Decoding techniques for the comprehension and assimilation

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1. Introduction

If you take a look at Professor Wirth and Professor Lozano´s handouts, you will realize that the language employed in the analysis and synthesis of mechanisms involves three main types of *communicative uses*: DEFINITIONS, DESCRIPTIONS (static and dynamic), and expressions of MATHEMATICAL REASONING. Each of these, in turn, implies a series of *rhetorical or discursive functions*: to define something, for example, we often need to classify, illustrate, detail position or location, report a process or specify functionality, for which we need *rhetorical techniques* such as the markers of division and subdivision, comparison and exemplification, spatial order, causality and result, chronological sequence, finality, etc. In an analogous fashion, to describe static objects we may also resort to expressions of similarity and contrast, shape, spatial location, or introduce dimensional measurements, whereas dynamic descriptions require the explanation of cause and effect and a chronological approach. So, what we have here called communicative use is a sort of macrofunction, the most global purpose from the speaker/writer. Subordinate to it there are usually minor functions (the rhetorical ones), accomplished through a repertory of textual markers or "signalling words" (the rhetorical techniques).

The purpose of this section is not only to help you understand the contents of the course, but also to raise your awareness toward the strategies, grammar and vocabulary used all throughout, so that you can broaden your functional knowledge and thus improve your communicative skills. You will be using most of the items presented here in your presentation later on: they roughly correspond to the elementary linguistic functions of *explaining*, *showing* and *telling*. For the most part they will be familiar to you; what we have done is bring them under a new light, in very specific technical contexts. The whole section has been divided into three major headings corresponding to the communicative uses before mentioned (definition, description, mathematical reasoning). Each one branches out into its subordinate rhetorical functions and offers an overview of linguistic resources together with several batches of exercises.

2. Definition

When we define something we individualize an object or concept from others. That is to say, we include it into a certain category or group. Let us examine an instance from Professor Wirth´s notes:

"Mechanisms (gear units) are systems for converting or transmitting movements and forces (torque). They consist of at least three links, one of which must be defined as the fixed or support link." (p.2)

Note that, for this definition to become fully informative, Prof. Wirth has specified the function and structure of the term he defines. Otherwise the category established would be too broad. Compare the former with these two other versions:

"Mechanisms (gear units) are systems)."

"Mechanisms (gear units) consist of at least three links."

Both appear to be too wide and underinformative: the first one says nothing about function, location or constitution. The second obviates the type of object or concept we are dealing with (the author of the definition is taking for granted that we know it). In summary, the most complete (and effective) definitions are *extended or expanded definitions*, which are enlarged upon by going into greater details concerning category, quality, function, location, illustration, or even by stating what the object/concept is not (negative definition). But prior to all that we need to take three elementary steps aimed at the individualization of our defined term: the correct use of articles, relative pronouns, and nominal modification.

2.1. Basic idividualization technique

2.1.1. Use of articles

Although you will be familiar with article use, here is a brief reminder plus a couple of practical exercises. Definitions make a*generic reference* to the object or concept they explain. This generic reference can be implemented through *the indefinitearticle*(A/AN), *the definite article* (THE), *a countable noun in the plural* form, or *anabstract or non-count noun with zero plural.*

A/AN --> Example: ***A gear unit*** *is a system for converting or transmitting movement and forces.*

THE --> Example: ***The gear unit*** *is a system for converting or transmitting movement and forces.*

A COUNTABLE NOUN IN THE PLURAL --> Example: ***Gear units****are systems for converting or transmitting movements and forces.*

AN ABSTRACT OR NON-COUNT NOUN WITH ZERO PLURAL --> Example: ***Overpressure*** *is a type of mechanical stress that may generate deformations like contraction or shrinkage on the body on which it is applied.*

2.1.2. Use of relative pronouns

Subordinate relative clauses are extremely important in technical language. They allow us to specify meanings and express additional information without having to interrupt the flow of discourse with a new sentence. The definition samples before provided can be rephrased into relative structures:

Example: ***A gear unit*** *is a system for converting or transmitting movement and forces. --> A gear unit is*

a system ***that/which*** *transmits or converts movement and forces.--> A gear unit is a system*

by/with/through which *movement and forced are transmitted or converted.*

--> Here is a brief reminder of the relative pronoun usage:

WHO is only used for people (with a subject or object function):

e.g. The teacher whogave us the lecture. (Subject)/ The teachers who we asked about the problem.
(Object)

Note:The teacher that gave us the lecture(colloquial, non-standard)

When it is the object of a preposition, the preposition tends to go separately in sentence-final position. The same clause can be reformulated with "whom", but then it tends to go right after the preposition and is reserved for very formal styles:

e.g. The teachers who we gave our homework to. / The teachers to whom we gave our homework (very formal style).

However, also in highly formal contexts we may find:

e.g. The teachers whom we gave our homework to.

WHOM is only used for people. In the past it was often used as the object of the clause, but nowadays "who" is much preferred.

E.g. The teachers who we asked about the problem. The teachers whom we asked about the problem (very formal style).

(See the explanation above for when it is the object of a preposition)

THAT / WHICH are used indistinctly for the rest of subjects and objects (for things), but the usual object of preposition is "which":

e.g. The mechanisms that/which convert movements and forces. (Subject)
The mechanisms that/which have been designed by the team. (Object)
The mechanisms with which the desired forces were obtained (Object of preposition)

WHOSE is a possessive relative that can be used for people and things:

e.g. A mechanism whose links are driven.
The teacher whose lectures we attend.

