
Collapse Stages

Technical Specification LV13200			
Core Diameter (Inch)	64.3	Engine RPM	11,000
Length (Inch)	120	Schedule Velocity (ft/s)	1807
Shaft Thrust	20,000-31,500 lb	Turbine pressure ratio (H/L)	1.8
Pressure Temperature	80°	Efficiency (H/L)	86.8
Exhaust Ratio	4.75-5.1	Overhaul period (hrs)	17-28.8
Pressure Temperature	80°	Lead-in (H/L/Inch)	1.24E-07

pdf: model of a turbine

Global Corp offers a full line of gas turbine engines for a variety of applications. Coming in a range from 400 to 40,000 horsepower, our engine power both marine vehicles as well as aircraft. The LV13200 is the most powerful engine produced to date at Global Corp. This new engine covers the 20,000 to 31,500 pound thrust class and has been designed specifically for 200-passenger aircraft. It is currently offered on the Airbus A321, part of the successful ECOM aircraft family and will enter service in the spring of 2006.

The LV13200 builds on proven technology gleaned from other Global Corp. advanced engine programs to deliver the lowest cost of ownership for 200-passenger aircraft operation. Global Corp. has incorporated technological advances in the LV13200 that enable a reduction in parts count. With a new core, the engine has advanced low and reduced maintenance cost. The LV13200 covers all current and anticipated core and engine requirements to provide longevity and high reduced weight. With reduced noise levels, it will provide better engine efficiency. Since the LV13200 will enable 16,000 to 18,000 many airports that have narrow and more quiet.

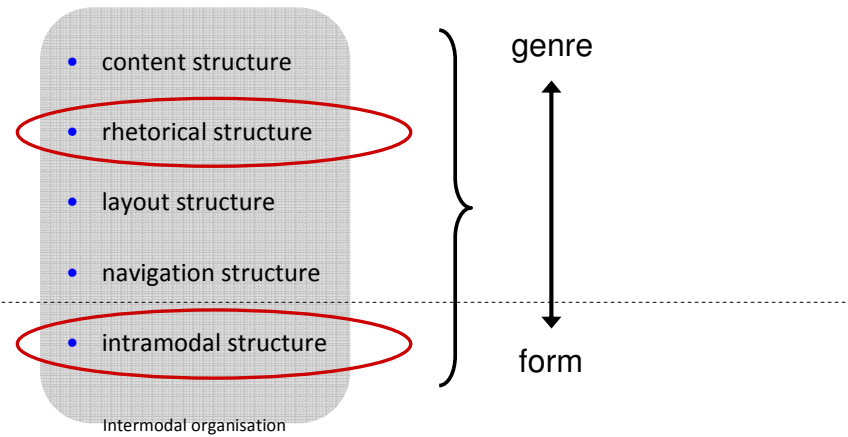
For airlines contemplating the future acquisition of new 200-passenger aircraft, the LV13200 meets the requirements for low cost and clean, quiet, reliable and durable power.

In the last few decades, air traffic volume has increased considerably, whereas the total quantity of fuel consumed has increased almost

This has been achieved by using the operating temperatures as well as the use of efficient aerodynamic design and by the use of lighter weight materials. In order to further increase the efficiency of the LV13200 the clearance distance between the stator and casing has also been reduced. This increase in efficiency can save airlines significant operating costs. The incorporation of advanced coatings in the LV13200 increases the engine margin, thus increasing the stability and active safety of engine flow conditions.