--> Remember that in technical writing the preposition is normally placed before "which" or "whom" and not at the end of the sentence, as it usually is in speaking.

--> For the sake of agility and communicative economy, technical English often uses what we know as contracted relatives:

Active contracted relatives: can be rephrased by means of a gerund:

e.g. The mechanism that/which rotates clockwise = The mechanism ***rotating*** *clockwise.*

Passive contracted relatives: can be rephrased by means of a past participle:

e.g. The mechanism that/which has been designed by the students = The mechanism ***designed*** *by the students.*

2.1.3. Use of nominal modification

We can individualize the concept we are defining by modifying the noun we are using in our definition. Modifying means stating qualities and properties with adjectives or grammatical categories acting as such: other nouns (e.g. a steel mechanism), gerunds (*e.g.* a rotating mechanism), past participles (*e.g.* a driven crank), and even adverbs (*e.g.* a clockwise rotation, an on/off switch) and prepositional phrases (*e.g.* a rotation to the right/left, the cogwheel next to the shaft). *Premodification* is the placing of these structures before the noun. *Postmodification*, also known as *qualification*, is their placement after the noun. However, there are certain restrictions and not all structures can be pre or postmodifiers.

Premodification

There is a strong tendency in technical English to compress the message by accumulating adjective-like structures before the noun. Nevertheless, if we abuse of this technique the discourse so generated may sound very humdrum, clumsy, or be difficult to read. In general we should not place more than three adjectives in the same premodifying chain. We reserve premodification for one-word adjectival units. Besides, it must be borne in mind that there is a standard order of collocation; the most inherent unit (a classifying adjective/noun/gerund/past participle/adverb) is the one placed most closely to the noun, while subjective qualities go in the farthest position. Of course we may vary positions for special emphasis, especially with adjectives of colour, size and shape.

subjective comment --> size --> shape --> age --> colour --> pattern --> origin --> material --> purpose --> classifying quality --> NOUN HEAD

(E.g. a creative 20-cm square 3-year old black striped German steel rotating mechanism)

--> Remember:

Although occasionally you may find examples like this one in technical writing, it is not advisable to pile up so many adjectival terms before the noun: not only are they extremely difficult to absorb (we have to wait a long time for the noun head to appear), but it may also be hard to work out how all of these premodifiers are meant to relate to one another.

Most often, postqualifying alternatives with the prepositions *of*, *with*, *by*, or *from* are more natural and clarifying. Take a look at the above example: Should we interpret it as a German mechanism (a mechanism devised or made in Germany), or as a mechanism made out of German steel? What is striped, the (German) steel or the mechanism? As excessive premodification may lead to confusion and clumsy constructions, it is recommended not to accumulate more than three premodifiers.

--> Remember:

a) Adjectives involving measurements (figures) become hyphenated and take the singular form in attributive position, even though they are plural in predicative position.

E.g. A mechanism which has three cogwheels (predicative) = a three-cogwheel mechanism (attributive)

b) In some cases (with verbs that indicate result) the order of adjectives implies differences in meaning:

e.g. The worker filed the steel tip blunt vs. The worker filed the blunt steel tip

(In the first example it was the filing that made the tip blunt. In the second, the tip was already blunt before the filing).

c) Coordinated adjectives are to be separated by a comma or the preposition *and*. On the contrary, if an adjective in the chain is subordinated to the noun head (that is, forms an inseparable block with it) and the preceding adjective modifies the whole block, then both adjectives must be written without commas or the preposition *and*:

e.g. Coordination: *A popular, creative, useful device.*
Subordination: *A creative multi-link rotating device*.

Postmodification or qualification

When the modifier involves a preposition it is usually placed after the noun. Lengthy modifiers also take this position.

Examples:

Prepositions -->
- *A chain with three links*
- *A chain of this size*
- *A shaft below/above the wheel*

Lengthy modifiers -->
- *A device to test the function*
- *A machine too difficult to operate*
- *A handling rather easy for the structural complexity*
- *A subject worthy of attention*
- *The technical features mentioned above / above mentioned*
- *A mechanism producing more profitability*

(Note that the "lengthy modifiers" usually involve prepositions, comparatives, or contracted relative clauses)

2.2. Rhetorical functions implicit in definitions

2.2.1. Classification

We can classify objects, concepts, etc. by fitting them into differentiated categories. Here we have some examples that may help:

a DEVICE = is usually a clever mechanism devised or invented to solve some particular mechanical problem (*e.g.* a thermostat, which regulates temperature)

an INSTRUMENT = is usually a small manufactured object which enables us to perform some precise action or measurement (*e.g.* a pyrometer, with which we can measure high temperatures)

an APPARATUS = is usually a complicated mechanism or assembly of many different pieces used for some scientific experiment or test (*e.g.* a bomb calorimeter, with which we can find out the calorific value of a solid or liquid fuel)

a TOOL = an instrument held in the hand and used by workmen (*e.g.* a chisel, a pair of pliers)

Other useful categories are:

a SYSTEM / STRUCTURE
a DESIGN
an APPLICATION of…
a SOURCE of (energy, power, etc.)
a RELATION between… / a FUNCTION of…/ an EQUATION
a QUANTITY
a PART of…/ an ELEMENT of…/ a COMPONENT of…/
a METHOD / a MEANS / a WAY --> of doing…
a SCIENCE / a DISCIPLINE / a BRANCH of
a (geometrical) SHAPE / FIGURE / BODY
a FORCE
a RATE of
a KIND of = a SORT of = a CLASS of = a VARIETY of = a TYPE of = a CATEGORY of
an EXAMPLE of= an INSTANCE of = a SAMPLE of

--> Remember:

1) *Methods, ways* and *means* are: ADOPTED / PUT INTO PRACTICE / EMPLOYED / USED / INTRODUCED / APPLIED.

2) *Means* is a noun of invariable form that can be treated as singular or plural (but the singular noun *"mean"* does not exist).

3) The categories of subdivision (*kind, sort, class, variety, type,* even *(sub)category*) can be used in the following way:

There are *X* ***types / kinds****, etc.* ***of*** *mechanisms*
Mechanisms ***are / can be of*** *X* ***types.***
Mechanisms ***may belong to*** *X types*
We ***can classify / divide*** *mechanisms* ***into*** *X types*
Mechanisms ***can / may be classified / divided into*** *X types*
We can ***classify*** *mechanisms* ***according to several criteria***
We can ***classify*** *them* ***according to their position*** *in…*
We can classify them ***according to whether*** *they rotate or not / according to whether they do…*
Among *the most important types of mechanisms* ***are****…*
They ***can be further subdivided into****...*
They ***fall into / break into / divide into / split into*** *X types of…*

4) Other expressions for generic categorization are:

Mechanisms can be ***categorized/ classified as belonging to****…*
This mechanism ***belongs to****…*
Among *these* ***we can distinguish****…/* ***it is useful to distinguish****…*
We ***shall be concerned with*** *X kinds of…*
These ***can besplit / classified / broken / divided into****…*
These ***consist of*** *…*

5) Broad expressions to tackle a classification are:

By *mechanism we* ***understand*** *a structure consisting of…*
We ***take*** *the word "mechanism"* ***to mean****…*
This value of the equation ***means / signifies*** *that…*
The ***main / distinguishing / distinctive*** *features of this device are…*
The main ***features / traits / characteristics / properties*** *of this device are…*
This type of mechanism ***is known / referred to / defined as*** *a beam-and-crank mechanism.*
This mechanism arrangement may ***be considered / regarded / looked on / seen / taken / accepted as*** *the standard one for this type of application.*
This piece ***acts / serves as*** *a link between those two elements.*
This piece ***is often used / employed as*** *a link between those two elements.*

2.2.2. Composition

Another way to define something or to expand a definition is by indicating what elements or parts form the object or concept in question. Here is a brief repertory of interesting expressions:

Mechanisms must ***include / consist of / contain / comprise*** *at least three links*
Mechanisms ***are composed of / made up of / formed by*** *at least three links*

Cranks, joints, bearings, wheels, etc., may be the ***constituents*** */* ***components of*** *a mechanism.*
Cranks, joints, bearings, wheels, etc. may ***constitute*** */* ***make up*** */* ***form*** *a mechanism.*

2.2.3. Functionality

Often we define by specifying function or use. For example:

"A gear unit is a mechanical system ***for converting and transmitting*** *movement and force."*

--> Remember: *FOR + GERUND* is used to express the finality or purpose of inanimate objects, not human intentions (these are expressed with the "*TO INFINITIVE"*):

We *take this course* ***to learn****Mechanics*but***This course*** *is* ***for learning*** *Mechanics*

We can use the relative clauses studied in previous sections:

"A gear unit is a mechanical system ***which/that converts and transmits*** *movement…"*

"A gear unit is a mechanical system ***with which to convert and transmit*** *movement…"*

"A gear unit is a mechanical system ***to convert and transmit*** *movement and force* ***with****"*

Other possibilities within the functionality repertory are these:

1) Verbal structures meaning *"make possible/feasible/viable"*

e.g. Gear units **make possible the conversion and transmission of** movement and force
Gear units **make possible for engineers/us to convert and transmit** movement and force
Gear units **make possible that movement and force are/be** transmitted and converted
Gear units **enable engineers/us to transmit and convert** movement and force
Gear units **enable movement and force to be** converted and transmitted
Gear units **cause** movement and force **to be** transmitted and converted
Gear units **allow** movement and force **to be** transmitted and converted
Gear units **permit movement and force to be** transmitted and converted
Gear units **permit engineers/us to** transmit and convert movement and force

2) *"Make"* and *"Let"*

e.g. *This gear* ***makes*** *the wheels* ***turn***= (causes them to rotate)
This gear ***lets*** *the wheels* ***turn*** = (permits their rotation)

--> Remember: *"let"* is usually spoken, not written. Both *"let"* and *"make"* are used with the bare infinitive (that is, the infinitive without "TO")

3) The words *"function"* and *"duty"*, either with a noun phrase, an infinitive with "TO" or with preposition + gerund:

e.g. *The **function/duty** of gear units is **the conversion and transmission** of movement and force*

*The **function/duty** of gear units is **to convert and transmit** movement and force*

*Gear units have/perform the **function/duty of transmitting and converting** movement and force*

4) The words *"aim"*, *"purpose"*, *"object"* , *"goal"*, *"view"* + infinitive with "TO"

e.g. *The **aim/purpose/object/goal** of gear units is **to convert and transmit** movement and force*

*Gear units are designed **with a view to convert and transmit** movement and force*

Or with preposition + gerund

e.g. *Gear units are designed **for the purpose of converting and transmitting** movement and force*

*Gear units are designed **with the object/aim of converting and transmitting** movement and force*

*Gear units are designed **with a view to convert and transmit** movement and force*

5) The verbs *"serve"*, *"act"*, and *"use"*

*e.g. Gear units **serve to convert and transmit** movement and force*

*Gear units **serve/act as a means/ method/way of converting and transmitting**...*

*Gear units **are used as a device to convert and transmit** movement and force*

*Gear units **are used to convert and transmit** movement and force*

6) The final conjunctions

*e.g. Gear units are designed **to** convert and transmit movement and force*

*Gear units are designed **so as to** convert and transmit movement and force*

*Gear units are designed **in order to** convert and transmit movement and force*

*Gear units are designed **so that/in order that** we (can/may/should) convert and transmit movement and force*

*Gear units are designed **so that/in order that** movement and force are/(can/may/should be) converted and transmitted*

--> Remember: *SO THAT / IN ORDER THAT* require a sentence with a conjugated verb (either in the active or in the passive voice), not an infinitive.