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multimodal semiosis



adapted from the GeM model; Bateman et al. 2001

multimodal analysis



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- content - in terms of:
 - medium (html, jpg, wav/mp3), mode, code
 - experiential, field
- layout – in terms of:
 - arrangement of units in space and time
 - positioning of units relative to one another
 - framing or highlighting of elements
- navigation structure – in terms of:
 - hyperlinks, navigation buttons etc.
 - functionality buttons
 - bibliographical references
 - headlines, captions etc.
 - references to document external (re-)sources

multimodal analysis



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- experiential
 - lexis (terminology, collocations)
 - lexico-grammar (transitivity: process types, participants, circumstances)
- interpersonal
 - interactivity (active linking, document manipulation by the recipient)
- textual
 - cohesive relations
- logico-semantic relations
 - expansion, projection
- status
- rhetorical structure
 - further specification of logico-semantic relations:
concession, opposition, disjunction, problem-solution, cause-consequence,
proposal-evidence, events-generalization, etc. (Mann & Thompson 1987)

Rhetorical structure	Rhetorical Structure Theory (RST; Mann, Thompson 1987): elaboration, purpose etc.
Conjunctive relations	Markers for spatial-temporal relations: <i>then, in the next step;</i> Contribution to textual cohesion
Cohesion	Anaphora resolution (e.g. These "three dimensional printers" "They make ...")
Generic structure	Overarching discourse relations; Contribution to textual coherence Generic Structure Potential (GSP; Hasan 1985/1989a, b)

multimodal cohesion and coherence

- different modes jointly contribute to multiseiosis, i.e. the process of meaning-making in multimodal documents
- cohesion:
 - verbal cohesion
 - visual cohesion
 - cross-modal cohesion
- coherence
 - subject to interpretation by the recipient

multimodal analysis



- formulae, programming code
 - highly conventionalised, abstract representations
 - cohesive ties (bracketing, lexical repetition etc.)
- features for intramodal analysis of other modes?
 - highly conventionalised schematic figures, flowcharts
 - conventionalised forms of data presentation such as tables
 - data-driven visual and virtual representations such as 2D and 3D CAD models
 - metadata descriptions of objects, processes and circumstantials in images, photographs, schematic figures

cross-modal cohesion



- simple repetition
- complex lexical repetition (shared a lexical morpheme, but no formal identity) |
ex.: prototype - prototyping – prototyped
- simple mutual paraphrase
- simple partial paraphrase
- other complex paraphrase
- [antonymous complex paraphrase]

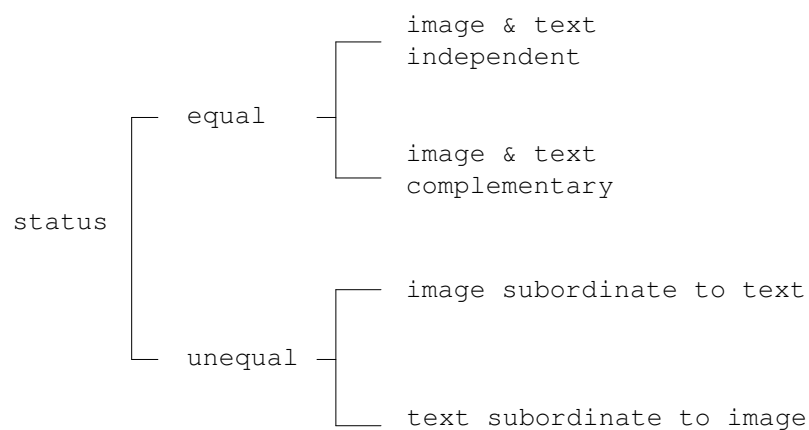
cross-modal relations: status of modes



- relative **status** of modes
 - text supporting image (*anchorage*),
 - image supporting text (*illustration*),
 - text and image equal / complementary (*relay*)
(Barthes 1977)
- equality | inequality

(cf. also Martinec, Salway 2005)