7) Other expressions of finality or purpose

e.g. Gear units ***aim to transmitand convert*** *movement and force*
Gear units ***are aimed at transmitting and converting*** *movement and force*
Gear units ***are meant to transmit and convert*** *movement and force*
The conversion and transmission of movement and force is necessary. ***To this end, we design gear units/gear units are designed***

2.2.4. Illustration

Illustration is a loose way of defining by itself, but it is a very common—and useful—extension in any definition or description. We illustrate by *giving examples*, by *comparing* the defined term with something else (we indicate points of *similarity* and*contrast*), and often we have to *list* or *enumerate* more than one point or example.

Expressions for giving examples

For example/instance,…
Let me provide an example of…
Take, as an example…
As an example of this, we illustrate*…/ we will/can* ***mention****…*
Here is ***one such example of*** *this idea /* ***One such example of*** *this idea is…*
As an illustration*, we will* ***consider/mention…***
As typical of this, *we shall consider…*
This idea ***can be best elucidated by example.Let us take the case of…***
As in the case of *X, Y is / does…/ X does this,* ***as is the case of*** *Y*
In many instances *X is / does…*
In some cases *X is / does…*
With the possible exception of…
If X does so, ***say,*** *in this way/in such way that…*
A counterexample is *X /* ***X is a counterexample of…***
Some Xs, ***such asthis*** *one, are / do…*
Such Xs as this *one are / do…*
X is very interesting. ***Such*** *interest consists of…*
X does this ***such as*** *(= of the kind which) are encountered in…*
X is one way of doing this ***such as*** *(= of the kind which) occur in…*
*…****and so onand so forth***

Expressions of comparison

When compared to *X, Y is / does…*
X is ***comparable to / with*** *Y.*
In comparison, *this is…*
X seems / is better ***by comparison.***
For the purpose of comparison, *X is considered / we (shall) consider*

Superiority & Inferiority

X is better / more useful than Y
X is ***a little / slightly / much / far / way (American English) /a lot (colloquial)*** *better /more useful than Y*
X is ***a much better / more useful*** *mechanism* ***than*** *Y*
X is ***a much better / more useful*** *mechanism* ***to use***
X is worse/ less useful than Y
X is ***a little / slightly / much / far / way (American English) /a lot*** *worse / less useful than Y*
X is ***a much worse / less useful*** *mechanism* ***than*** *Y*
X is ***a much worse / less useful*** *mechanism* ***to use***

X is superior / inferior to Y … ***from certain points of view***
in certain respects */ features / ways*
from the point of view of *efficiency / utility / costs, etc.*
with regard to *efficiency / utility / costs, etc.*
in *efficiency / utility / costs, etc.*
in being more /less *efficient / useful /economical, etc.*
in giving greater / lesser *efficiency / utility / costs, etc.*
in that it is *more / less efficient / useful /economical, etc.*
in so far as / in as much as it is *more / less useful / efficient, etc.*

This mechanism has ***fewer*** *components* ***than*** *this other one.*
This mechanism offers ***a tenfold improvement*** *of performance.*
This mechanism is ***the best ever*** *(made).*
X is ***half as*** *good* ***as*** *Y*
X is ***a thousandth as*** *strong* ***as*** *Y.*
The quality of X is ***half as*** *good* ***as it is for*** *Y*

Equality

X is ***as*** *good* ***as*** *Y*
X is ***almost as*** *good* ***as*** *Y*
X is ***as*** *useful* ***a*** *material* ***as*** *Y*

X is ***not so*** *good* ***as*** *Y*
X is ***not quite so*** *good* ***as*** *Y*
X is ***not quite such a*** *good material* ***as*** *Y*
X is ***not quite such a*** *good material to use*

Similarity

X ***is exactly the same as*** *Y*
X is ***identical with*** *Y*
X is ***exactly the same*** *in design / properties* ***as*** *Y*

X is ***identical in*** *design / properties* ***with*** *Y*
X and Y are ***(virtually) identical / alike / similar / the same***
X is ***roughly the same as*** *Y*
X is ***similar to*** *Y*
X is ***like*** *Y*
X, ***like*** *Y, is / has…*

X does… ***as*** *Y* ***does***
and so does *Y*
as it is in *Y*

Both *(X and Y) are / have / do…*

X does not do… ***nor / neither does*** *Y*
and neither does *Y*
and *Y* ***does not*** *do it* ***either***

Just as *X can do it, so too Y can (do it)*
As *important / good, etc.* ***as*** *X* **,** ***is*** *Y*
Doing X ***is very much like*** *doing Y*
This is ***equivalent / tantamount to say****ing that…*
It is ***as though*** *we could do…*
X is ***like that of…***
X is more ***akin to*** *Y than to Z*
Likewise, *X is / does…*
X has been ***likened / compared to*** *Y*
X does this ***in much the same way (as)*** *Y does it*
As *X does this,* ***so does*** *Y*

Contrast

X ***is different from / differs from*** *Y* ***in its*** *shape /* ***in the sense that…***
several respects
the fact that…
that it is…
as much as…

by its *efficiency / shape, etc.*

It is useful ***to differentiate / distinguish / make a distinction between*** *X and Y*

X, ***unlike*** *Y,*
as distinct from *Y, is / has / does…*
as opposed to *Y,*

X has / does this, ***as against***
as compared with*(the features of) Y*
as opposed to

X has this / does this, ***while / whilst / whereas*** *Y does not*
X ***does not*** *need a Y,* ***as*** *Z* ***does***
While / whilst / whereas *X does this, Y does not*

On the contrary
Conversely
In contrast to
Nonetheless = ***nevertheless***
Yet
However
Versus
In spite of *(the fact that) =* ***despite*** *(the fact that) /* ***notwithstanding***
Contrary to
X ***contrast with*** *Y in…*
Although = ***though***
Instead (of)
Rather,
The pattern is reversed with *X*

--> Remember: *negative definitions* are a variant of contrast. They consist of saying what the concept does not mean in order to avoid confusion.

Example: ***By*** *X* ***we do not mean / take to mean / understand…but…***

Expressions of listing or enumeration

Furthermore / moreover / yet another point is / in addition (to) / besides / in addition (to) / apart from /and what is more, /adding to

As well as / along with / together with / coupled with / also / too / not only…but also…/ in turn

Except for /with the exception of…/ but / excepting

In the first place / to begin with / to start with / firstly,…
Next / there after / then…
Secondly / thirdly / finally / lastly / last (but not least)…
On the one hand…, (on the other…) / For one…, (for another…) --> (also used for contrast)

3.Description

Description is an important part of technical and academic writing. Any good description must be: *orderly*, *clear*, *accurate*, and *complete*. This means it should show some organization (*i.e.* inductive/deductive, of increasing or decreasing relevance, spatial—from top to bottom & vice versa, from left to right & vice versa, from front to back & vice versa…), it should offer a distinct picture of what is being described—its details must be significant and correct—and cannot miss out anything important. It must create a dominant impression and details should be used to support it.

3.1 Static description

By *static* description we understand the description of people, objects, concepts, relationships, etc. according to: physical appearance or traits (layout, shape, size, colour, structure, materials, etc.), additional characteristics (convenience, simplicity, acceptability, etc.), functions and uses, and types and subcategories. For some of these aspects we can resort to the structures of basic individualisation (above all to those of nominal modification), classification, illustration (comparison, similarity and contrast) and functionality we have just learned or reviewed to formulate definitions.

3.1.1. Description of shape

Shape can be described in these various ways:

1) By means of specific *geometrical nouns and adjectives*

(*e.g. a* ***cylinder***, ***cylindrical***)

2) By means of *comparisons*, either with geometrical figures or with well-known everyday objects. The endings *"—like"* and *"—shaped"* are often used

(*e.g. a* ***cylinder-like*** *or* ***cylinder-shaped*** *object, a* ***log-like*** *or* ***log-shaped*** *object*)

3) By means of *periphrasis*

(*e.g. an object* ***which/that has the shape of*** *a cylinder/log, an object* ***having the shape of****..., an object* ***with the shape of****...*)

3.1.2. Description of dimensions

Imagine a rectangle whose base is 25 cm long and whose height is 5cm.

There are several ways of expressing these measurements:

a) *This rectangle is 25 cm long and 5 cm high.*
b) *This rectangle has a length of 25 cm and a height of 5 cm.*
c) *This rectangle is 25 cm* ***in*** *length and 5 cm* ***in*** *height.*

And all this information can be further compressed with the help of compound adjectives. Remember that they are hyphenated and take the singular form—review *"nominal modification"* under 1.5.2.1.3):

Example: *This is a 25-cm long and 5-cm high rectangle*

3.1.3. Description of location

There are a number of spatial markers that may lead to confusion. Let us comment on them:

a) *over / under* versus *above below*

Above & below are used when the figures are simply on the same geometrical plane. *Over & under* when there is some covering, movement, or contact.

E.g. The box is ***under*** *the table (covering)*
The switch is on the wall ***under*** *the shelf (covering)*
The wheel moves ***over*** *the plate (movement)*
The plane flies over the city (movement)

b) *under* versus *underneath*

Under is a preposition and requires a complement. *Underneath* can function as a preposition or an adverb. As an adverb it needs no complement and can go alone:

e.g. The box is ***under*** *the table = the box is* ***underneath*** *the table = It is* ***underneath***

c) *at the end* (spatial)versus *in the end* (attitudinal).