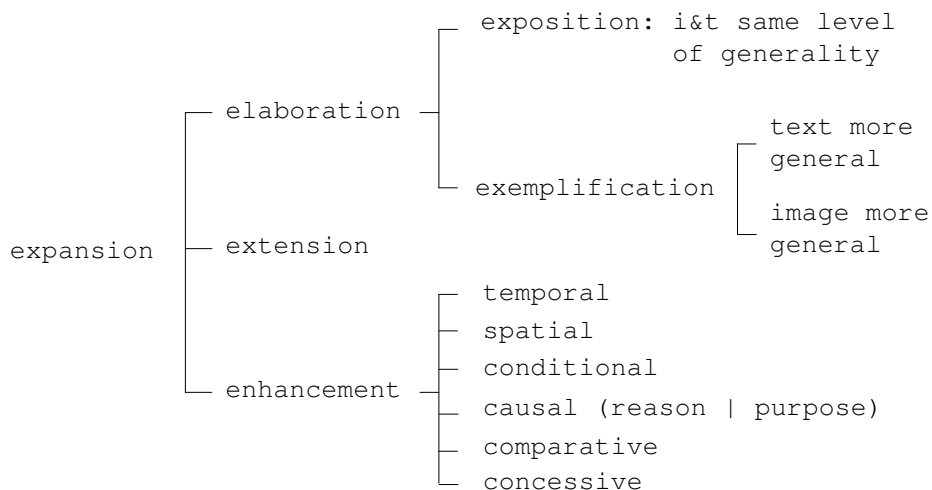
cross-modal relations: status of modes



cross-modal relations: logico-semantic relations

- logico-semantics:
 - expansion:
 - elaboration (elaboration on the meaning of another unit by a more detailed description of it)
 - extension (extension of the meaning of another unit / mode by adding further, related information)
 - enhancement (of a mode by qualifying it in terms of time, place, cause, and other circumstantial meanings)
 - projection
- ⇒ possibility of extension of these relations to further discourse units and other modes such as images, tables, formulae, 3D models etc.

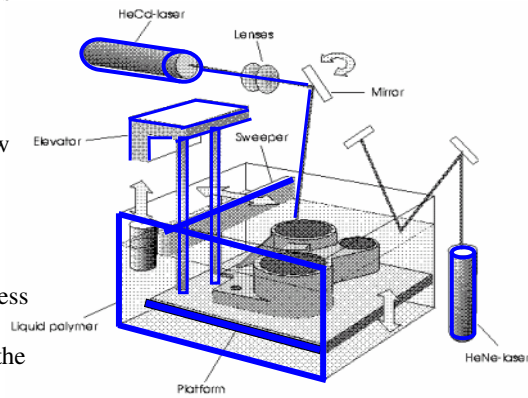
cross-modal relations: logico-semantic relations



cross-modal cohesive clusters: objects in different modes

The technique [stereolithography] builds three-dimensional models from [liquid photosensitive polymers](#) that solidify when exposed to ultraviolet light. As shown in the figure below, the model is built upon a [platform](#) situated just below the surface in a [vat](#) of liquid epoxy or acrylate resin.

A low-power highly focused UV [laser](#) traces out the first layer, solidifying the model's cross section while leaving excess areas liquid. Next, an [elevator](#) incrementally lowers the platform into the liquid polymer. A [sweeper](#) re-coats the solidified layer with liquid, and the [laser](#) traces the second layer atop the first.



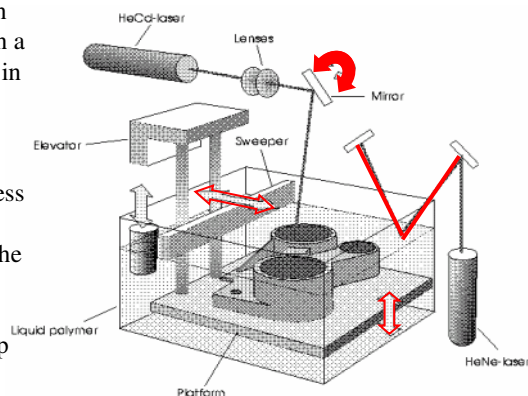
text more general than image

cross-modal cohesive clusters: processes in different modes

The technique [**stereolithography**] builds three-dimensional models from liquid photosensitive polymers that solidify when exposed to ultraviolet light. As shown in the figure below, the model is built upon a platform situated just below the surface in a vat of liquid epoxy or acrylate resin.