E.g. ***At the end*** *of the line is point A.*
The mechanism has been repaired ***in the end*** *(= finally)*

d) *beside* versus *besides*

Beside means *"next to"*, whereas *besides* is a marker of enumeration and means *"in addition (to)".*

E.g. There is a small wheel ***beside*** *the big one.*
There other factors to consider ***besides*** *costs.*

Other useful markers of location are:

Upper / higher / lower	*across*
AT the front /the back = IN / AT the rear	*along, alongside*
ON / TO the left / right (hand-side)	*through, throughout*
IN the middle // AT / IN the centre	*behind*
ON one side / ON the other (side)	*between (two objects) / among*
Round /around / about	*in = inside = within*
Next to = adjacent to	*near = close to = by*
IN the background / foreground	*apart / away / some distance FROM*

ON top of	*AT the top of / the bottom / foot / base of*
Outside = out of	*halfway = midway between…*

Upside down = inverted
Inside out

Upwards / downwards
Inwards / outwards = to the inside / to the outside
Forwards / backwards = to the front / to the rear = to the back
Sidewards

Clockwise / anticlockwise = counterclockwise

Level with = at the same level

Opposite = in front of = facing

Emphasizers: *at the VERY top / bottom, RIGHT / JUST in the centre / middle*

3.1.4. Description of properties & conditions

Useful description patterns:

"X is a material which / that ***HAS / POSSESSES / EXHIBITS*** *the property of…"*

"X is a material which / ***does*** *…****under these conditions****"*

Description of faults

To describe faults we use the modal verbs will (for the present) and would (for the past). (Watch out: contracted verbal forms are only to be used orally)

Examples: What is wrong with this mechanism?
_ ***It´s*** *the wheel. It* ***won´t*** *turn properly.*

What was wrong with the mechanism yesterday?
_ It ***was*** *the wheel. It* ***wouldn´t*** *turn properly.*

Description of arrangement

Here are some examples of verbs and syntactic structures denoting organisation and positioning:

This mechanism is so ***disposed / ordered / planned / arranged / organised / designed / set out*** *that two links are driven.*

The links ***can bearranged / disposed*** *in a variety of ways.*

The shafts ***are arranged / disposed*** *at varying distances from the wheel / radially around the block / in a radial pattern.*

The ***arrangement / disposition*** *of these elements varies with the type of mechanism.*

The ***arrangement / disposition*** *of these elements at this specific angle ensures proper functioning.*

A ***system / arrangement****of gears connects the shaft to the wheels.*

Description of manner

Manner and arrangement are two closely related ideas. This is a repertory of structures:

The mechanism is ***so designed that*** *it will last long* --> emphasis on the result
designed so that *it will last long* --> emphasis on the way / manner
the results are brought about

The piece is ***so designed that***
designed so that *it fits the notch /* ***as to*** *fit the notch*
designed in such a way that

The mechanism ***is such that it permits*** *the wheel* ***to*** *move in the opposite direction.*

The diameter of this piece ***must be of such a size so that it fits*** *the notch.*
so as to fit *the notch.*

The mechanism ***is of such size that*** *it can serve these purposes.*

The mechanism, ***as*** *originally* ***planned****, could not have served our purpose.* --> (=as it had been planned, in that original form)

This mechanism has special coupler curves and ***as such*** *(it) can be used to guide workpieces or tools.*

The piece has been made of metal. Pieces ***madein this way / manner*** *are much more resistant = Pieces* ***so / thus made*** *are much more resistant.* --> In fact this is a contracted passive relative (see 2.1.2) enlarged by so / thus / in this way manner. *So* and *thus* go before the past participle.

3.2. Dynamic description

Dynamic or process description is a type of text that simply tells what happened. Therefore it can be considered narrative. Its account of events entails following

a *timeprogression* or *chronological order*, establishing relationships of *cause and effect*, and reporting the stages through which *processes and procedures* take place.

3.2.1. Time progression

The verb tenses most commonly used (in the active & passive voices) are the *simple past*, the *past perfect*, and the *present simple* (for a detailed revision of the passive voice and complex temporal & manner sentences see the appendix).Next, a list of useful chronological terms is provided:

Meaning (approximately) ***BEFORE***

formerly	*to begin with*	*at the beginning / outset / onset*
prior to (+ noun / gerund)	*initially*	*to start / initiate / begin /commence*
first (of all) / firstly…	*previously*	*to date from / go back to / to precede*
preceding (adj.)	*beginnings / origins*	*long before*

to establish /to create / to set up

Meaning (approximately) ***AFTER***

Having done X…	*Now that we have done X…*	*Once we have done X…*
By the time X is done…	*By the end of…*	*Soon after X happened…*
henceforth	*subsequently*	*in the long / short run*
successively	*next*	*then*
afterwards	*later on*	*to follow / followed by*
ever after /ever since	*sequential(ly)*	*once / until = till*
progressive (ly)	*in due course / time*	*in the future*
presently = shortly = soon		

Meaning (approximately) ***AT THE SAME TIME***

while / whilst (formal)	*meanwhileat*	*present*
simultaneously	*in (+ months & years)*	*now*
during	*on(+ weekday / date)*	*at the moment*
as	*at (+ hours)*	*for the time being= for the moment*
ongoing (adj.)	*currently*	*in /during the course of*
under way		

continue = go / carry / keep on, be in progress

Meaning (approximately) ***FINALLY***

in / at the end	*throughout*
eventually	
at last	
last(ly)	

to finish / conclude / terminate / end / cease / quit / complete / be over / bring to an end / come to an end / to leave off

Some syntactic structures of interest: contracted time clauses (by means of a gerund, a past participle, a noun, or even an adjective) are a common way of shortening temporal statements. We resort to them when the subject is the same in both parts of the statement (*i.e.* at both sides of the comma), otherwise we use full-length sentences.

Examples:

Before we represent *the bars of the mechanism by position vectors, we must select the precision points of the wished function.* **(=FULL-LENGTH TIME STATEMENT)**

--> ***Before / Prior to representing*** *the bars of the mechanism by position vectors, we must select the precision points of the wished function.* --> ***After / On selecting*** *the precision points of the wished function, we represent the bars of the mechanism by position vectors.* **(=GERUND CONTRACTIONS) --> *Once selected*** *the precision points…, we represent…* **(=PAST PARTICIPLE CONTRACTION)**

Before, prior to, when, on, while, in, after **-->** admit the **gerund contraction** ***When, while, once, if*** **-->** admit the **past participle contraction.** They can also be used **with an adjective** (*e.g.* ***When necessary***, ***if possible***, ***once clean***, ***while still hot*…**)
After, on, before, during, in the course of --> They can shorten the time clause by **preceding a noun** (*e.g.****Duringinstallation*…**)

3.2.2. Expression of cause and effect

List of useful terms:

consequently / in consequence = logically = thus (very formal) = hence (very formal) = therefore (formal) = so (less formal)

in this way

for this / that reason = the reason / explanation for this /that is… = on that account / on account of (+ noun / gerund) / the reason why is…

as a result (of this)

this explains why.. / that is the reason why…

because /as / since / for

owing to/ due to / because of

accordingly

in turn

Now that X is so, Y is…(implies a present time element)

When / If X is so, (then)…

The effect /result / consequence / outcome / aftermath / solution of this is X (noun) / to do X / doing X

to cause / bring about / provoke / give rise to / to produce	*to result in*
to lead to / be conducive or helpful to (+ noun / gerund)	*to result / stem / derive / arise from*
to make something /somebody do something else	*to be originated /generated by…*
to cause something /somebody to do something else	*to be due to something*
to trigger something off	*to be caused by something*
to be likely to do something / be… (= will probably)	
to be liable / susceptible to do something / be…	

to be apt to do something / be…

to allow for

to prevent / keep something from doing something else

Some other useful specific verbs of effect are these:

To change / turn / convert into

to counteract / balance /counterbalance /to compensate

to prevent / avoid / obviate / eliminate / reduce

to achieve / obtain / effect / accomplish /attain

to exert / act on

to evolve / generate / develop

to work / function / operate / run(intransitive) versus *to actuate / operate* (transitive)

to drive / move / travel / slide / reciprocate / oscillate / swing / traverse / cross / rotate = turn = revolve

to circulate / be at rest / be stationary / be in motion = moving

to increase = augment / decrease = reduce

to speed up = accelerate = make go faster / to slow down = decelerate = make go slower = retard

to elevate / depress

to fire / ignite

to expel / exhaust / discharge / eject

Sometimes the effect can be expressed in the form of **variables**. To that end, we use certain verbs (*vary, increase, decrease,*and for the absence of change *remain* and *stay*) nouns (*increase, decrease, reduction, expansion,* etc.) markers like *according to, as, so* or *with,* and comparatives. Below are some examples of the expression of variables:

The higher *the velocity of rotation,* ***the greater*** *the friction on the pieces.* ***As*** *the velocity of rotation* ***increases****,* ***so*** *the friction on the pieces* ***increases****. The friction on the pieces* ***increases / augments with*** *the velocity of rotation. The friction* ***varies according to / with*** *the velocity.*

Pressure ***varies inversely as*** *the volume.*
This level of friction is acceptable as long as ***it remains constant****.*

3.2.3. Expression of procedural sequence

The description of processes and procedures (that is, the way things happen or are done) must always state clearly its purpose and usually shows the basic principles of the object / device / mechanism, etc. described (as regards functioning).

The **verb tenses** most commonly used are:

General descriptions --> present passive tense

(e.g. X is operated / arranged / tested / developed…)

Particular descriptions --> past passives

(e.g. X was operated /arranged / tested / developed…)

Besides those applied to narrative, **useful terms to employ** here are the following:

a) Process verbs showing the beginning, middle, or end of the process

e.g. The / This process ***begins / starts / commences*** *--> with / when…*
The / This process ***finishes / concludes*** *--> after / when / once…*

Verbs of beginning: ***start, begin, commence, initiate, set out***
Verbs of continuation: ***continue, carry on, go on, keep on, proceed***
Verbs of end: ***end, finish, stop, cease, quit, leave off, complete, terminate***

b) Duration verbs indicating change of state during the process

e.g. ***develop, extend, shorten, lengthen, broaden, widen, speed up, slow down, reduce, cooldown, warm up, etc.***

c) Markers of sequential stages

e.g. ***During / AT****the* ***stage / phase / step / interval / part…***
The process ***has = consists of = comprises / involves = entails*** *several stages.*
The mechanism arrangement ***goes through = undergoes*** *several stages.*
Pressure / velocity, etc. is ***raised / reduced in stages.***

d) Verbal and adverbial expressions indicating method

e.g. *This function is* ***effected / performed / obtained*** *by this piece. --> This piece* ***effects /performs / obtains*** *this function.*
The compressor is obtained ***by the driving of the*** *crank /* ***by driving the*** *crank.*

The two swinging-block linkages are obtained ***by the rotation and oscillation of*** *these cranks /* ***by rotating and oscillating*** *these cranks.*

By doing this = by so doing / with the help of this = with the aid of this / thanks to this / by means of this = thereby / by the use of this

To adopt / apply *a method or material*

To exploit / make use of *resources, inventions or objects*

To use / utilise / employ *properties, methods, materials, resources, inventions, or objects*

4. Formulation of mathematical reasoning

There are three salient scientific functions in the expression of mathematical reasoning: the formulation of*hypotheses* and *conditions*, the *reference to calculation steps*, and the expression of *results* and *deduction*.