A low-power highly focused UV laser [traces](#) out the first layer, [solidifying](#) the model's cross section while [leaving](#) excess areas liquid. Next, an elevator incrementally [lowers](#) the platform into the liquid polymer. A sweeper [re-coats](#) the solidified layer with liquid, and the laser [traces](#) the second layer atop the first.

image more general and unspecific than in text



Generic structure



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1 Overview of Rapid Prototyping

The term rapid prototyping (RP) **refers to** a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data. These "three dimensional printers" **allow** designers to quickly create tangible prototypes of their designs, rather than just two-dimensional pictures. Such models **have** numerous uses. They **make** excellent visual aids for communicating ideas with co-workers or customers. In addition, prototypes can be **used** for design testing. For example, an aerospace engineer might **mount** a model airfoil in a wind tunnel to measure lift and drag forces. Designers have always **utilized** prototypes; RP allows them to be made faster and less expensively.

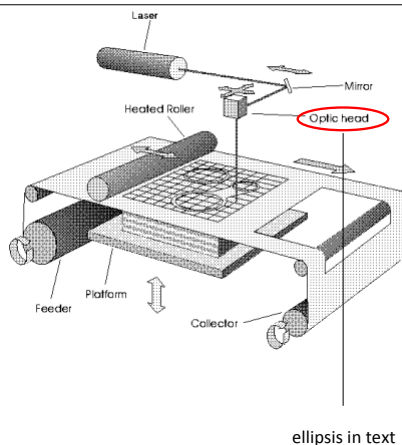
Relational processes
e.g. in definitions etc.

Material processes
e.g. in explanations and examples

cross-modal clustering



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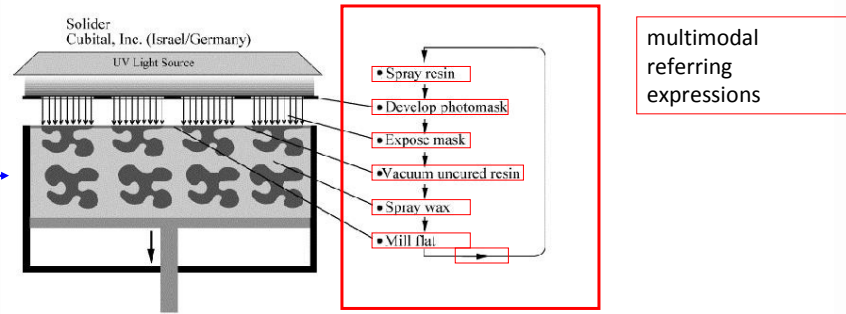
ellipsis in text

As shown in the figure below, a **feeder/collector** mechanism advances the sheet over the build **platform**, where a base has been constructed from paper and double-sided foam tape. Next, a **heated roller** applies pressure to bond the paper to the base.

A focused **laser** cuts the outline of the first layer into the paper and then cross-hatches the excess area (the negative space in the prototype). Cross-hatching breaks up the extra material, making it easier to remove during post-processing. During the build, the excess material provides excellent support for overhangs and thin-walled sections. After the first layer is cut, the platform lowers out of the way and fresh material is advanced.

3.4 Solid Ground Curing

Developed by Cubital, Inc. (Israel/Germany), SGC is somewhat similar to stereolithography (SLA) in that both use ultraviolet light to cure photosensitive polymers. Unlike SLA, SGC cures an entire layer at a time. Figure 5 depicts solid ground curing, which is also known as the solider process. First, photosensitive resin is sprayed on the build platform. Next, the machine develops a photomask (like a stencil) of the layer to be built. This photomask is printed on a glass plate above the build platform using an electrostatic process similar to that found in photocopiers. The mask is then exposed to UV light, which only passes through the transparent portions of the mask to selectively harden the shape of the current layer.



multimodal referring expressions

Figure 5: Schematic diagram of solid ground curing.

crossmodal referring expressions

After the layer is cured, the machine vacuums up the excess liquid resin and sprays wax in its place to support the model during the build. The top surface is milled flat, and then the process repeats to build the next layer. When the part is complete, it must be de-waxed by immersing it in a solvent bath. SGC machines are distributed in the U.S. by Cubital America Inc. of Troy, MI. The machines are quite big and can produce large models.

cohesion:
anaphora



• modality:

verbal indicative phrases in text vs.
imperative phrases in the image

“photosensitive resin is sprayed on the build platform”

vs.