4.1. Formulation of hypotheses and conditions

A hypothesis is a kind of assumption made as a starting point for a line of reasoning. Some expressions:

a) Possibility / probability

It is normally indicated with *if-clauses* (= conditional clauses) and the modal verbs *may*, *can*, and *should*. We must bear in mind that these structures and verbs in the present denote probability or a less remote possibility than in the past.

If such an x exists, then…
Should x be negative, then…
If so, x would / will be…
If successful, this might…

Should is used when *"if"* is omitted. It has formal or literary nuances and can be translated as "*in the case that"*:

e.g. ***Should*** *x be equal to y, then…*

b) Setting of conditions & requirements

It is mainly accomplished through imperatives (*e.g. "Suppose / assume"* and mostly with the verb *"Let"*), conditionals (with *"if"*, *"provided that"*, *"providing that", "on condition that…"*), gerunds (*e.g "assumingthat"*), past participles (*e.g. "Given…")* and specific prepositions, adverbs or conjunctions (*e.g. "under this hypothesis", "unless x >0", "whatever x"*). Here are some examples:

Let the relation x = y	*if x >0*
Let there be a relation between x and y	*unless x >0*
Let x be the value of y	*on the assumption that x>0*

Let x = y	*on the hypothesis that x >0*
Let x be equal to y	*on condition that x>0*
Let x and y coincide	*provided that x>0 = providing that x>0*
x being assumed (to be) positive	*to take x = y / x as y*
(Let us) suppose / assume x>0 / x to be positive	*to set x equal to y / x be equal to y*
To equate x to y	*x is assumed to be…*
X is taken to be negligible and is disregarded	*the assumption is made that…*
It is assumed / supposed / taken for granted that…	*x is postulated to be zero*
Under these assumptions…	*under the abovementioned hypothesis…*
Given an x such that…, it may…	*Let us assume / suppose…*
Suppose / assume that…	*say that…*
Take / consider the equation / case…	*if we take the equation…*
Whatever x…	

The setting of conditions and requisites may be also expressed by means of the subjunctive, sometimes with structures including the modal verb *should*. When we instead use a conjugated verb, we must remember that American English and highly formal British discourse build the subjunctive with the bare infinitive, whereas colloquial or less formal British English reproduces the indicative mood:

e.g. The teacher wants him to solve the equation (BrE & AmE)
The teacher wants ***that hesolves*** *the equation* (everyday BrE)
The teacher wants ***that hesolve*** *the equation* (AmE & formal BrE)

This is especially noticeable with the verb to be:

e.g. The research team wants him to be the team-leader (BrE & AmE)
The research team wants ***that heis*** *the team-leader* (everyday BrE)
The research team wants ***that hebe*** *the team-leader* (AmE & formal BrE)

Remember as well that certain verbs takingthe *THAT-construction* complete it with the present subjunctive (especially in formal BrE & AmE): *ASK, REQUEST, REQUIRE, COMMAND, DEMAND, ORDER, PROPOSE, RECOMMEND, SUGGEST, INSIST.*

E.g. It is ***suggested that*** *x* ***be / is*** *equated to y.*
It ***required that*** */ X* ***requires that*** *y* ***should be*** *a constant / that y* ***remains (1)*** *constant.*
We propose that x ***be*** */* ***is*** *a constant.*

(1)remain *in AmE & formal BrE*

Other examples of requisites / conditions:

e.g. ***No matter how*** *optimum the solution* ***may be****, it cannot be extended to other types of problems.*

For this hypothesis to stand, ***there has to be proof that*** *x* ***satisfy / satisfies*** *the equation.*

4.2. Reference to calculation steps

Remember that most times this reference is done using the impersonal passive (that is, without an agent complement) in order to achieve impersonality and objectivity

(e.g. The solution is calculated by assuming x>0)

To make / carry out a calculation	*to apply a criterion /theorem*
A step by step calculation	*to solve a problem*
An equation in a single unknown / in n unknowns	*to set / tackle / cope with a problem*
To reason / argue	*to find the key to a problem*
Reasoning / argument	*to seek / find (out) / work out a solution*
To find the solution to the equation	*to demonstrate*
To find the root of the equation	*to estimate*

Occasionally we may need to refer to figures, tables, graphs or illustrations:

As(is) shown in the table / diagram / graph / figure / chart / statistics…. Figure 1 / Table 1, etc….

As can be seen / observed // As we may see in Figure 1…
As follows…/ As is shown in the diagram at the top…/ As illustrated by Figure 1…
According to the figure…/ See illustration on page 95
We illustrate this diagrammatically in Figure 1 / Shown here is…/ This is plotted in Fig.1
Now look at Figure 1… (oral presentation)
Let us look at this schematic diagram (oral presentation)
Now let´s turn to the pie-chart in front of you (oral presentation)
If you look at the table below, you can see…(oral presentation)
As you may conclude from this synoptic view…(oral presentation)
Now, looking at the figure in the graph below…
Figure 1 brings out the importance of…
The diagram illustrates…
As is made clear by Table 1 below…
In Table 1…

As (is) shown in the illustration… = As shown in the illustration…= As the illustration on page 50 shows…

4.3. Expression of results and deduction

Taking into account that x>0,…
From the abovementioned condition it follows that…
It may be seen / deduced / inferred / gathered /concluded / estimated...
…, which gives / yields that x is positive
…, which means / implies / entails that…
Then we have / get / obtain x>0
…, which explains why x is positive.

Here the expressions of cause and effect already studied may prove very helpful:

Therefore	*consequently*
Hence (initialsentence position)	*with the result that…*
Whence (= from where --> mid-sentence position)	*as a result*
Thus	*so that*
To result in…	*lead to*