“spray resin”

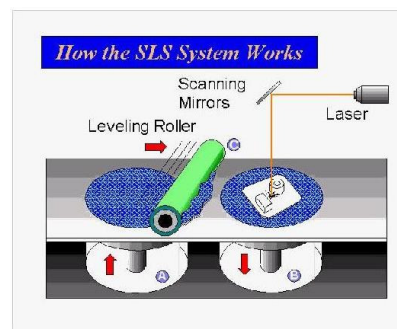


anaphoric referring expressions

cross-modal cohesion: conjunction in text and figure

[...] solid ground curing (SGC) is somewhat similar to stereolithography (SLA) in that both use ultraviolet light to selectively harden photosensitive polymers. Unlike SLA, SGC cures an entire layer at a time. Figure 5 depicts solid ground curing, which is also known as the solider process. **First**, photosensitive resin is sprayed on the build platform. **Next**, the machine develops a photomask (like a stencil) of the layer to be built. This photomask is printed on a glass plate above the build platform using an electrostatic process similar to that found in photocopiers. The mask is **then** exposed to UV light, which only passes through the transparent portions of the mask to selectively harden the shape of the current layer.

non-explicit parallel conjunction
in text and image



text as complex paraphrase of image

teaching materials / teacher to student:

[ctd. from previous slide] As shown in the figure below, a feeder/collector mechanism advances the sheet over the build platform, where a base has been constructed from paper and doubles-sided foam tape. Next, a heated roller applies pressure to bond the paper to the base. A focused laser cuts the outline of the first layer into the paper and then cross-hatches the excess area (the negative space in the prototype). Cross-hatching breaks up the extra material, making it easier to remove during post-processing. During the build, the excess material provides excellent support for overhangs and thin-walled sections. After the first layer is cut, the platform lowers out of the way and fresh material is advanced. The platform rises to slightly below the previous height, the roller bonds the second layer to the first, and the laser cuts the second layer.

Scoping:
reference to larger and
distributed sections
document parts

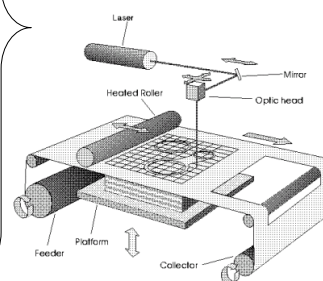


image as complex paraphrase of text

scientific paper / expert-to-expert:

- a. Laser Sintering (SLS), and their use in the HIP process to fabricate tool steel mold cavities, Figure 1.
- b. The interaction of software programs necessary for Curved LOM is illustrated in Figure 2 (see [1] for an expanded description). The algorithms are incorporated in two separate packages.
- c. In fact, the cured shell fit almost perfectly on a freshly-built mandrel, as illustrated in Figure 5.

interactivity and cohesion in 3Dpdf

- cohesive devices:
 - repetition of terms
 - paraphrasing
 - text – construction data
 - interaction activated cohesion
- new forms of interactivity
 - user interaction with the document
 - manipulation of an image or model



Core Tip Diameter (Inch)	48.5	Design RPM	13,000
Length Range (Inch)	120	Engine Air Velocity (ft/s)	1,917
Subsidiary	20,000-21,000 ft	Turbine pressure ratio (T4)	1.9
Rated temperature	80	Efficiency (3%)	88.4
Rated life	4,251-5.1	Rated pressure ratio	1.7-20.4
Rated temperature	80	Leading Edge (ft/s)	1,245-1,017

Global Corp offers a family of gas turbine engines for a variety of applications. Covering a range from 400 to 40,000 horsepower, our engines power both marine vehicles as well as aircraft. The LV3300 is the most recent engine developed for the market at Global Corp. This new engine covers the 40,000 to 40,000 horsepower range and has been designed specifically for the 200 passenger aircraft. It is currently offered in the following 32 ft span of the standard E200 aircraft family, and will enter service in the spring of 2005.

This LV3300 engine provides a significant advantage from other Global Corp advanced engine programs to deliver the lowest cost of ownership for 200 passenger aircraft operators. Global Corp has incorporated technological advances in the LV3300 that enable a reduction in parts count. With fewer parts, the engine has a lower acquisition and reduced maintenance cost. The LV3300 consists of a cast and articulated intake and a variable geometry compressor to provide longevity and high reduced weight. With reduced intake bleed it will provide better engine benefits, even the LV3300 will include 18 gals. (minimum) reports that have surface and noise quiescence.

For airlines contemplating the future acquisition of their 200 passenger aircraft, the LV3300 meets the requirements for low cost and clean, quiet, reliable and available power.

In the last few decades, as traffic volume has increased considerably, so has the total quantity of fuel consumed. This increased demand is

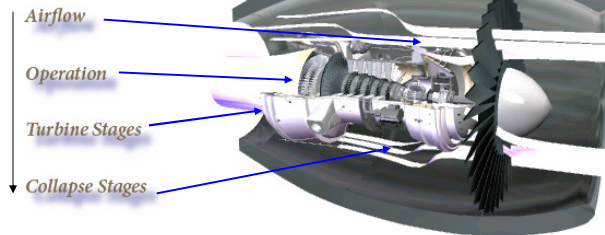
mitigated. The LV3300 reduces the total bleed increased fuel efficiency. This has been achieved by raising the operating temperatures to meet the use of efficient performance design while the weight/weight controls. In order to further increase the efficiency of the LV3300 the clearance distance between the intake tip and casing has also been reduced. This increase in efficiency can save airlines significant operating costs.

The implementation of advanced technology in the LV3300 reduces the engine weight, thus increasing the stability and safety of engine drive conditions.

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LV13200
implicit
sequencing



Technical Specification LV3200

Fan Tip Diameter (inches)	68.5	Design RPM	13,000
Length, flange to flange	128	Exhaust Jet Velocity (ft/s)	1917
Takeoff thrust	29,000-31,500 lb	Turbine pressure ratio (t-t)	1.9
Flat rated temperature.	86°	Efficiency (t-t%)	86.4
Bypass ratio	4.75 - 5.1	Overall pressure ratio	27 - 29.8
Flat rated temperature	89°	Loading (BTU/h/ft3/atm)	1.24E+07



corpus annotation

```
<unit id="u-01.106">3.2 Laminated Object
Manufacturing</unit>
<unit id="u-01.109"><xlink:href="//gemBase/unit[@id='u-
01.118']" role="text-to-image" from="u-01.109" to="u-01.118"
status="unequal-image-subord" logsem="enhancement-temporal"
cohesion="complex-paraphrase"/>As shown in the figure below,
a feeder/collector mechanism advances the sheet over the
build platform, where a base has been constructed from paper
and double-sided foam tape. [see next slide] </link></unit>
<unit id="u-01.118" alt="Bilder/Figure2" objects="laser
mirror platform collector ..." processes="vertical_move
horizontal_move"/>
<unit id="u-01.119">
  <xlink:extended role="caption" title="figure caption">
  <xlink:locator href="//gemBase/unit[@id='u-
01.118']"/>Figure 2: Schematic diagram of laminated object
manufacturing.</xlink:extended></unit>
```

summary and future research



- integrated characterisation of relations between modes in multimodal documents
- new forms of interaction / cohesive devices between modes in multimodal documents

- new forms of production and reception skills by both learners and teachers

references



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